



**International Council for Research and  
Innovation In Building and Construction**  
CIB W070 Facilities Management and Maintenance

**Proceedings of the**



CIB W070 INTERNATIONAL CONFERENCE IN FACILITIES MANAGEMENT  
**FM IN THE EXPERIENCE ECONOMY**



**University of São Paulo - Escola Politécnica**  
**Department of Construction Engineering**  
**São Paulo, 13<sup>th</sup> – 15<sup>th</sup> September, 2010**

**Edited by**  
**Prof. Dr. Moacyr Eduardo Alves da Graça**

**CIB Publication 336**

CIB - International Council for Research and Innovation in Building and Construction

CIB Proceedings: Publication number: 336

CIB W070 2010 INTERNATIONAL CONFERENCE IN FACILITIES MANAGEMENT  
FM in the Experience Economy

Proceedings of the São Paulo 2010 CIB W070 International Conference, held in SESC-Pinheiros, São Paulo, Brasil.  
13<sup>th</sup> – 15<sup>th</sup> September, 2010

Edited by Alves da Graça, Moacyr Eduardo, Escola Politécnica, University of São Paulo  
© 2010 Escola Politécnica, University of São Paulo  
Printed in Brazil (September, 2010)

All rights reserved. No part of this book may be reprinted or reproduced or utilized in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying and recording, or in any information storage or retrieval system without permission in writing from the publisher.

The publisher makes no representation, express or implied, with regard to the accuracy of the information contained in this book and cannot accept any legal responsibility or liability in whole or in part for any errors or omissions that be made.

The reader should verify the applicability of the information to particular situations and check the references prior to any reliance thereupon. Since the information contained in the book is multidisciplinary, international and professional in nature, the reader is urged to consult with an appropriate licensed professional prior to taking any action or making any interpretation that is within the realm of a licensed professional practice .

Published by  
Department of Construction Engineering  
Escola Politécnica, University of São Paulo  
São Paulo  
Brasil

Further Copies may be ordered by contacting:

Prof. Dr. Moacyr Eduardo Alves da Graça  
Department of Construction Engineering  
Escola Politécnica, University of São Paulo  
Email: moacyr.graca@poli.usp.br

CIB W070 INTERNATIONAL CONFERENCE IN FACILITIES MANAGEMENT  
**FM IN THE EXPERIENCE ECONOMY**

13 - 15 SETEMBRO 2010 - SÃO PAULO - BRASIL  
ESCOLA POLITÉCNICA DA UNIVERSIDADE DE SÃO PAULO



**CIB W070 2010**  
**SÃO PAULO - BR**

Organization:



# Conference Organization

## Conference chair

**Moacyr Eduardo Alves da Graça**, Professor, Escola Politécnica, University of São Paulo, Brazil  
Coordinator of MBA/USP Facilities Management

## Joint CIBW070 Coordinators

**Danny Shiem-Shin Then**, Associate Professor, Hong Kong Polytechnic University  
**Edward Frank Finch**, Professor, University of Salford, UK

## Scientific Committee Members

**Ad Straub**, Senior Researcher, TU Delft, The Netherlands  
**Danny Shiem-Shin Then**, Associate Professor, Hong Kong Polytechnic University  
**Edward Frank Finch**, Professor, University of Salford, UK  
**Elzbieta Trocka-Leszczynska**, Associate Professor, Wroclaw Technical University, Poland  
**Goksenin Inalhan**, Assistant Professor, Istanbul Technical University, Turkey  
**Igal Shohet**, Associate Professor, Ben-Gurion University, Israel  
**Jan Bröchner**, Professor, Chalmers University of Technology, Göteborg, Sweden  
**John Smallwood**, Professor, Nelson Mandela Metropolitan University, South Africa  
**Justine Cooper**, Research fellow, University of Greenwich, UK  
**Kathy Roper**, Associate Professor, Georgia Institute of Technology, USA  
**Keith Jones**, Professor, University of Greenwich, UK  
**Kenji Motohashi**, Head professor, Building Research Institute, Japan  
**Michael Fenker**, Research fellow, School of Architecture Paris-la-Villette, France  
**Michael Pitt**, Professor, Liverpool John Moores University, UK  
**Moacyr Eduardo Alves da Graça**, Professor, Escola Politécnica, University of São Paulo, Brazil  
**Paul Dettwiler**, Associate Professor Zurich University of Applied Sciences, Switzerland  
**Qi Zhou Moss**, research fellow, University of Salford, UK  
**Rogério Fonseca Santovito**, Research fellow, Escola Politécnica, University of São Paulo, Brazil  
**Sarel Lavy**, Assistant Professor, Texas A&M University, USA  
**Svein Björberg**, Professor, Norwegian University of Science and Technology, Trondheim, Norway  
**Tore Haugen**, Professor, Norwegian University of Science and Technology, Trondheim, Norway

## Organizing Committee

**Cláudia Miranda de Andrade**, MBA/USP Facilities Management, São Paulo, Brazil  
**Danny Shiem-Shin Then**, Associate Professor, Hong Kong Polytechnic University  
**Edward Frank Finch**, Professor, University of Salford, UK  
**Moacyr Eduardo Alves da Graça**, Professor, Escola Politécnica, University of São Paulo, Brazil  
**Paulo Eduardo Antonioli**, MBA/USP Facilities Management, São Paulo, Brazil  
**Rogério Fonseca Santovito**, Research fellow, Escola Politécnica, University of São Paulo, Brazil

# Table of Contents

Foreword: Dr. Danny Shiem-Shin Then	9
Foreword: Professor Eduardo Finch	11
Preface: Dr. Moacyr E. A. da Graça	13
Acknowledgements	15
<b>Session A - Key Notes</b>	<b>17</b>
<b>Designing for Experience - Implications for Real Estate and Facilities Management</b>	<b>19</b>
Professor Chris Voss, BSc (Eng), MSc (Econ), PhD, ARSM London Business School - London/UK	
<b>The “Office Code“</b>	
Izabel Barros, PhD Applied Research & Consulting - Steelcase Inc. - Rio de Janeiro/Brazil	21
<b>Session 1 - User experience and FM</b>	<b>23</b>
<b>Who is the user?</b>	<b>25</b>
OLSSON, Nils O.E.; BLAKSTAD, Siri Hunnes; HANSEN, Geir K. Norwegian University of Science and Technology	
<b>Usability Evaluations - User Experiences - Usability Evidence</b>	<b>37</b>
HANSEN, Geir Karsten; OLSSON, Nils; BLAKSTAD, Siri H Norwegian University of Science and Technology	
<b>Using user complaints in social housing for feedback in the product development process of construction projects</b>	<b>49</b>
BRITO, Juliana Nunes de Sá; FORMOSO, Carlos Torres Federal University of Rio Grande do Sul	
<b>User’s needs, desires and experiences: A comparative study of way-finding design in shopping malls</b>	<b>61</b>
INALHAN, Goksenin; TEMEL, M. Marina Istanbul Technical University	
<b>Adding value to users in hospital facilities management: a Brazilian experience</b>	<b>75</b>
SAFATLE, Daniella Kulaif; SANTOVITO, Rogerio Escola Politécnica - São Paulo University	
<b>Session 2 - Conceptual Models in FM</b>	<b>87</b>
<b>Facilities Manager = Innovation Manager?</b>	<b>89</b>
MOSS, Qi Zhou School of the Built Environment, University of Salford, UK	
<b>A Model For Assessing the Maturity of Facility Management as an Industry Sector</b>	<b>99</b>
BANYANI, Maulidi Abdallah; THEN, Danny. S.S. The Hong Kong Polytechnic University, Hong Kong SAR, China	
<b>The Business Process Outsourcing Strategy in Facilities Management</b>	<b>111</b>
MACEDO, Carlindo Martins Escola Politécnica da USP	
<b>Innovative Procurement and Partnerships in Facilities Management</b>	<b>123</b>
JENSEN, Per Anker Technical University of Denmark	
<b>A Conceptualisation for the Future Health Care Sector in Western Economies and its Relationship to Facilities Management</b>	<b>139</b>
HOFER, Susanne; DETTWILER, Paul Institute of Facility Management, Zurich University of Applied Sciences	
<b>The interfaces and impacts of designs, design management and scope at the facilities management</b>	<b>151</b>
MANESCHI, KAREN; B. MELHADO, SILVIO Escola Politécnica - USP - Construction Engineering Department	

<b>Session 3 - WWW - Work, Worker and Workplace</b>	<b>161</b>
<b>Experience of concentration or distraction: the cost to knowledge organizations</b>	<b>163</b>
JUNJA, Parminder; ROPER, Kathy O. Georgia Institute of Technology, Atlanta, Georgia, USA	
<b>Workplace preferences – does age make a difference?</b>	<b>175</b>
ROTHER, Peggine; LINDHOLM, Anna-Liisa; HYVÖNEN, Ari; NENONEN, Suvi Aalto University School of Science and Technology	
<b>Environmental preferences of office occupiers</b>	<b>191</b>
KARHU, Jessica; ROTHER, Peggine; FALKENBACH, Heidi; LINDHOLM, Anna-Liisa; HYVÖNEN, Ari; LAITALA, Ari Aalto University of Science and Technology	
<b>Offices - the need to design both the spatial and social configuration in new ways</b>	<b>203</b>
STEEN, Jesper Royal Institute of Technology, Sweden	
 <b>Session B - Key Note &amp; CIB W070 Open Forum</b>	 <b>213</b>
<b>Facility Management: A Crossroad</b>	<b>215</b>
Professor Kathy O. Roper Georgia Institute of Technology - Atlanta, USA	
<b>Facilities Management and Added Value: An Euro FM Research Initiative</b>	<b>217</b>
Per Anker Jensen Technical University of Denmark	
 <b>Session 4 - Case Studies in FM</b>	 <b>229</b>
<b>Samarco Mineração S.A. Case Study: a contract management tool applied to facilities</b>	<b>231</b>
PEREIRA, Monick Porto; RICARDO, Sergio; TOLEDO, Antonio; MERIGUETI, Fabio Samarco Mineração S/A	
<b>The Influence of the Structure and Work Organization o Service Delivery: a Case Study in Facilities Services</b>	<b>243</b>
JUNGMAN, Milton Accenture, Brazil	
<b>Facilities Management in Industries and the Master Service Catalogue as a tool to achieve a positive user experience</b>	<b>255</b>
CAMPOS, Mauro Sérgio Kyriazi Escola Politécnica da Universidade de São Paulo	
<b>ICT initiatives in primary education: the case of Plan Ceibal in Uruguay</b>	<b>267</b>
CARDELLINO, Paula <sup>1</sup> ; LEIRINGER, Roine <sup>2</sup> <sup>1</sup> Facultad de Arquitectura, Universidad ORT, Montevideo, Uruguay <sup>2</sup> Construction Management, Chalmers University of Technology, Gothenburg, Sweden	
<b>A survey of Information Technology Applications in Palestine</b>	<b>281</b>
ENSHASSI, Adnan; ABED, Kaerm School of Civil Engineering, IUG, Palestine	
<b>Quality Management System applied to architecture offices: report on a Brazilian experience in the city of Rio de Janeiro</b>	<b>295</b>
SALGADO, Mônica Santos Federal University of Rio de Janeiro	
 <b>Session 5 - Sustainable Facilities Management</b>	 <b>307</b>
<b>Green Buildings and FM - A Case Study on How FM Influences the Environmental Performance of Office Buildings</b>	<b>309</b>
KYRÖ, Riikka <sup>1</sup> ; MÄÄTTÄNEN, Eeva <sup>1</sup> ; ANTTILA, Anna <sup>2</sup> ; LINDHOLM, Anna-Liisa <sup>1</sup> ; JUNNILA, Seppo <sup>1</sup> <sup>1</sup> Aalto University, Finland, <sup>2</sup> ISS Palvelut Ltd., Finland	
<b>The role and effectiveness of a formal sustainability policy in facilities management</b>	<b>321</b>
PRICE, Samantha Jayne <sup>1</sup> ; PITT, Michael <sup>1</sup> ; MARMOT, Alexi <sup>2</sup> ; TUCKER, Matthew <sup>2</sup> ; MCLENNAN, Peter <sup>2</sup> ; UCCI, Marcella <sup>2</sup> <sup>1</sup> Liverpool John Moores University <sup>2</sup> University College London	
<b>Sustainable Asset Management of Heritage Buildings</b>	<b>333</b>
JONES, Keith; LIAO, Hanwen School of Architecture & Construction, the University of Greenwich	
<b>Improvement Suggestions for Sustainability Certification – Standardization and FM</b>	<b>347</b>
SCHNEIDER, Daniela; LENNERTS, Kunibert Karlsruhe Institute of Technology (KIT), Germany	
<b>Facilities management and building's environmental performance</b>	<b>359</b>
DEGANI, CLARICE MENEZES; CARDOSO, FRANCISCO FERREIRA University of São Paulo	

<b>The AQUA-FCAV Built Environment Sustainability Certification: an approach to water management</b>	<b>371</b>
SANTOVITO, Carla Cristina; GONÇALVES, Orestes Marraccini Escola Politécnica, University of São Paulo, Brazil	
 <b>Session 6 - Special Topics in FM</b>	 <b>381</b>
<b>Influence of FM Factors on Location Decisions of Manufacturing Firms</b>	<b>383</b>
CIARAMELLA, Andrea <sup>1</sup> ; DETTWILER, Paul <sup>2</sup> <sup>1</sup> Dipartimento BEST, Politecnico di Milano, Italy <sup>2</sup> IFM, Zurich University of Applied Sciences, Switzerland	
<b>Performance-based procurement by the Dutch Governmental Buildings Agency</b>	<b>395</b>
STRAUB, Ad Delft University of Technology	
<b>Developing a categorization matrix of Key Performance Indicators (KPIs): A literature review</b>	<b>407</b>
LAVY, Sarel <sup>1</sup> ; GARCIA, John A <sup>2</sup> ; DIXIT, Manish K. <sup>1</sup> <sup>1</sup> College of Architecture, Texas A&M University, USA <sup>2</sup> Alpha Facilities Solutions	
<b>Risk Assessment of Ammunition Threats to Critical Infrastructures</b>	<b>421</b>
SHOHET, Igal M.; SCHENKER, Andras; BENDOR, Gabi Ben-Gurion University of the Negev, Israel	
<b>System transferability of Facility Management</b>	<b>435</b>
BANEDJ-SCHAFII, Mandana; LENNERTS, Kunibert Karlsruhe Institute of Technology (KIT), Germany	
<b>The Influence of Iranian Culture on the Attitude towards Built Asset Maintenance</b>	<b>447</b>
KIAIE, Maryamalsadat; JONES, Keith University of Greenwich, UK	
<b>Risk, culture, and implementing environmental health in facilities management</b>	<b>457</b>
LIEBER, Renato Rocha UNESP - University Estadual Paulista, Brazil	
 <b>Session C - Key Notes</b>	 <b>475</b>
<b>The Experience Economy Approach in the Real Estate Market</b>	<b>477</b>
Prof. Dr. João da Rocha Lima Escola Politécnica - University of São Paulo	
<b>Facilities Management - Coming of Age: What are the expectations?</b>	<b>479</b>
Professor Danny Shien Then The Hong-Kong Polytechnic University, China	
 <b>Session 7 - Urban Facilities Management</b>	 <b>481</b>
<b>Trends in Retail Centres Recycling Initiatives</b>	<b>483</b>
BAHARUM, Mohamad Rizal <sup>1,2</sup> ; PITT, Michael <sup>1</sup> ; RILEY, Michael <sup>1</sup> <sup>1</sup> School of Built Environment, Liverpool John Moores University <sup>2</sup> University Malaya	
<b>Heritage and management in the transformation of industrial canal zones: the case of B5 in The Netherlands</b>	<b>495</b>
CURULLI, Irene <sup>1</sup> ; KOOLEN, Gertjan <sup>2</sup> <sup>1</sup> Eindhoven University of Technology, The Netherlands <sup>2</sup> Province Northern-Brabant, Department of Strategic Planning, The Netherlands	
<b>Inclusive Tourism and Barrier free Istanbul European Capital of Culture</b>	<b>511</b>
JNALHAN, Goksenin <sup>1</sup> ; SUNGUR ERGENEOGLU, Asli <sup>2</sup> <sup>1</sup> Istanbul Technical University <sup>2</sup> Yildiz Technical University	
<b>Gentrification and city improvement districts: a case study of residents' perceptions in Claremont, South Africa</b>	<b>525</b>
CATTELL, Keith; MICHELL, Kathy; BOWEN, Paul; FLORENCE, Tim University of Cape Town	
<b>The effects of studentification on the residential neighbourhood of a university suburb: A study of the University of Cape Town in Rondebosch</b>	<b>543</b>
ORDOR, Uche; CATTELL, Keith; MICHELL, Kathy; BOWEN, Paul University of Cape Town	

<b>Session 8 - ISTP - Input Savings Technologies and Processes</b>	<b>557</b>
<b>Efficiency assessment of thermal environment for Grade A air-conditioned offices in Hong Kong</b>	<b>559</b>
WONG, Ling Tim; HUI, Pui Shan; MUI, Kwok Wai; CHEUNG, Chin To The Hong Kong Polytechnic University	
<b>State of Standardization in Embodied Energy Computation: The need for a Protocol</b>	<b>571</b>
DIXIT, Manish Kumar; FERNÁNDEZ-SOLÍS, Jose; LAVY, Sarel; CULP, Charles Texas A&M University, USA	
<b>Examination of existing facilities management approaches to climate change</b>	<b>585</b>
DESAI, Apeshka; JONES, Keith University of Greenwich, UK	
<b>Building energy management support system for managing the facilities of individual departments within universities</b>	<b>597</b>
TU, Kung-Jen; LIN, Cheng-Hong; LAI, Jing-Fen National Taiwan University of Science and Technology	
<b>BIM server for HVAC energy consumption simulations: new data structure and interfaces for a popular application</b>	<b>615</b>
FERREIRA, Sérgio Leal; PETRECHE, João Roberto Diego; LEITE, Brenda Chaves Coelho Escola Politécnica da Universidade de São Paulo, Brazil	
<b>The water demand management throughout twelve years of the Water Conservation Program of the University of São Paulo</b>	<b>629</b>
SILVA, Gisele Sanches da; TAMAKI, Humberto Oyamada; GONÇALVES, Orestes Marraccini Polytechnic School, University of São Paulo, Brazil	
<b>Session 9 - Maintenance and Maintainability</b>	<b>641</b>
<b>The contribution of the pedestal paving system to building maintainability</b>	<b>643</b>
BERNARDES, Mauricio; BARROS, Mercia Maria S.B. University of São Paulo, Brazil	
<b>Facilities Management for Building Maintainability: A Research Framework</b>	<b>655</b>
LAU, Wai Kin; HO, Daniel Chi Wing The University of Hong Kong	
<b>Feedback of architectural projects with base in studies of pathological manifestations in buildings of structural masonry</b>	<b>671</b>
CARLINO, Alex Elias; MACENA FONTENELLE, Maria Ardenise UNICV - Universidade de Cabo UFSCar - Universidade Federal de São Carlos	
<b>Residential condominium study in João Pessoa city – Brazil concerning to maintenance</b>	<b>683</b>
MEIRA, Alexsandra Rocha <sup>1</sup> ; BATISTA, Ana Paula da Silva <sup>2</sup> ; FUZARI, Dayelly Gonçalves <sup>3</sup> <sup>1</sup> Federal Institute of Education, Science and Technology of Paraíba, Brazil <sup>2</sup> Federal University of Campina Grande, Brazil <sup>3</sup> Norberto Odebrecht, Angola	
<b>Maintenance in educational facilities – three public schools in São Paulo, Brazil</b>	<b>697</b>
FRANÇA, Ana Judite Galbiatti Limongi; ORNSTEIN, Sheila Walbe Faculty of Architecture and Urbanism, University of São Paulo, Brazil	
<b>Maintenance costs of condominiums in João Pessoa - Brazil</b>	<b>709</b>
MEIRA, Alexsandra Rocha; SANTANA, Djanice Silva de; SILVEIRA, Durwal Albuquerque da Federal Institute of Education, Science and Technology of Paraíba, Brazil	



## Foreword

### Dr Danny Shiem-Shin Then

Joint-Coordinator

CIB Working Commission W070

Facilities Management and Maintenance



The uninterrupted series of international symposia of The CIB Working Commission W070 on *Facilities Management and Maintenance* since its inception in 1979 is a stark reflection of the maturing and acceptance of an integrated management approach of built facilities as a business resource that is customer-focused and business-driven. The 2010 Sao Paulo Symposium's theme on *Facilities Management in the Experience Economy*, provides a focus on the service side of facilities management which is at the heart of the practice of FM, whether the experience is reflected in the delivery of hard or soft FM services, roll out of corporate workspace reconfigurations, efficient management of outsourced services or effective leveraging of operational facilities in corporate branding or recruitment and retention of staff.

Over the last three decades of my involvement with CIB W070 I have seen shifts in focus from technical considerations to management issues in relation to the physical assets (i.e. buildings) in the 1970-80s to integration of functional processes in the 1990s. In the 21<sup>st</sup> century, the emphasis seems to polarise towards a realisation that business outcomes have a better chance of being fulfilled when limited resources are appropriately combined to deliver set targets. In facilities management and maintenance, our efforts are often seen by the uninitiated as being reactive and defy effective management. Not so long ago the notion of innovations in FM seems alien to the business world which viewed FM as a necessary evil, labour intensive and a growing expense. Yet, in my opinion, it is the very diversity of facilities management that lends itself to innovative initiatives. With 98% of the existing built environment needing constant attention in upkeep and maintenance, and accountable for more than 50% of the energy consumed worldwide, the current push towards a more sustainable world in the future will mean that FM professionals are at the heart of initiatives that will make a difference towards a greener sustainable mother Earth.

Providing support to business achievements in terms of appropriate facilities and support services is core to facilities management, whether in-housed or externally sourced. The main differentiator of good facilities management is no longer technical competences but relies on skilful procurement and management of resources (people, property and technology), grounded on a thorough understanding of supporting business needs within a level of affordability.

The broadening acceptance of facilities management as a profession is already evident in six continents, apart from Antarctica. The skills set in facilities management potentially covers areas in strategic facilities planning; space planning and workplace strategies; asset management and maintenance; and facilities support services procurement and management. The creative potential in FM does not lie in looking at each of these areas in

isolation. FM innovations must emanate from new enabling processes, enhanced capabilities from new knowledge and new relationships between the various stakeholders. Clearly, there will be a period of adjustments in management culture and training before real benefits can be realised. But there is no denying that we are in a period of development that offers opportunities for FM to be embedded as an integrated part of an overall business planning process. For multi-national businesses, the facilities dimensions are not longer national in context; very often, corporate facilities issues are dealt with on a regional or even global scale.

Working Commission W070 has, and will continue to be, a unique forum for voicing or even debating changes in education and training, research and practice, new relationships between stakeholders. FM is clearly in the midst of transformations: from a traditional reactive-transactional role to one of the fastest growing profession and taking on a strategic role with responsibilities for a major business resource that is increasingly seen as critical in improving human productivity by leveraging the workplace environment through efficient and effective management of the built facilities. The continuing challenge of W070 is to remain relevant against this sea change brought about by convergence in digital and communication technologies and social transformation in lifestyles and nature of work in the future.

The content of the CIB W070 2010 São Paulo International Symposium clearly testify to the diverse scope of research in facilities management and asset maintenance. This, in my opinion, is a big plus for the growing band of FM academic and professionals around the world. I sincerely hope the Symposium meet up to your expectations as a forum of exchange of knowledge and practice.

On behalf of the CIB W070 2010 Organising Committee, I am particularly grateful for the generous local industry sponsorships and professional institutions within Brazil. In particular a special thank you to Professor Moacyr from the Civil Construction Engineering Department of the University of São Paulo in Brazil, for taking on the onerous task of hosting this first CIBW070 international conference in the continent of South America.

I would like to express my appreciation and thanks to members of the São Paulo 2010 Organising Committee and members of the Scientific Committee, and to all contributing authors for their valued contributions, without which this memorable international event would not have been possible. I thank you for your continuing support.

August 2010

Danny Shiem-shin Then

*Hong Kong, China*

Danny Shiem-shin Then, Associate Professor

Department of Building Services Engineering

The Hong Kong Polytechnic University

Hung Hom, Kowloon

Hong Kong, CHINA

Tel: (852) 2766 4558 Fax: (852) 2765 7198 Email: [bessthen@polyu.edu.hk](mailto:bessthen@polyu.edu.hk)

## Foreword

### Professor Edward Finch

Joint Coordinator of CIB W070

Director of the Centre for Facilities Management

University of Salford, UK



Two years is a short time. It seems like only last year that colleagues from CIB W070 last convened at the CIB W070 Symposium in Edinburgh. But the world since that time has changed significantly. Major global events have occurred. Soon after the conference of June 2008 we witnessed extraordinary turbulence in the economic markets. In October of that year, the U.S. President George W. Bush signed the Emergency Economic Stabilization Act, involving a 700 billion dollar Treasury fund to purchase collapsing bank assets. In January of 2009 Austria, Japan, Mexico, Turkey, and Uganda secured their seats on the United Nations Security Council. In the same month the Icelandic government and banking system collapse. In April of the same year we had the outbreak of influenza (swine flu) with the earliest reported cases from Mexico, succeeded by re-categorization of the outbreak as a global pandemic by June of the same year. By October the International Olympic Committee award the 2016 Summer Olympic Games to Rio, Brazil. By November 2009, in the Middle East, Dubai was requesting a debt deferment causing panic in the global markets. In December the UNFCCC's United Nations Climate Change Conference 2009 conference was held in Copenhagen, Denmark. This gave rise to the 'Copenhagen Accord' which was drafted by the US, China, India, Brazil and South Africa on December 18, and was judged a "meaningful agreement" by the United States government.

Yes, indeed the world is changing apace. Facilities management has changed accordingly, with a growing emphasis on cost reduction; sustainability; hygiene and health; security and growth in emerging global FM markets. With such change brings a need to understand the problems that we face and to innovate accordingly. Research and innovation within the facilities management profession continues to highlight new techniques and insights: this despite the poor recognition of the discipline as a legitimate holistic academic discipline. Government and state funding to support the discipline is often piecemeal, lacking focus. In the face of these challenges, it is perhaps surprising to see the energy and depth of work that persists at CIB W070 conferences. This year's symposium, hosted by the Escola Politecnica University of Sao Paulo is no exception. Academics from around the world take the opportunity to discuss their research findings. Such findings are often the fruits of many years of labor, beginning with a research grant or a kernel of an idea. Not only do we see a diversity of robust and novel research being presented: we also see the involvement of FM professionals. This is a particularly encouraging feature of facilities management in Brazil, where innovation is highly regarded and the findings of research are valued. It is hoped that such a lead will be followed

by other countries. It is with great anticipation that I attend this symposium. I hope that it will give rise to the signing of the 'Facilities Management' Accord – one which paves the way for a creative solution to the challenge which is the *experience economy*.

August 2010

Edward Finch  
*Salford, UK*

Prof. Dr. Edward Finch  
**University of Salford**  
**School of the Built Environment**  
Room 437B Maxwell Building,  
Greater Manchester, M5 4WT.  
+44 (0)161 295 7309

E.Finch@salford.ac.uk

## Preface

### **Prof. Dr. Moacyr E. A. da Graça**

Chairman of CIB W070 2010 – São Paulo - BR

Member of CIB Working Commission W070

EPUSP - Escola Politécnica, University of São Paulo

Coordinator of MBA/USP – Facilities Management



This is a year of reflection. It is the first year of a new decade. It is time to put oxygen in our lungs and run fast to a new vision.

Facilities Management can be described as ‘work in progress’. It is a dynamic activity with ‘ends’ and ‘means’ changing all the time. FM professionals need to be eclectic, with a solid view about global changes and their impact in FM. FM professionals must be pro-active people with knowledge in several disciplines. The main purpose of FM professionals is to make people’s lives easier, more efficient, more effective, safer, healthier, more productive, more comfortable and sustainable. This can be achieved by organizing all the infra-structure to support human activities in a diverse range of buildings in a diversity of places and environments. The FM activity is related to the entirety of people’s experience in all kind of places. The FM role is to transform the world into a better place to live. A better place to work, to shop, to study, to entertain: it is all we need and want. Technological development and growth of the Internet in the last decades has changed relationships between people all over the world. The change is here, to stay. People are connected and money movement occurs in a continuous flux. Nothing remains constant, values do not remain the same, and aspirations are inconstant. We are not the same. FM must change accordingly. The relationships between people and places are changing fast and the complexity of the systems variables is growing apace. We need to understand this new world and we need to develop the ability to manage complexity via the systems approach. FM is about managing complexity to improve the experience of the human condition in relation to the built environment. By doing so we assure that living will always be a better experience.

Welcome to the new world, welcome to the Experience Economy!

The theme of this conference “FM in the Experience Economy” was chosen because the organizing committee strongly believes that FM research and practice in the current decade will be focused on people’s experience in the built environment. This is because the world has changed and people and their feelings, perceptions, and sensations are becoming more and more selective, putting their aspiration level higher and higher. The emphasis is on people, life and the environment. This is a dematerialization process, breaking out from the constraints imposed by the industrial revolution.

FM is not a new activity, but it has been viewed as an activity where the focus has been on resources, processes, buildings, services, technology and people in order to fulfill user’s needs. Previously, it has been a passive behavior focusing on the supply side. FM was and is viewed in some organizations as a cost involving a lot of people that really do not contribute to the success

---

of the organization, only being concerned with the maintenance of the physical environment. We need to change this scenery, via perception of users, showing the effective FM action.

This implies that we need to open the way to demand management focusing on the user experience. We need to understand the user behavior, the user needs, the user experiences and more: we need to manage and systematize the user experience (in a broad sense). We need to learn how to design experiences. Good facilities management briefings with good design. We have the necessary tools but we need to put them to work. Research in this area is essential.

We need to practice FM which focuses on the User Experience (UX) , looking at the demand side, managing experiences and putting the resources to work .

I call this kind of action in FM practice: **UX FM – User Experience Facilities Management.**

The aim of this conference is the discussion of FM in the scenery of the Experience Economy.

The theme, discussed in all Key Notes, creates the basis for the discussions in the subsequent technical sessions.

This Symposium has been in preparation for two years, since Brazil was chosen to host the 2010 Conference (at the preceding conference in Edinburgh W070 Symposium in 2008).

The Conference Program includes 5 Key Notes from experts; approximately 50 technical papers presentations and the Open Forum.

Enjoy the Experience of CIB W070 2010 – São Paulo – Brazil!

August 2010

Moacyr E. A. da Graça  
*São Paulo, Brazil*

Prof. Dr. Moacyr E. A. da Graça  
Escola Politécnica da Universidade de São Paulo  
Departamento de Engenharia de Construção Civil  
Av. Prof. Almeida Prado, Trv. 2, no. 83  
Cidade Universitária – São Paulo – SP  
BRAZIL  
05508-900  
Phone: + 55 11 3091-5458;  
Fax: +55 11 3091-5715  
Cel: + 55 11 9293-8645

e-mails:  
moacyr.graca@poli.usp.br  
meag@tavola.com.br

## Acknowledgements

This Conference was made reality with the strong support of:

- PCC- Civil Construction Department of EPUSP
- EPUSP - Escola Politécnica, University of São Paulo
- FDTE – Foundation for the Engineering Technological Development
- SESC – Commerce Social Service – São Paulo
- CIB Secretariat

And the financial support from the sponsors:

- Design On
- Hines
- John Richard
- Jones Lang LaSalle

the support of the following institutions:

- ABRAFAC
- ANTAC
- ASHRAE
- CBCS
- CORENET
- GAS
- GRUPAS
- LARES

and the media support provided by:

- Buildings
- Infra
- Emerald

I would like to thank the members of the Scientific Committee for the review of all submitted papers. Thanks to the authors who are the core and the life of the Conference.

I would like to thank Amilcar Gay Filho from SESC by the support of the infra-structure of the event. I would like to thank Silvia, Cassius, Regina and Cleide from EPUSP and FDTE for their dedication making things happen.

I would like to thank Prof. Claudia Andrade and Prof. Paulo Antonioli from MBA/USP for their active participation in the Organizing Committee. I would like to thank Mea Pinas and Peggy Van Ash from CIB Secretariat for their effective support to our demands.

Sincerely thanks to all the people who cooperate for the success of this Conference.

Special thanks to Danny Then and Eddy Finch for the leadership of W070 and really effective participation in a lot of decisions via infinite number of e-mails.

Finally, this list would be incomplete without the thanks to my friend Prof. Rogerio Santovito from MBA/USP, who is working with me for 10 years, and who did his best, spending a lot of time and energy helping me to organize all things. Rogerio sometimes took my place when I was impeded to work in this especially difficult year to me.

Thank you all for everything.

August, 2010

Moacyr E. A. da Graça  
São Paulo, Brazil





## Session A - Key Notes

### Prof. Dr. Moacyr E. A. da Graça

EPUSP Escola Politécnica, University of São Paulo - MBA/USP FM - São Paulo/Brazil

### Designing for Experience - Implications for Real Estate and Facilities Management

19

Professor Chris Voss, BSc (Eng), MSc (Econ), PhD, ARSM  
London Business School - London/UK

### The “Office Code“

21

Izabel Barros, PhD  
Applied Research & Consulting - Steelcase Inc. - Rio de Janeiro/Brazil



## **Designing for Experience: implications for Real Estate and Facilities Management (\*)**

Professor Chris Voss, BSc (Eng), MSc (Econ), PhD, ARSM



Professor Chris Voss is professor of Operations and Technology Management at London Business School where he has been deputy dean and department chair. He gained his bachelor's degree from Imperial College, London and his MSc and PhD from London Business School. He is one of the leading researchers and publishers on service operations. In recent years he has made a particular study of the design and value of experiential services. His publications in the area have included: Innovation in Experiential Services, Experience and the Brand, Trends in the Experience and Service Economy – the Experience Profit Cycle, NSD Processes and Practices in Experiential Services and Service Design for Experience-centric Services. Professor Voss has been an advisor and consultant to many commercial and government organizations. He was founder and chairman of the European Operations Management Association and is a fellow of the British Academy of Management, Decision Science Institute, Production and Operations Management Association and the Royal Society of Arts.

(\*)Presentations are available for download in <http://www.fmresearch.co.uk/events.html>



## The “Office Code” (\*)

Izabel Barros, PhD



Dr. Izabel Barros is an expert on people-centered strategies for innovation and organizational effectiveness. Dr. Barros has over 20 years of experience as a professor and professional consultant in the development and implementation of innovation projects and change management. Native of Rio de Janeiro, Brazil, she has a Ph.D. degree from the Institute of Design, at the Illinois Institute of Technology, in Chicago (USA). Dr. Barros is also a certified engineer with Masters’ degrees in both Product Design and Production Engineering. In the education arena, she has headed the Office for International Affairs and The School of Technology at the University of Amazonas, in Manaus (Brazil), where she was responsible for bridging research and innovation to industry. In the same University she was a professor of Design and Ergonomics, at the Department of Design, and acted as Visiting Professor in Germany and in the USA. She has lectured extensively in Brazil, United States and Europe, and is the author of several articles and publications. Currently she is the leader of the Applied Research & Consulting team in Latin America at Steelcase Inc., headquartered in Michigan (USA), where she delivers projects related to innovation, knowledge capital, change management and the strategic uses of the work environment.

(\*)Presentations are available for download in <http://www.fmresearch.co.uk/events.html>



## Session 1 - User experience and FM

**Prof. Dr. Per Anker Jensen<sup>1</sup> & Prof. Dr. Moacyr E. A. da Graça<sup>2</sup>**

<sup>1</sup> Technical University of Denmark - Centre for Facilities Management - Lyngby/Denmark

<sup>2</sup> EPUSP Escola Politécnica, University of São Paulo - MBA/USP FM - São Paulo/Brazil

### **Who is the user?**

25

OLSSON, Nils O.E.; BLAKSTAD, Siri Hunnes; HANSEN, Geir K.  
Norwegian University of Science and Technology

### **Usability Evaluations - User Experiences - Usability Evidence**

37

HANSEN, Geir Karsten; OLSSON, Nils; BLAKSTAD, Siri H  
Norwegian University of Science and Technology

### **Using user complaints in social housing for feedback in the product development process of construction projects**

49

BRITO, Juliana Nunes de Sá; FORMOSO, Carlos Torres  
Federal University of Rio Grande do Sul

### **User's needs, desires and experiences: A comparative study of way-finding design in shopping malls**

61

INALHAN, Goksenin; TEMEL, M. Marina  
Istanbul Technical University

### **Adding value to users in hospital facilities management: a Brazilian experience**

75

SAFATLE, Daniella Kulaif; SANTOVITO, Rogerio  
Escola Politécnica - São Paulo University





## Who is the user?

**Nils O.E. Olsson**

Norwegian University of Science and Technology  
nils.olsson@ntnu.no

**Siri Hunnes Blakstad**

Norwegian University of Science and Technology  
siri.blakstad@ntnu.no

**Geir Karsten Hansen**

Norwegian University of Science and Technology  
geir.hansen@ntnu.no

### Abstract

This paper elaborates on the user concept. There have been tendencies towards a simplification in how users are addressed. Most discussions about users tend to more or less implicitly assume that there is only one group of users. We challenge this view. To illustrate our claims from an empirical perspective, we have mapped user categories in a number of different projects, both in briefing, design and construction as well as in use. As a background, we have studied how different user categories have been addressed in some stakeholder literature. Our research is based on a case study of user structures related to a number of buildings. For each case, we have mapped the different stakeholders that were involved in different parts of the project lifecycle as user representatives. Multiple sources of information are used, including document studies, interviews and observations. This paper is part of ongoing work to develop the theoretical and methodological foundation for usability of buildings. Previous studies have shown that in order to assess usability, one has to focus on the effect of the building on the user organization's fulfilment of goals, and end users satisfaction and experience. Most literature on stakeholder management focuses on users as one easily defined and homogenous group. Our results indicate that there are several types of users. While the question "Who is the user?" is easy to answer in some cases, it requires a more differentiated answer in other cases. The research is limited to the Norwegian experiences. The true value of buildings is to support and shelter their users. To both users and owners, it is this ability that creates long term value of buildings. Usability can be understood as the extent to which a building can be used by users to achieve goals with regards to effectiveness, efficiency and satisfaction.

**Keywords:** Usability, user, representation, buildings

# 1. Introduction

## 1.1 Background

Usability can be understood as the extent to which a product (or in our case, a building) can be used by users to achieve specific goals in a specified context with regards to effectiveness, efficiency and satisfaction (ISO 9241-11). Usability is therefore related to fulfilment of user needs. This raises the question “Who is the user?” In our studies of usability we have noticed that the user perspective may vary between different user groups and levels (Hansen and Knudsen 2006, Blakstad et al. 2010). In this paper we aim at investigating who the user really is, or rather who the users are. We have mapped user categories in three case studies of different projects, both in briefing, design and construction as well as in use. This paper is part of the ongoing work to develop the theoretical and methodological foundation for Usability of buildings.

More specifically, the purpose of this paper is to:

- Give an introduction to how the user roles has been discussed in previous studies
- Propose a model for categorisation of different types of user roles
- Utilise the categorisation to illustrate which users that have been involved in different phases of the studied projects
- Discuss to what extent a categorisation of user roles can support future work on usability

## 1.2 Method

In recent years theory, methods and tools for evaluation of usability of buildings have been developed (e.g. CIB 2005, Jensø et al 2004, Hansen et al 2005, Hansen and Knudsen 2006, Alexander 2008, Fenker 2008, Blakstad et al 2008, Nenonen et al 2008, Blakstad et al 2010, Hansen et al 2010). This paper is intended as an elaboration of this work.

We have mapped user categories in a number of different projects. This study is a case study based on trailing research (Finne et al. 1995). In the terminology of Yin (2003), this is a multi case study. The research is based on studies of three Norwegian building projects in both the private and public sectors. For each case, an analysis was made of which stakeholder that were involved in a user perspective. Multiple sources of information are used, including archives, interviews and observations. In order to analyze the information related to the buildings, codified data were entered into a database. The codification has been reviewed across the cases by the research team in order to achieve a uniform coding. We have strived to illustrate

variations between different buildings, and the studied cases were selected with this in mind. In addition, user participation may differ through different project phases. We base the analysis on the following general project phases (based on PMI 2008):

- Initialisation
- Planning
- Project execution
- User in normal operation

## 2. User categories

Usability is defined as “the extent to which a system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use”.

Users are stakeholders. Freeman (1984) discussed stakeholders as groups and individuals who can affect an organization. PMI (2008) defines stakeholders as individuals and organizations who are actively involved in a project, or whose interests may be positively or negatively affected as a result of project implementation or successful project completion. According to Atkin and Skitmore (2008) and Winch (2010), stakeholders can be divided into internal and external. Internal stakeholders are directly involved in a project, while external stakeholders are not directly involved in the decision making, but are influenced anyway by a project.

We have studied how different user categories have been addressed in some stakeholder literature (including Pinto and Slevin, 1988; Frooman 1999; Jones and Wicks 1999; Samset 2003; McElroy and Mills 2003; Atkin and Skitmore, 2008; Vischer, 2008; Jepsen and Eskerod, 2009; Winch 2010). We find that most literature on stakeholder management focuses on users as if the users are one easily defined and homogenous group. However, there are categorisations of user roles. Kernohan et al (1992) make a distinction between stakeholders at the demand and the supply side, and defines three different kinds of users: occupants, visitors and owner(s) / tenants organizations. Alexander (2003) highlight two important roles representing the users side in Facilities management; the intelligent client and the informed buyer. In Norwegian facility management literature, three fundamentally different roles are described: The user, the owner and the facility manager (NOU 2004, Haugen 2008, Sæbøe and Blakstad 2009). In the following we will use the two first categories (owner and facilities manager) and add a more differentiated “user”-category in order to develop a more nuanced terminology.

To illustrate user roles, we propose a model that differentiates “users” into different categories. We have elaborated on this categorisation of user roles, and have chosen a supply chain

approach. In the supply chain approach, services are produced, originating in a building. We therefore look for customers in a number of steps of the supply chain, originating in the building itself, then focusing on activities taking place in the building. Buildings have owners, even though they may not be directly involved in the operations that take place in the buildings.

Facilities management personnel work directly related to a building and supporting facilities in the building. This means responsibility for facilities management, maintenance etc. – in many ways at the “supply side”, acting on behalf of the users. At the same time the FM service providers are actual users of the building as they are performing service to the other user groups in the building, usually labelled as the “demand side”

The customers of facilities management are in essence the service providing organisation, typically an organisation based in the building. It may be practical to differentiate between management of the service providing organisation, and the employees providing the service. Typical examples of service providers include teachers in a school, doctors and nurses in a hospital and bank clerks in a bank, while the management would be headmasters, hospital management and bank executives. The management represents the strategic level in the user organisation, presumably acting on behalf of the organisation as a whole.

The customers of the service providers can be termed service receivers. These are users benefitting from the service provided by the previous user group. They are typically customers to the service provider. Typical examples include pupils in a school, patients in a hospital and customers of the bank.

Services can be provided to several stakeholders. We propose to include users with a relation to the (direct) service receivers, calling them indirect service receivers. This is a group of people with a relation to the service receivers, such as customers of the service receivers, or having some other relation to the service receivers. Examples are parents who have children in a school, relatives of patients in a hospital, or business relations to the customers of a bank.

Note that the sequence does not imply any judgement of relative importance of the users. In addition, we do not intend to categorise “end users” or “main customer” or similar prioritisation. As a summary, we propose the mentioned user categorisation, and have used it in the study to illustrate how such a model can be used. The user categories are:

- Owners
- Facilities management and service personnel (operating the building)
- Management of the organization based in the building
- Service providers
- Service receivers

- Indirect service receivers

### 3. User involvement

Both theory and practice in building design highlights the importance of involving users and their experience in briefing and design. In the theory of briefing and participatory design, user involvement is described as crucial in order to both specify demands, as well as to make the most out of the new facilities (e.g., Duffy 1990, Kernohan et al 1992, Horgen et al 1999, Blyth and Worthington 2001, Gjersvik and Blakstad 2004a and b, Duffy and Worthington 2004, Våland 2010). In many cases, user involvement is related to both new facilities and new work processes and organization, because organizations commonly link organizational change with physical changes in the facilities (Olsson 2006, Henriksen et al. 2006).

Våland (2009) divides the different theoretical concepts of user involvement in design processes as: Participatory design, user-centred design and ethnography in design. Jensø (1999) discusses involvement in two perspectives: user as expert and user as representative. The expert is the knowledge provider, to facilitate right decisions. User representatives act on behalf of those who intend to use the result of the project. User representatives take part in the decision making. Through their participation, they contribute to the justification and legitimisation of decisions. In doing so, user involvement can avoid later protests and disagreements with the design outcome. Users as representatives can be a tool to achieve democracy in the working environment (Trist & Bamforth 1951, Emery & Thorsrud 1976). User involvement is a part of the Norwegian working environment act (Arbeidsmiljøloven 2006).

It is important to be aware of the distinction between the two roles as expert and representative. In one particular situation, one user representative may to a certain extent have both roles, and they can be difficult to distinguish and to combine. In particular, it is the representative role which can be challenging. In a best case user involvement can serve as a tool for democracy, in a worst case the user representative can be seen as alibis in a larger process (Henriksen et al. 2006). The expert role is usually easier for the individual, because the users only provide their professional opinion, and are usually to a lesser extent blamed for the final decision, especially if the final outcome is not according to their recommendations.

We find that not only are users a diverse group of people, user representatives are also diverse related to who they are, what role they have and the degree of involvement.

## 4. Case studies

### 4.1 St Olavs Hospital in Trondheim

The plan for a new university hospital in Trondheim was made in 1991, which was approved by the Norwegian Parliament in 1993. In 2002 the parliament decided to build the university hospital at its current location based on the plans for Phase 1 of the building programme. The first phase of the construction of the new hospital in Trondheim, consisting of four centres making a total of app. 90 000 m<sup>2</sup>, was completed on August 6th 2006. Phase 2, consisting of six centres is planned for completion in 2011/2012. To begin with, the project was organised under the local county. A health care reform was carried out during the project planning, moving responsibility for providing health care services from the counties to five regional health authorities.

In the case of St. Olavs hospital, it is the Central Regional Health Authority which is responsible for operation of the hospital. A temporary public organisation called Hospital Development Project for Central Norway is responsible for construction of the hospital on behalf of the Central Regional Health Authority. During planning, user representatives for hospital and university staff and patients were involved. An important vision in this project was the patient-focused care concept, and that both the building project and the organisational development should take the patient perspective into account in the briefing and design. Involving patients was an important aspect of the patient-focused care concept. Especially hospital staff (including nurses) got tightly involved in the planning as professional user representatives. The involvement got so far that one could question whether the representatives were the user's representatives in the project, or the project's representatives towards other users. Future facilities management personnel were also involved in planning. In hospitals, the service receivers are mainly the patients who get treatment. Patient representatives were also involved, mainly through patient interest organisations, but in some occasions also as individuals. Indirect service receivers include relatives.

### 4.2 Nord Trøndelag University College. Nylåna, Røstad

Nord Trøndelag University College campus is located close to the centre of Levanger, a small town north of Trondheim. The campus has a complex group of buildings, totally 28.000 m<sup>2</sup>, of varying age and use. 2500 students and employees have their daily work at the campus. The case study Nylåna with offices for administration and teaching facilities has a total area of 10.800 m<sup>2</sup> including offices for administration and teaching facilities. The planning process was initiated in 1992 by an open architectural competition. Lack of funding led to a long planning phase. The building was completed in August 1999.

The ownership of the building is the Norwegian Directorate of Public Construction and Property (Statsbygg). Statsbygg is responsible for organising, planning and completing building projects

within set frameworks for budgets, time limits and quality. The responsibility of facilities management, operations and maintenance is divided in two; the Statsbygg regional office taking care of building and property related aspects, and the University College own service personnel taking care of equipment, furniture, cleaning, security and other services. Every Statsbygg project shall establish a contact group with representatives from the owner (department), users and Statsbygg to support the involvement of the users. To fulfil requirements in The Working Environment Act, the labour organisations should also be represented in the group.

Service providers are teachers and staff at the University College. In this project, three different departments relocated into one building. The user group was pointed by the three departments. Starting up, the user organization consisted of one user representative and the head of the department from faculty. User participation in the project was ensured through the user coordinator participating in the design meetings. The user coordinator came from the internal facilities management staff. Service receivers are students, who were involved in the user groups. Indirect service receivers are a somewhat lesser obvious group in this case. Norwegian students do not pay tuition fees, but parents of students are still indirect service receivers. Future employers of the students may also be in this category. These users were not involved.

When the planning and construction processes go on for several years, it is a challenge to establish continuity. Both the project management and the user organization had several changes of personnel, which caused frustrations among the participants in the process. The changes of persons involved also caused changes in the priorities on user demands and requirements and preferences when coming to design solutions.

### **4.3 Freight terminal**

Oslo's new airport was opened in 1998. An airline company made an investment in the new freight terminal, which was build on leased land in the airport area. The airport authority owns the land where the airport is located. The investment was managed by the air freight business unit of the airline. The airline had established an own project management organization, with senior representatives from all involved business areas. The airfreight business unit operated the freight terminal mainly by themselves, but some services were outsourced. In addition, there were service agreements with the equipment suppliers. The local airfreight business unit was divided into two parallel units – one for operation and one for sales and marketing. Both units utilized the freight terminal. Users from both units were involved in planning of the new terminal. In addition, labour unions were involved. A planning group was established, with a mix of experienced users and management representatives.

Service receivers of the freight terminal were mainly shipping agents but also individual businesses who booked air freight for their own goods. The largest customers were involved in preparations, but mainly on a management level and to a lesser extent as individual user representatives. Indirect service receivers include both good receivers and goods senders, both

Table 1. Different user categories in the studied projects.

Project phase	Case	Owner	Building operation, facilities management	Management of organisation based in the building)	Service providers	Service receivers	Indirect service receivers
initialisation	<i>St Olav's</i>	<i>Municipality</i>	<i>Facilities management</i>	<i>Hospital management</i>			
	<i>Nålåna</i>	<i>Ministry of Education</i>		<i>Head of the University college/dept.</i>			
	<u>Freight terminal</u>	<u>Airline top management</u>					
Planning	<i>St Olav's</i>	<i>Regional health care company</i>	<i>User represent. Facilities management</i>	<i>Hospital management</i>	<i>User represent. hospital staff</i>	<i>User represent. patient organisations</i>	
	<i>Nålåna</i>	<i>Statsbygg</i>	<i>User represent. Facilities Management</i>	<i>User represent. teachers and admin. staff</i>	<i>User represent. from students</i>		
	<u>Freight terminal</u>	<u>Airline top management</u>		<u>Local management</u>	<u>User representatives</u>	<u>Mail distributors</u>	
Project execution	<i>St Olav's</i>	<i>Regional health care company</i>		<i>Hospital management</i>	<i>Full time user representatives</i>		
	<i>Nålåna</i>	<i>Statsbygg</i>		<i>User coordinator</i>			
	<u>Freight terminal</u>	<u>Airline top management</u>	<u>User representatives</u>	<u>Local management</u>	<u>User represent. and union represent.</u>	<u>Mail distributors, Forwarding agents</u>	
User in normal operation		<i>Regional health administration</i>	<i>Facilities management department of the hospital</i>	<i>Hospital management</i>	<i>Hospital staff</i>	<i>Patients</i>	<i>Relatives to patients</i>
	<i>Nålåna</i>	<i>Statsbygg/ Internal FM</i>	<i>Statsbygg / Internal FM organisation</i>	<i>Head of the University college</i>	<i>Teachers and administrative staff</i>	<i>Students</i>	<i>Visitors, users of conferences</i>
	<u>Freight terminal</u>	<u>Airline top management</u>	<u>Airline facilities management dept. and suppliers</u>	<u>Local management</u>	<u>Airline freight staff</u>	<u>Mail distributors, Forwarding agents</u>	<u>Owners of goods to be transported</u>



who could be customers of the shipping agents or to the airline directly. Table 1 shows that in the studied cases, owners and management of service providers usually are involved in all phases of the preparations, and are typically the only ones involved in the early phase. From the planning phase, service providers got involved, and in some cases service receivers. Facilities management were somewhat involved in planning, but to a lesser extent than service providers. However, involvement was rarely in the briefing part, but on a more conceptual level. Indirect service receivers got engaged with the buildings in the operations phase.

## 5. Concluding discussion

We began by studying how the user roles has been discussed in previous studies. As we elaborate on the user concept, we find that there are many aspects of the term “user”. It is our impression that the diversity in the user concept has not always been fully acknowledged. In practice and literature, there have been tendencies to towards a simplification in how users are addressed. It is sometimes more or less implicitly assumed that there is only one homogenous group of users. We propose a model for user categorisation based on a supply chain approach. In the supply chain approach, services are produced, originating in a building. The proposed model has been utilised the categorisation to illustrate which users that were involved in different phases of the studied cases. We believe that our proposed categorisation model did serve a purpose in structuring the users. Even though the cases are related to different types of buildings with different types of users, the proposed general user roles were found in the studied cases. In addition, user representatives vary extent throughout the processes, crating discontinuities in user involvement. While the question “Who is the user” is easy to answer in some cases, it requires a more differentiated answer in other cases.

Our study shows that this type of categorisation of users can support future work on usability. The categorisation highlights different user roles and perspectives that can be included in different project phases. It may also visualise user groups that might not be included in a planning process, or discontinuities in user involvement. In a usability perspective, different tools for usability analyses may be needed when studying usability from different user perspective. The supply chain focus can contribute to a nuanced understanding of users and user needs in different parts of the supply chain. The supply chain perspective may also question the concept of “end user”, as users are seen as a set of users with different perspectives, rather than highlighting one particular user group as the most important.

Future studies should apply this type of categorisation model on a wider range of buildings and usability analysis situations. We found the pattern of facilities management - service providers - service receivers - indirect service receivers to be useful and appropriate. However, there is more work to be done to find more practical and nuanced categorisations of owners and other users less directly related to the building and services provided in a building. On the other hand, it may not be beneficial to all studies to aim at including all possible users. In that perspective, we hope that our proposed model highlights the commonly most important user roles.

## References

Alexander K (2003) A strategy for facilities management. *Facilities*. Volume 21, number 11/12 pp 269-274

Alexander K (2008) Usability: philosophy and concepts. In *Usability of Workplaces, Phase 2. CIB W111 research report*.

Arbeidsmiljøloven (2006) *Lov om arbeidsmiljø, arbeidstid og stillingsvern mv. (arbeidsmiljøloven)*. (Working environment act). <http://www.lovdatab.no/all/nl-20050617-062.html>. Retrieved 22.2.2010

Atkin, B, Skitmore, M. (2008) Editorial: Stakeholder Management in Construction. *Construction Management and Economics*. 26(6) pp 549-552

Blakstad S H, Hansen G K, Knudsen W (2008) Methods & tools for evaluation of usability in buildings. In *Usability of Workplaces, Phase 2. CIB W111 research report*.

Blakstad S H, Hansen G K, Olsson N, Knudsen W (forthcoming) Usability Mapping Tool. Paper, *CIB World Congress, Manchester 2010*.

Blyth A, Worthington J (2001) *Managing the brief for better design*. Spon Press UK

CIB (2005) *Usability of workplaces, report on case studies*. Rotterdam, Netherlands, International Council for Research and Innovation in Building and Construction.

Duffy F, Worthington J (2004) *Working without walls. An insight into the transforming government workplace*. DEGW and the Office of Government Commerce. [http://www.ogc.gov.uk/documents/cp0039\\_working\\_without\\_walls.pdf](http://www.ogc.gov.uk/documents/cp0039_working_without_walls.pdf), retrieved 27.5.2010

Emery, F, Thorsrud, E. (1976). *Democracy at Work. The Report of the Norwegian Industrial Democracy Program*. Martinus Nijhoff Social Sciences Division, Leiden.

Fenker M (2008) Towards a theoretical framework for usability of buildings. In *Usability of Workplaces, Phase 2. CIB W111 research report*.

Freeman, R. E. (1984). *Strategic management: A stakeholder approach*. Boston: Pitman Publishing.

Finne, H, Levin, M, Nilsen T. (1995). *Trailing research A model for useful program evaluation*, IFIM-paper 4/95, Trondheim: SINTEF IFIM/Jeff Frooman. Stakeholder Influence Strategies. *The Academy of Management Review*, Vol. 24, No. 2 (Apr., 1999), pp. 191-205

ISO 9241-11:1998 Ergonomic requirements for office work with visual display terminals (VDTs) -- Part 11: Guidance on usability.

Jensø, M, Hansen, G K, Haugen T, (2004), Usability of buildings. Theoretical framework for understanding and exploring usability of buildings. Paper, *CIB W70 Hong Kong International Symposium, Facilities Management & Asset Maintenance, "The Human Element in Facility Management"*, December 2004.

Jepsen, A.L., Eskerod, P., (2009) Stakeholder analysis in projects: Challenges in using current guidelines in the real world. *International Journal of Project Management*. Volume 27, Issue 4, May 2009, Pages 335-343

Jones, T. M, Wicks, A.C.(1999). Convergent Stakeholder Theory. *The Academy of Management Review*, Vol. 24, No. 2 (Apr., 1999), pp. 206-221

Gjersvik R., Blakstad S H (2004a) Towards Typologies of Knowledge Work and Workplaces. In *Facilities Management. Innovation and performance*, ed. Alexander et al. London, SPON press.

Gjersvik R., Blakstad S.H. (2004b) Designing knowledge work space: Archetypes of professional service work as a tool for change. In *Living knowledge. The dynamics of professional service work*, ed. Carlsen A et al. Palgrave Macmillian. UK.

Hansen, G K, Haugen T, Jensø M, Knudsen W (2005) Case study: Nord-Trøndelag University College, Nylåna, Røstad. CIB Task Group 51, Usability of workplaces. SINTEF/NTNU.

Hansen, G. K., Knudsen W (2006) Usability – A matter of perspective. The case study of Nord Trøndelag University College. *CiB W70 Trondheim International Symposium, Changing user demands on buildings*. Trondheim 12. – 14. June 2006

Hansen G K, Blakstad S H, Knudsen W, Olsson N (forthcoming) Usability Walkthroughs. Paper CIB World Congress, Manchester 2010.

Haugen T I (2008) *Forvaltning, drift, vedlikehold og utvikling av bygninger. Temahefte 1: Facility Management*. Tapir forlag. Trondheim

Henriksen, B, Olsson, N, Seim, A. (2006). Adjustments, effectiveness and efficiency in Norwegian hospital construction projects?. *Proceedings CIB W70 Trondheim International Symposium. Changing User Demands on Buildings*, 12–14 June 2006, Trondheim, Norway.

Horgen T, Joroff M L, Porter W, Schön D A (1999). *Excellence by design. Transforming workplace and work practice*. John Wiley & Sons. US

Kernohan D, Gray J, Daish J, Joiner D (1992) *User participation in building design and management*. Butterworth-Heinemann. UK.

McElroy, B. Mills, C., (2003) Managing stakeholders. In: R.J. Turner, Editor, *People in project management*, Gower, Aldershot (2003), pp. 99–118.

Nenonen S, Rasila H, Junnonen J-M, Kärnä S (2008) Customer Journey – a method to investigate user experience. In Usability of *Workplaces, Phase 2. CIB W111 research report*.

NOU 2004:22 *Velholdte bygninger gir mer til alle*. Regjeringen.no. Oslo

Pinto, J.K. Slevin, D.P. (1988) Project success: definition and measurement techniques. *Project management journal*, Vol XiX, No 1

PMI. 2008. *A Guide to the Project Management Body of Knowledge: PMBOK® Guide*. Project Management Institute, Newton Square, PA.

Samset, K. (2003). *Project Evaluation – Making investments succeed*. Tapir Academic Press, Trondheim

Sæbøe, O E, Blakstad S H (2009) *Fasilitetsstyring. Verdiskaping – Verdiøkning - Verdibevaring. Temahefte 2: Eiendomsutvikling og forvaltning*. Tapir forlag. Trondheim

Trist, E, Bamforth, K.W. (1951). Some consequences of the Longwall method of coal getting. *Human Relations* 4:1, 3–33.

Yin, R.K. (2003). *Case Study Research: Design and Methods*. Sage, Thousand Oaks, CA/London/Dehli.

Våland M S (2009) End User Participation as an Input to Shape the Brief in Architectural Competitions. A Threefold Translation Process. *Nordic Journal of Architectural research* 2/3 2009, page 108 - 122

Våland M S (2010) *What we talk about when we talk about space: And User Participation between Processes of Organizational and Architectural Design*. PhD Thesis Copenhagen Business School.

Vischer, J.C., (2008) Towards a user-centred theory of the built environment. *Building research & information* (2008) 36(3), 231–240

Winch, G.M. (2010). *Managing Construction Projects – An information Processing Approach*. Blackwell Publishing, Chichester, UK

## Usability Evaluations – User Experiences – Usability Evidence

### **Geir Karsten Hansen**

Norwegian University of Science and Technology  
geir.hansen@ntnu.no

### **Nils O. E. Olsson**

Norwegian University of Science and Technology  
nils.olsson@ntnu.no

### **Siri Hunnes Blakstad**

Norwegian University of Science and Technology  
siri.blakstad@ntnu.no

### **Abstract**

In this paper, we elaborate and reflect on usability evaluations and the applicability of results for other projects. Usability evaluations are based on different user's experiences and assessments on how well the buildings perform. Evaluations are based on different methods and aspects, depending on objective, purpose, focus, competence and resources. Usability is defined as "*the extent, to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.*" (NS-EN ISO 9241/1998). The paper is based on theory on evaluations methods and qualitative research. The empirical data is mainly from several case studies mainly from two Norwegian usability projects undertaken in the last 8 years. The case studies have covered a broad range of methods used in order to test their suitability related to the concept of usability and within a common methodological framework USEtool. The paper argues that usability evidence must be related to contextual understanding. Usability evaluations have to look on the interaction between architecture, technology and organisation. Previous studies have shown that in order to assess usability one has to focus on the effect of the building on the user organizations fulfilment of goals, as well as the end users satisfaction and experience. Theory affirms that context-dependent knowledge from case studies is not less valid than general theoretical (and context-independent) knowledge.

Usability evaluations give feedback on user experiences of their workplace. The value of such evaluations for feed forward to new projects or improving existing facilities mainly lies in the ability to understand the user experiences and to translate those into adequate products and solutions. Consequently, the results of research into evaluation needs to be translated into a form which will be quickly and easily accessible to clients, designers, decision makers and others involved in the building process.

**Keywords:** Usability, Buildings in use, Evaluation methods, Applicability

## 1. Introduction

Usability evaluations are based on different user's experiences and assessments on how well workplaces or buildings perform and are related to fulfilment of user needs. The concept of usability is recently adapted to buildings through the work in the CiB W111 Usability of workplaces, but has its origin in relation to applications within product design, information technology and web-design (Alexander, 2004). According to ISO 9241-11, Usability is defined as "*the extent to which a system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*" (ISO, 1998). An important approach to usability is that a product has value only insofar as it is used and whether it contributes to and supports the owners and users activities. By itself a product has no value. In this perspective buildings can be regarded as products or premises to achieve strategic goals such as enhanced productivity, reduced operating costs, increased innovation, knowledge exchange, or attractivity to clients and qualified workers to mention some. This is also in line with Joroff et al. (1993) who describes the real estate as the fifth resource for production. The approach of looking at buildings as a way to fulfil their strategic objectives and not only as a way to house people and activities is quite new and is supported by work of Becker and Steele (1995), Horgen et al. (1999) and Grantham (2000).

Traditional, most owners and occupants, as well as designers and constructors, seldom perform evaluations of how well their buildings perform related to usability aspects. A systematic evaluation of buildings in use should be an effective way not only to collect information, but more important, to produce knowledge both in relation to the planning of new buildings and for the development and change of existing buildings. According to Jensø et al. (2004), Blakstad et al. (2008) and Blakstad et al. (2010), evaluations should be based on different methods and aspects, depending on objective, purpose, focus, competence and resources. There are already many concepts, definitions and methods that are relevant to a buildings condition, standard and quality. Most of these look at the building as a physical object and do not associate the building with its usability. This view is supported by Alexander (2004) that claims that conventional approaches to building performance often focus on technical, functional, and operational aspects of their use. Testing functionality means making sure that the product works according to given specifications, while more important testing usability means making sure that people can find and work with the functions to meet their demands and needs. To be successful in use, a product's functionality will therefore be critical, but not sufficient.

Our main perspective is on usability's relation to organizational goals and output and the effect of the building. This means that methods for evaluation of usability will have to explore the user experience of buildings, the relationship between buildings and multiple users, the process and time, as well as the culture, work style, and goals of the organization. In this paper, we elaborate and reflect on usability evaluations and the applicability of results for other projects. The aim of the study has been to develop and test a methodology that the owners and users of buildings can use to assess usability in their own building portfolio. An important discussion is whether the results or findings from those evaluations can be considered as valid and reliable, and whether

context dependent knowledge from usability evaluations can be feed forwarded to new projects or be generalized and added to a more generally applicable body of knowledge.

## 2. Research methods and process

The work to apply the usability concept in building design, construction, management and use has been developed through a programme of action research, comprising an intensive series of case studies and associated workshops carried out both within the CiB W111 and in several national case studies representing a variation of companies and disciplines (Alexander et al 2004). Here we present the methodological discussion related to the process of developing and testing different methods to evaluate usability within a common framework named USEtool (Blakstad, 2010). This paper is based mainly on the experience from a number of Norwegian case studies in close collaboration with project partners, each providing a case that has been used for testing and developing methods and tools. Our cases have been university colleges, workplaces (offices) and secondary schools. We have had real users and stakeholders participating such as students, teachers, administration staff, representatives from owner and facilities management staff. The researchers and the project partners have been engaged in participatory workshops to develop the project's aims and approach to evaluation, as well as to reflect on the results of various tests of methods and tools. The aim of the testing has not been primarily to evaluate the actual workplaces or spaces as such, but to gain experience with use of the methods, tools and indicators as they were developed and refined. Several methods such as interviews, document analysis, structured group interviews, walkthroughs and workshops have been tested in cases and have been included in the USEtool handbook. As a part of the development process, also questionnaires such as ASTM and DQI have been tested. However, questionnaires are not part of the final set of methods in the USEtool handbook.

The presented research is based on an action research or applied research approach (Lewin, 1946). According to Johansson and Lindhult (2008), action research aims at combining research and development, through involvement of practitioners and users. Our work can also be described as a "real world enquiry" focusing on practice with the limitations and challenges this implies (Robson 2002). The validity, reliability and the generalizability of the methods in general will be discussed later in this paper.

## 3. Theoretical framework

Searching in literature, we find various approaches and understanding of terms associated with the use of buildings and quality of use. According to OECD (2000) an evaluation is defined as a '*Systematic and objective assessment of an ongoing or completed project, program or policy, its design, implementation and results*'. In general, we can distinguish between different approaches in ex post project evaluations. Evaluators, especially those who aim at including a user perspective typically prefer holistic evaluations based on a diverse set of approaches and indicators, typically combinations of quantitative and qualitative evaluations (OECD 2000).

Government agencies and municipalities often are expected to apply a socio-economic perspective, where benefits and costs are being processed to as great extent as can be defended scientifically (Sager 1991, Small 1999), while property investors typically apply the business perspective, which can be supported by a performance measurement approach (Olsson et al 2008).

Since the introduction of Post Occupancy Evaluation in the late 60s, several building evaluation tools have been introduced. According to Preiser et al (1988), a post-occupancy evaluation (POE) is: “*the process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time*”. Methods within the field of post occupancy evaluation focus on the users and their needs, and ideally include both physical, technical and psychosocial aspects and evaluations. Examples of this are Design Quality Indicators (DQI), ASTM and Buildings Use Studies (Leaman, and Bordass 2001). However, in practice, we have seen that most POE methods have focused on technical aspects, and less on the building’s relation to the users due to the fact that many methods for POE evaluate the building in relation to functional and technical requirements as evaluation parameters. A search in literature on building evaluation gives a number of different evaluation tools that have been developed in order to assess a certain design or building in use. Examples are ASPECT, BREEAN, ST&M, LEED, EPFS etc. Such methods often focus on specific and limited aspects such as building technology, health and safety, working environment or user satisfaction and well-being. Other methods are concerned with evaluation of the direct use of buildings (data of occupancy etc).

According to Steinke et al (2010) there is no industry-accepted definition of building evaluation, nor is there a standardized method for conducting such evaluation. In contrary, as shown in this paper, you find that the different building evaluation methods and tools range from specifically assessing limited aspects to generally assessing whole building design. In a study of Steinke et al (2010) the evaluation tools were categorized according to the dimensions of performance and user groups assessed using the following four categories;

- Service performance. Focus on enhancing the service experience for clients
- Functional performance. Focus on creating a quality work environment for staff
- Physical performance. Focus on physical design and technical performance
- Financial performance. Focus on financial efficiency.

From 17 building evaluation tools in this study, 16 tools covered physical performance, and others covered one or two categories within the same tool. Only one tool covered all the four dimensions simultaneously (Shiem-Shin Then, 2005). An overview of different tools can also be found in Baird et al (1996) and Voordt & Wegen (2005).

One of the interesting methods described, has been BPE, building performance evaluation, first presented by Preiser (1989) in the book Building Evaluation. The methods and focus in BPE



have moved towards a more holistic, process-oriented approach. This means that not only facilities, but also other aspects like organizational, economic, social and political aspects are taken into consideration. In 1997, the POE process model was developed into an Integrative Framework for Building Performance Evaluation (Preiser and Schramm, 1997), followed by other publications such as Learning from our Buildings (Federal Facilities Council, 2001), Improving Building Performance and Evaluating Building Performance in Healthcare Facilities; An organizational Perspective (Steinke et al, 2010). The last based on the established multidimensional framework Balanced Scorecard (Kaplan & Norton, 1996), developed to a conceptual model; The Building Performance Evaluation (BPE) Scorecard. The BPE Scorecard views facilities from four perspectives or performance dimensions, and allows a variety of existing evaluation tools to be incorporated into the methodology.

Chan, Beckman & Lawrence (2007) argues that in despite of a long tradition on studies on organizations, there has been relatively little systematic work linking the built environment with organization theory or vice versa. It seems that organizations rarely see the physical environments as an important factor to their business strategies. On the other hand we find literature that strongly underline the effect the built environment has on several aspects of organizational functioning (Becker, 1981), and the fact that the built environment defines the context in which work processes, services, social interactions and outcomes is taken place (Becker, 1981; Bitner, 1992).

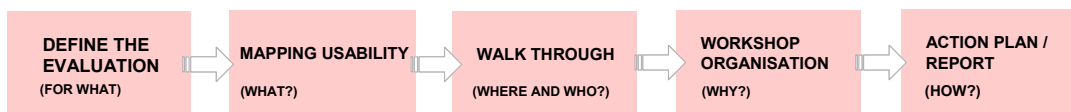
Within the work of the CiB W111 Usability of workplaces, there has been developed a theoretical framework describing the concept of usability, and different methods and tools have been studied and examined in several case studies the last 6 – 8 years (Jensø et al 1994; Hansen et al, 2005; Hansen et al 2006, Alexander, 2004; Blakstad et al, 2008). Alexander (2008) underlines that seen in an organizational context; Buildings usually will be part of a portfolio of buildings and are evaluated in terms of their asset value. He argues that the tools and metrics for considering the use value of buildings are less well developed and understood. This is in line with Granath and Gilliard (2008) that state that “*usability cannot be evaluated simply on the product alone but also with respect to how the product is perceived by and interacts with the user*”. Fenker (2008) relates usability to user experiences and social relations between users and facilities and describes usability as a process that can only be understood as a social construction where the building act as a sort of stage. According to Fenker, “*...the artefacts are bearers of a set of possibilities and constraints as well as, most importantly, activity and social practices models.*”

Usability evaluations are based on different user’s experiences and assessments on how well the buildings perform regarding different parameters. A building’s performance can never be seen or understood isolated from an organisational and technical perspective, as those aspects interact and influence each other. Usability has hence a complex nature and can be described as a “wicked problem” Blakstad et al (2008). Such problems are characterized by no definitive formulation of solutions, and they are open to multiple interpretations (Rittel and Webber 1973). According to Blakstad, an adequate approach to “wicked problems” will require multi-method strategies using a triangulation of methods and evaluations with multiple perspectives.

This is in line with findings from previous studies showing that evaluations work best when they are based on several methods and aspects, depending on objective, purpose, focus, competence and resources (Frechtling, 2002). All this implies that usability evaluations are complex, that there is a need for simplification and that the evaluator possesses both theoretical and practical knowledge and skills (Baird et al 1996). Blakstad et al (2008) describes how different methods and tools were explored and tested according to their relevance and validity for usability in several Norwegian cases. As pointed out earlier, few of the available methodologies aim directly at evaluation of usability related to organizational objectives. However, they found that many traditional research and evaluation methods had potential to be developed for the purpose of usability evaluation.

#### 4. Usability evaluations in Norwegian case studies

In a number of Norwegian case studies, several methods and ways of doing usability evaluations have been studied. The purpose of the Norwegian work has been to provide building owners, users and Facility Managers with knowledge of usability in order to support continuous improvements. As a result, a common usability framework or methodology named USEtool has been developed. The recommended process for mapping usability consists of five stages (figure 1). For each stage there is a description of the goals, the methods and tools used and the expected results from each method and stage (Blakstad et al, 2010).



*Figure 1: USEtool framework. The evaluation process (Blakstad et al., 2010)*

Methods used in the USEtool methodology have been; Document analysis, interviews, structured group interviews, walkthrough and workshop. The framework reflects the importance of understanding and taking in consideration the contextual conditions that may determine the outcome of the user experiences with the building or workplace (Hansen et al. 2006; Fenker, 2008).

#### 5. Applicability of results from usability evaluations

The purpose of this paper is to discuss important aspects of evaluation of usability, and the applicability of the results for other projects. Usability evaluation within the USEtool context, can be regarded as a methodology (Silverman, 2007) referring to the choices one makes about cases to study, methods of data gathering, forms of data analysis. Most of the methods proposed in USEtool are quantitative methods like interviews, focus groups, document or textual analysis, observation etc. mainly conducted within a case study context. USEtool complements other methods used in more traditional post occupancy evaluations or building performance studies.

Quantitative methods like questionnaires, statistics etc will give some idea of how much, how usual or unusual a given phenomena occurs. Those methods will give some background information, but not necessary any explanation.

Usability evaluations are not only concerned about how, but also on the question of why. They study meanings as well as causes (Hammersley, 1992). In literature we find a number of different methods for evaluation of efficiency both related to buildings and to organizations. We also have quite a few methods for evaluation of effectiveness and satisfaction, but effectiveness is more difficult to assess. Related to our perspective on buildings as means of production, effectiveness will be the most important. Of the methods we have used so far, interviews, participatory methods, and walkthroughs are methods that will be well suited for further development in order to evaluate effectiveness, but we will also need to develop criteria that can be used in quantitative studies such as questionnaires.

The value of usability evaluations for feed forward to new projects mainly lies in the ability to understand the user experiences and to translate those into adequate products and solutions. An important discussion is whether the results or findings from usability evaluations can be considered as valid and reliable, and whether context dependent knowledge from usability evaluations can be fed forward to new projects or be generalized and added to a more generally applicable body of knowledge. The idea behind evidence based design is to have significant number of results from several case studies or project to say something about the validity for other projects (Hamilton et al., 2009). From a usability perspective this is not necessary a universal truth isolated from any given context. Back to the problem of copy and past thinking, rather than learn and translate. This is more in line with Kroll (2005) that underlines that *“evidence-based design means not using a cookbook approach to building design”*. Every facility is built within a specific set of requirements and constraints, and consequently each requires a tailored approach. The aim should be to intelligently adopt or adapt the research and apply it to new projects. One big discussion about qualitative research is contextual sensitivity (Silverman 2007) and the awareness of the context in understanding the studied phenomenon. The question of reliability and validity is therefore a main issue discussing usability evaluation, user experiences and usability evidence.

In the following we relate the discussion of usability evaluation methods to the questions of reliability, validity and generalizability.

## 5.1 Reliability

Reliability is related to consistency of a measure. Hammersley (1992) defines reliability to the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions. That means that it deals with replicability or the question of whether the research could be repeated with the same results, interpretations and claims. As argued earlier in this paper, usability is strongly depending on context, situation and perspectives, and hence could not be reliability at all. Moisander and

Valtonen (2006) suggest two ways to improve reliability in non-quantitative work. One is to make the research process transparent, and the other is to pay attention to theoretical transparency. In this type of research, reliability cannot be ensured through large, representative samples of research material. The methods to summarize information may be affected by judgmental subjectivity. To a certain extent, the subjectivity is intended, as we want to map the perceptions of different user representatives. The problem of reliability may therefore be considerable in each of the sub-studies. To compensate for this, several studies have to be made.

## 5.2 Validity

Validity concerns how well a measure does in fact measure what it is intended to measure. The findings could be valid for other contexts if;

- Statistics enough case studies giving the same findings
- There are some similarities between case studies carried out and a given project.

The question is if usability evaluations and user experiences could be generalized and be valid for other contexts and situations? To address validity in our cases, several evaluation methods are used. This means a method triangulation. The combined use of methods gives a better measure than each of the methods or tools independently. According to Yin (2003), case studies using multiple sources of evidence are generally rated as having a higher quality, compared to those that rely only on single sources of information. In contrary, Flyvbjerg (2004) argues that the key advantage of qualitative research is its ability to give insight into local practices and is important for the development of a nuanced view of reality. According to Flyvbjerg, this is one of the strongest characteristic of qualitative research, the possibility of falsify ability as an excellent way to test the validity of any research finding.

## 5.3 Generalizability

Generalizability is a main aim in quantitative research and is normally achieved by statistical sampling methods or procedures. In qualitative analysis, generalizability is a very important and debated issue. Generalizability refers to the extent to which findings from a study apply to a wider population or to different contexts. Generalizability can be discussed along two dimensions: generalizability of experiences from the use of the proposed method, and generalizability of the results from the studies. The results from each study may have limited generalizability. The experiences from use of usability evaluation methods are likely to have a higher degree of generalizability than the actual evaluation results, even though both are context dependent. A common argument against case studies and other qualitative studies has been the lack of generalizability, and indirectly against reliability. Seen in isolation, case studies are context dependent. It is typically said that it is up to the reader to judge if a previously conducted case study is relevant in the context he or she studies. However, more generalizable

results may be established through a series of replications and validations. When the number of studies with consistent results grows, the confidence in the findings should increase. As the number of case studies increases, it is possible to perform meta-analyses of the cases, a similar way as meta studies (studies of studies) are common in for example medicine. Especially if the case studies, and other qualitative research, are conducted in a uniform way, the possibilities to observe general trends across a number of studies increases. Through our work with usability, we have developed a common framework for usability evaluations, named USEtool (Blakstad et al, 2010). This framework has been used both in student projects and in real life, giving us a good basis for meta-analysis. Related to our proposed tool and method for evaluating usability, a uniform way of conducting usability evaluations will enable us to perform meta-analyses of our evaluations and hence improve the question of generalizability.

## 5.4 Experiences

One may always discuss the external validity of qualitative methods. According to Halvorsen (2008) the main question is not if results may be generalized but if knowledge can be transferred to other settings. The validity and reliability of the methods in general can be discussed. One important aim for the development of the methods have been their ability to produce and/or obtain relevant information and experience relating to the defined topics for evaluation, understanding the situation and context, and obtaining differences in interests and opinions, rather than focusing on consensus. In one case we used both qualitative methods and questionnaire in the evaluation. The results were very concurrent and gave the same picture, but the qualitative methods gave a much more richer and useful material to understand why and where when discussing possible strategizes and activities to improve building performance and usability for the users.

From what we have seen in the case studies and tests, the described methods and tools really assess usability within the given context, with special focus on the effectiveness of the facilities and their ability to support value creation in the user organization. We acknowledge the fact that one cannot generalize directly from the results of highly context dependent evaluations such as USEtool. In fact, the Usability concept is context-dependent in nature. One of the case studies showed a university college with a very high score on building performance and coloration between program and completed building, but still showed a lack of usability due to change in pedagogic, increased student number, lack of changing culture among the department (Hansen et al., 2006). In another case we found a high degree of pride and high academic score among the pupils, in spite for a building performing really badly.

One may argue that the contextual knowledge gained from applying the methods described, is as important as the generic results for building performance. The main contribution is the way these methods are combined in a structured framework with process descriptions and easy-to-use guidelines, as well as the operationalized relation to effectiveness and usability. Further testing carried out by our project partners will reveal the method's usefulness, simplicity, and the necessary amount of resources to carry out evaluations.

## 6. Acknowledgements

The work has been supported by Sør-Trøndelag County, Statsbygg and Statoil. We also thank users and other stakeholders for active and important participation in the different cases, providing us with necessary feedback and input for developing the USEtool.

## References

- Alexander K, Fenker M, Granath JÅ, Haugen T and Nissinen K (2004). Usable workplaces: Action research. Paper, CIB World Building Congress 2004, Toronto, Canada.
- Alexander K (2008) Usability: philosophy and concepts. In Usability of Workplaces, Phase 2. CIB W111 research report.
- Baird G et al (1996) Building Evaluation Techniques. New York, McGraw-Hill
- Becker F and Steele F (1995) Workplace by Design: Mapping the high performance workscape. San Fransisco, CA: Jossey-Bass
- Blakstad SH, Hansen GK and Knudsen W (2008) Methods & tools for evaluation of usability in buildings. In Usability of Workplaces, Phase 2. CIB W111 research report.
- Blakstad SH, Olsson N, Hansen GK and Knudsen W (2010). Usability Mapping Tool. CIB Publication 330, CIB W111:Usability of Workplaces - Phase 3, pp 17-29
- Bitner MJ (1992). Servicescapes: The impact of physical surroundings on customers and employees. Journal of Marketing pp 57-71
- Chan JK, Beckman S L and Lawrence P G (2007). Workplace design: A new managerial imperative, California Management Review 49(2), 6-22
- Federal Facilities Council (2001), Learning from our Buildings.A State-of-the-Practice Summary of Post-Occupancy Evaluation. Federal Facilities Council Technical Report No. 145 NATIONAL ACADEMY PRESS, Washington, D.C.
- Fenker M (2008) Towards a theoretical framework for usability of buildings. In Usability of Workplaces, Phase 2. CIB W111 research report.
- Flyvbjerg B (2001). Making Social Science Matter: Why social inquiry fails and how it can succeed again. Cambridge University Press
- Frechtling J (2002). The 2002 User-Friendly Handbook for Project Evaluation. National Science Foundation, Directorate for Education and Human Resources, Arlington

Granath JÅ, Gilleard J (2008) Usability in the Workplace: Case study of Pamela Youde Eastern Hospital Hong Kong. In Usability of Workplaces, Phase 2. CIB W111 research report.

Grantham C (2000). The future of work. The promise of the new digital work society. New York, NY:McGraw-Hill, Commerce Net Press

Halvorsen K (2008). Å forske på Samfunnet. En innføring i samfunnsvitenskapelig metode. Cappelen Akademisk forlag. Oslo

Hamilton DK and Watkins D H (2009). Evidence-Based Design for Multiple Building Types. Wiley Blackwell

Hammersley M (1992). What's wrong with ethnography?: methodological explorations. London & New York : Routledge

Hansen GK, Haugen T, Jensø M and Knudsen W (2005) Case study: Nord-Trøndelag University College, Nylåna. Røstad. CIB Task Group 51, Usability of workplaces. SINTEF/NTNU.

Hansen GK and Knudsen W (2006) Usability – A matter of perspective. The case of Nord Trøndelag University College. CiB W70 Trondheim International Symposium, Changing user demands on buildings. Trondheim 12. -14. June 2006

Horgen T, Joroff M, Porter W, Schon D (1999). Excellence by design. New York, NY:Wiley

ISO 9241-11 (1998) Ergonomic requirements for office work with visual display terminals. Guidance on usability

Jensø M, Hansen GK, Haugen T (2004). Usability of buildings. Theoretical framework for understanding and exploring usability of buildings. Paper, CIB W70 Hong Kong International Symposium, Facilities Management & Asset Maintenance, "The Human Element in Facility

Joroff M, Louargand M, Lambert S and Becker F (1993), "Strategic management of the fifth resource: corporate real estate", IDRC, Report No. 49. IDRC, Atlanta, GA.

Kaplan R S and Norton D P (1996). The Balanced Scorecard: Translating Strategy into Action Boston: Harvard Business School Press

Kroll K (2005). Evidence Based Design in Healthcare Facilities. Building Operating Management. Retr. 31 May 10 from <http://www.facilitiesnet.com/bom/article.asp?id=2425>.

Leaman A and Bordass B (2001) Assessing building performance in use: the Probe occupant surveys and their implications. In Building Research & Information, Volume 29, Issue 2 March 2001 , pages 129 – 14

- Lewin K (1946). Action research and minority problems. *Journal of Social Issues*, 2, pp 34-46
- Moisander J and Valtonen A (2006). *Qualitative marketing research : a cultural approach*. Sage Publications, London
- OECD (2000) *OECD glossary of evaluation and results based management terms*, Organisation for Economic Co-operation and Development, Paris
- Olsson N, Frydenberg S, Jakobsen EW, Jessen SA, Sørheim R and Waagø L (2008). *Investorers vurdering av prosjekters godhet ((Investors' evaluation of potential projects) Concept rapport nr 20*. Norwegian University of Science and Technology, available at [www.concept.ntnu.no](http://www.concept.ntnu.no)
- Preiser WFE, Rabinowitz HZ and White ET (1988). *Post-Occupancy Evaluation*. Van Nostrand Reinhold
- Preiser WFE and Schramm U (1997). *A conceptual framework for building performance evaluation*. In *Assessing Building Performance*. Elsevier Butterworth-Heinemann
- Rittel HWJ and Webber MM (1973) *Dilemmas in a General Theory of Planning*. In *Working papers from the Urban and Regional Development*. University of California Berkley.
- Robson C (2002). *Real World Research*. Second edition. Blackwell Publishing.
- Sager T (1991). *Planlegging med samfunnsperspektiv. Analysemetode*. Trondheim: Tapir forlag.
- Silverman D (2007). *Doing Qualitative Research*. SAGE Publications, London
- Small K (1999): "Project evaluation" in Gomez-Ibanez, J, Tye, W. B. and Winston C (eds.): *Essays in Transportation Economics and Policy, A Handbook in Honour of John R. Meyer*, The Brookings Institution, Washington D.C
- Steinke C, Webster L and Fontaine M (2010). *Evaluating Building Performance in Healthcare Facilities*. *HERD, Health Environment Research and Design Journal*
- Voordt T van der and Wegen H Br van (2005). *Architecture in Use*. Architectural Press, UK
- Yin RK (2003). *Case Study Research: Design and Methods*. SAGE, Thousand Oaks, CA/London/Dehli.



# Using user complaints in social housing for feedback in the product development process of construction projects

**Juliana Nunes de Sá Brito**

Federal University of Rio Grande do Sul  
Julianabrito.arq@gmail.com

**Carlos Torres Formoso**

Federal University of Rio Grande do Sul  
formoso@ufrgs.br

## Abstract

This paper presents the main results of a research project aimed at investigating how user complaints in social housing projects can be processed and analysed in order to provide feedback for the product development process. The focus of this paper is on the use of this information to support decision making during the stages of design, production and use of building facilities. Users' complaints were used because they represent valuable information about customer perception. Such information is easily obtained by managers because they are often collected by facility managers. The research strategy adopted was archive analysis, using a database of 7574 complaints from 42 house-building projects, located in the state of Rio Grande do Sul, Brazil. All the projects were funded by the Residential Leasing Program of the Brazilian Federal Government. There were three typologies of project: condominium of new terraced-house blocks, condominium of four to five new apartment buildings, and refurbished high-rise apartments building. Several statistical analyses were performed on those data. The data analysis indicated that the type of information collected from user complaints can be useful for understanding causes of client dissatisfaction with the project and also with the facilities' management services. A set of performance measures were produced, which can be used to support decision making, including the definition of building typology, the choice of building companies, and the design of the facilities' management services. A major limitation of this study was that it investigated only data produced by residents of the housing projects. Therefore, the information cannot be used for a precise identification of technical problems related to building pathologies or lack of maintenance. Another limitation has to do with the age of the projects investigated: they had between 3 and 5 years of occupation. That means that the range of complaints may be different from projects with longer periods of occupation. Understanding the usefulness of user complaint data is very important for the house-building sector, since those data constitute a fairly cost-effective source of feedback for the product development process. It is useful in terms of providing performance measures that are useful for different stakeholders, such as designers, building companies, funding agencies, developers, and facilities' management companies. This is particularly important in the social housing segment, where the incidence of quality problems tends to be greater.

**Keywords:** complaints, social house-building projects, feedback.

## 1. Introduction

Improving the quality of social housing is an issue of great concern in Brazil due to its importance in social and economic terms. This is a concern not only of private companies that develop and produce housing projects, but also of the government, which is responsible for promoting, funding and managing housing programs.

In the context of the manufacturing industry, the approach to product quality and cost reduction usually starts with recognizing customers' needs. In the same way, in the building industry it is necessary to characterise housing users and study their needs and expectations in order to be able to satisfy them. However, when users' requirements are not met, dissatisfaction soon arises after the purchase of the product or a service (Huppertz, 2007), and that can lead to different kinds of reaction by users, often starting with a complaint, going to a different supplier or retaliation [1] against the company. (Jambekar; Pelc, 2005; Day; Landon, 1977; Singh, 1988).

Hence, complaints offer important information from users and they can be considered a declaration of frustrated expectations and, therefore, an opportunity to improve the housing sector. They are an effective and cost-effective way to obtain information and to meet users' expectations of products and services (Barlow; Moller, 1996).

There are different ways of capturing information on customers' needs. Some of the more costly and less direct are the analysis of customers' expectations in parallel industries, the use of persons disguised as buyers, external audits and formal surveys. However the reception and handling of complaints constitutes a direct and effective method to understand clients, helping decision making in product development processes [2] (PDP). Eventhough there are other sources of information, users complaints are easily obtained by managers because they are often collected by organizations that produce or manage the facilities . Besides, if handled adequately, complaints can offer competitive advantages to the company.

In Product Development literature there are several studies on the product planning and development process, where the information obtained from current customers is used as feedback for the development of new products and to help satisfy future customers (Fundin; Bergman, 2003). However, it is necessary to handle this information in a way that allows the identification of which characteristics of the product or service are decisive for customer satisfaction.

According to Sampson (1999), the small number of studies on the issue is small, and investments in client feedback systems are limited, consequently, only rarely are these systems used to help companies identify their customers' preferences. Another factor that hampers complaints handling is companies' lack of capacity to undertake this task (Barlow; Moller, 1996). In a study undertaken in three manufacturing companies in Sweden, Fundin and Bergman (2003) affirm that companies still lack a formal structure to transfer their customers' feedback to the development of new products. However, the same study indicated that companies are willing to use that feedback as a guiding factor in their PDP.

Although the literature indicates limited use of complaints and low complaint rates (Barlow; Moller, 1996; Huppertz, 2007), those rates may vary depending on the factors involved in the purchase of the product or service, such as, for example, the value of the purchase; market competition; to which socio-economic group the customer belongs to; cost and benefits of the complaint; individual customers' tendency to complain and the importance of that purchase for the customer. (Barlow; Moller, 1996; Kim, 2003)

In the case of housing, the purchase value is considered high and the importance of the purchase for the customer is high, once most people only make one purchase of this kind in their entire life. In this case, according to Barlow and Moller (1996), customers usually complain because they feel that the service provided is worth the trouble of complaining. This trade-off is related to other factors mentioned above, such as, for example, the prior perception of the user regarding the resolution of the problem or the financial restitution of the repair of a defect in the house. That perception can be related to the complaint channels made available to users and to the evaluation of users' satisfaction with the handling of complaints [3].

Although there is consensus in the literature that the handling of complaints is advantageous both for customers and company, the issue receives little attention from the building sector. Customers' complaints are often received, but they are not dealt with appropriately, i.e., they are rarely processed and, when they are, they do not generate information that is subsequently used in decision making by the agents involved in buildings' production and maintenance. In view of that fact, this study considers that greater attention should be devoted to the information generated at the use stage of housing projects, providing feedback for the earlier stages of the PDP.

## 2. Aim

The aim of this paper is to investigate how complaints of users of social housing projects can be processed and analysed in order to provide feedback for the development process of housing products. The focus of the study is on the use of that information to support decision making in the design, production and facilities management.

## 3. Methods

The research strategy adopted was archive analysis, which, according to Yin (1994) is a method used to examine contemporary events. This study analysed a database of 7574 users' complaints in 42 social housing projects, with 3 to 5 years of occupation, located in the state of Rio Grande do Sul, Brazil. The data analysed are secondary, as they were recorded by a facilities management company [4] between December 2002 and September 2006 and subsequently compiled in a database by Brito (2009).

The complaints analysed were divided into three categories: (a) building failures [5]; (b) behavioural problems [6]; (c) maintenance problems [7]. Each category was statistically tested with physical characteristics of the projects and with activities or decisions related to the

development of the housing projects, as highlighted in Figure 1. Each analysis was associated with one stage of the projects’ development process where the complaints can be useful in the decision making. It should be highlighted that complaints can help formulate different indicators for different stages of the PDP, but this project was restricted to generating indicators based on existing data, limiting the indicators.

	AIM	STATISTICAL TEST
Design	Check if there is a relationship between the complaints about users’ <b>behavioural problems</b> and the <b>building typology</b> of the projects.	T-Test of independent samples of <b>behavioural problems</b> complaints (projects with three-years occupation)
Construction	Group the building companies by average value of complaint /hu: low, average, high.	Comparison test between the averages of complaints of <b>building failures</b> (One way ANOVA) and Post Hoc Tukey, ANOVA’s complement.
	Identify and compare the building systems that generate the largest number of complaints in all the building companies	Comparison test of the average of complaints <b>building failures</b> complaints (One way ANOVA) and comparison using Pareto charts.
	Identify and compare the building systems that generate the largest number of complaints in each <b>building company</b>	
Facilities management	Identify and compare the systems that generate the largest number of complaints related to the <b>facilities management</b>	Analyse the frequency of <b>facilities management</b> complaints in the most critical systems (Calculation of the average of complaints /hu in each system)
	Check if there is a relationship between the main behavioural problems of users and the <b>undertaking of social work</b> [8] with them in the period preceding their move into the housing projects.	T-Test of independent samples of <b>behavioural problems</b> complaints (projects with three-years occupation)

**Figure 1- Aims and statistical tests**

The results of the statistical analyses were discussed with agents involved in the provision and maintenance of the housing projects, i.e.: (a) facilities’ managers; (b) social workers; e (c) financing agents.

## 4. Results

The results of this study were grouped into three items, according to the development stage of the housing project, where the complaints can be useful to provide feedback to the process.

### 4.1 The use of complaints providing feedback to the design

The special characteristics of the built environment are seen by some authors as decisive factors for the behaviour of the people using those spaces. (Lynch, 1960; Lay, 2005; Lay, Reys, 2005) Hence, the study sought to find out whether the building typology influences the complaints about behavioural problems made by users of seven housing projects with three-years occupation, totalling 839 housing units. The projects evaluated are part of the Residential

Leasing Program of the Federal Government of Brazil and have the following building typologies: terraced-house blocks and apartment buildings.

In order to test this hypothesis, a t-test was carried out with independent samples, followed by the Levene test. Table 1 represents the valid sample for the three first years of occupation, the number of complaints and the averages of the sample analysed.

**Table 1: Sample used in the T-test with independent samples of behavioural problems x typology**

<i>Behavioural Problems Complaints</i>	<i>Typology</i>	<i>N (HU)</i>	<i>Average</i>
<i>Noise / Fight</i>	<i>apartment</i>	742	<b>0,036</b>
	<i>house</i>	97	0,030
<i>Presence of animals in the condominium</i>	<i>apartment</i>	742	<b>0,014</b>
	<i>house</i>	97	0,006
<i>Inappropriate use of common space/ equipment</i>	<i>apartment</i>	742	<b>0,012</b>
	<i>house</i>	97	0,003

Table 2 represents the results of the t-test for the seven projects evaluated.

**Table 2: T-test with independent samples of behavioural problems x typology**

<i>Behavioural problems complaints (1st, 2nd and 3rd year)</i>	<i>Hypotheses</i>	<i>Levene test</i>		<i>Hypotheses</i>	<i>T-test</i>	
		<i>F</i>	<i>Sig.</i>		<i>t</i>	<i>p value.</i>
<i>Noise / fight</i>	$\sigma^2_1 = \sigma^2_2$	11,52	0,00	$\mu_1 = \mu_2$	1,86	0,06
	$\sigma^2_1 \neq \sigma^2_2$			$\mu_1 \neq \mu_2$	2,00	<b>0,05</b>
<i>Presence of animals in the condominium</i>	$\sigma^2_1 = \sigma^2_2$	2,52	0,11	$\mu_1 = \mu_2$	-1,08	<b>0,28</b>
	$\sigma^2_1 \neq \sigma^2_2$			$\mu_1 \neq \mu_2$	-1,06	0,29
<i>Inappropriate use of common space/ equipment</i>	$\sigma^2_1 = \sigma^2_2$	26,12	0,00	$\mu_1 = \mu_2$	-3,30	0,00
	$\sigma^2_1 \neq \sigma^2_2$			$\mu_1 \neq \mu_2$	-3,01	<b>0,00</b>

The test showed that the typology interferes in the occurrence of complaints concerning noise and fights (p value <0,05), with higher frequency in houses or terraces. It also showed that the typology influences the complaints about inappropriate use of common space or equipment (p value <0,00), which may be related to design solutions that neglect leisure areas, influencing users' behaviour. That leads residents to use the collective spaces designed for circulation or other functions for their leisure activities, supporting some authors' opinion that affirm that the physical and spatial characteristics of a housing project can influence people's behaviour (Blanco, et al. 2003; Lay, 2005; Lay, Reys, 2005). The analysis shows that apartments present a higher average of complaints concerning the inappropriate use of common spaces than that of houses and terraces, which present 0,0120 and 0,0034 complaints/hu, respectively.

The complaints referring to the presence of animals in the condominium do not present a relationship with the building typology ( $p$  value  $<0,28$ ). It is important to note that, although the complaints averages are distant, 0,014 for apartments and 0,06 for houses, no statistical difference between them is proven. Hence, this study concludes that the presence of pets is a cultural issue and that the conflicts generated by the presence of pets depend on factors other than the project's building typology.

## 4.2 The use of complaints as feedback for the construction

The association of building companies with the number of complaints can provide important information to help decision makers when they contract companies, and also for the companies themselves to evaluate their performance in comparison with others in the same sector. In this sense, a statistical test was applied to the set of complaints with the aim of classifying the building companies in groups with significantly different complaints averages, as well as identifying the complaints average of each one of them to allow benchmarking.

In the analysis a comparison was made of the averages of the complaints made in the first year of occupation of the projects according to the building companies. It consists in a variance analysis (One Way ANOVA<sup>[9]</sup>) that is complemented by the Tukey procedure, which objective is the multiple comparison of averages, with this procedure being used after testing the significance with ANOVA. In the test, the database projects considered were those with complaints registered in their first year of occupation, making up 21 projects and a total of 3539 housing units, where 2581 complaints were registered.

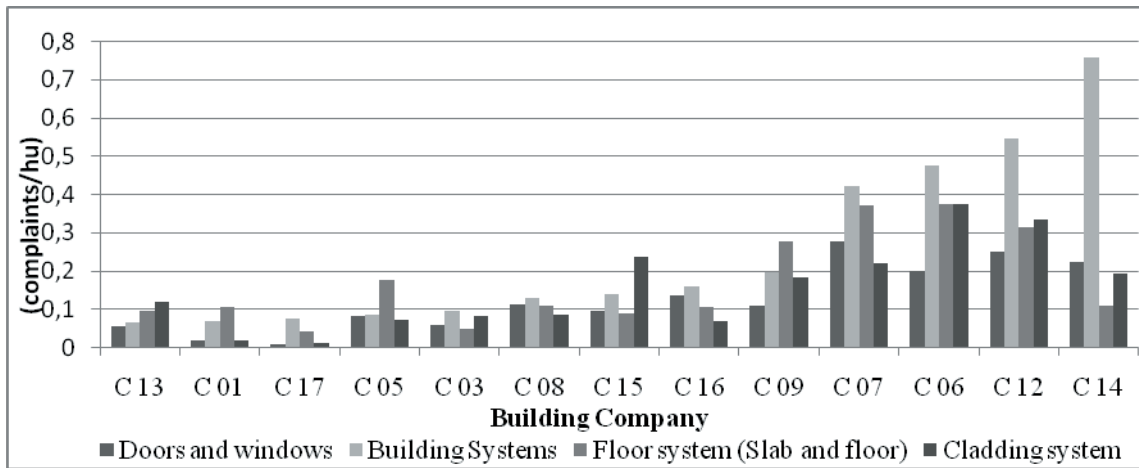
After the ANOVA ( $p$  value  $<0,001$ ), the Tukey was undertaken, indicating a significant difference between three groups of building companies, as shown in Table 3: (a) companies with a low incidence of complaints (0,00 to 0,29 complaints per HU); (b) companies with an average incidence of complaints (0,49 to 0,69 complaints per HU); and (c) companies with a higher incidence of complaints (1,21 to 1,41 complaints per HU).

Table 3 presents the groups of building companies according to the average value of complaints per housing unit. It can be observed that the group of companies in the lower section of the table has much higher averages than the others. In the case of the projects studied, which are Federal Government's initiatives, the choice of companies is the responsibility of the State, and it is up to the State to approve or reject specific companies' projects. Thus, the identification of the complaints averages of the companies active in the market, as well as the groups they are in, is useful information for the government, which can act effectively on the building inspection of the more problematic companies, and also establish the requirements for those companies in order to reduce the incidence of complaints.

**Table 3: Groups of building companies according to incidence of complaints / hu (Building failures)**

Building Company	N HU	Alpha = .05						
		1	2	3	4	5	6	7
Building Company 17	360	0,00						
Building Company 01	200	0,03	0,03					
Building Company 05	97	0,18		0,18				
Building Company 08	200	0,19		0,19				
Building Company 13	92	0,20						
Building Company 03	200	0,29						
-----								
Building Company 16	468,00				0,49			
Building Company 15	330				0,57	0,57		
Building Company 09	172				0,65	0,65		
Building Company 07	822				0,69			
-----								
Building Company 06	80						1,21	
Building Company 12	410						1,32	1,32
Building Company 14	108						1,41	
Sig.	3539	1	0,0575	0,4843	0,0513	0,4412	0,6377	0,8263

Given the complaints average for each company, it is important that they identify constructive system has the highest number of complaints so that they can improve the quality of their building or the design specifications of particular systems. The Paretto chart (Figure 2) compares the most critical systems in each building company.



**Figura 1- Building failures complaints**

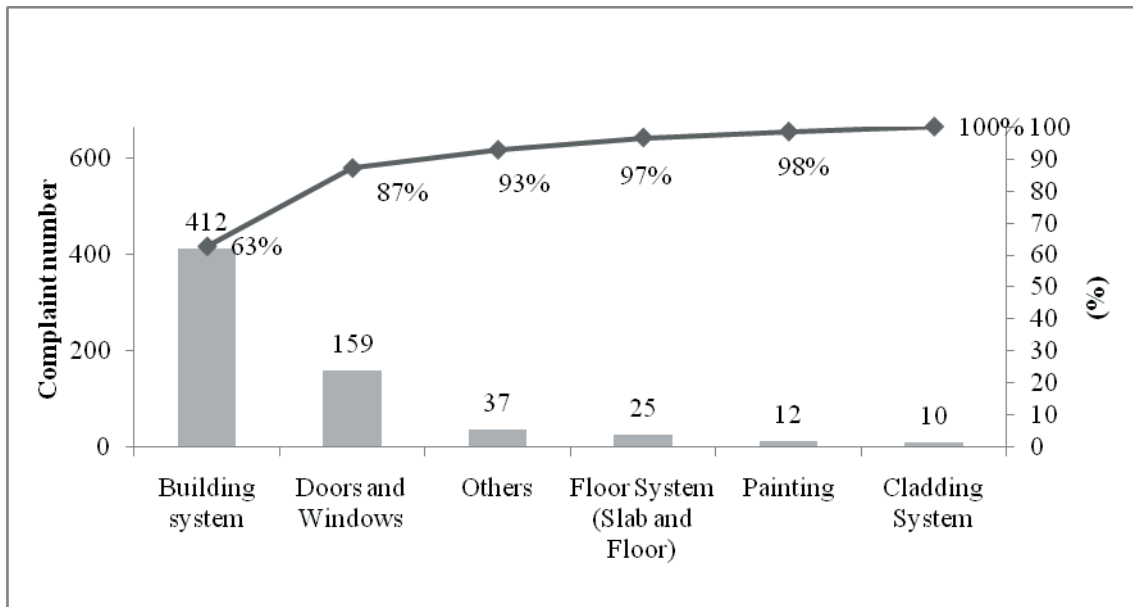
The chart shows that it is primarily the building systems and cladding that involve the highest averages of complaints in most companies. Besides, it can be seen that in 61% of the companies

analysed, the building systems are the most critical point when compared with other systems in the same company. This indicator is useful for decision makers to enable them to demand that companies have more control over the execution of those processes, and also that they improve the quality of execution.

### 4.3 The use of complaints as feedback for facilities management

Complaints can be useful for the facilities management of housing projects in the services related to common spaces, aimed at improving operation, conservation, or recovering their functional capacity, and they can also be used to propose adjustments that result in improvements for final users. In this sense, the study sought to identify and compare the systems that generate most complaints related to facilities management.

In order to do that, a descriptive analysis of the frequency of 645 complaints related to maintenance problems was made and it was identified that the systems that presented the largest number of complaints were the building systems and window frames, as shown in Figure 3.



**Figura 2- Maintenance problems complaints**

The study also identified the sub-systems and the most frequent maintenance problems through a frequency analysis. In the building systems, the hydro-sanitary installations and electrical installations were the elements that presented the largest number of complaints, with 94%. Hydro-sanitary installations represent 58% and electrical installations represent 36% of the complaints in building systems. The complaints with the highest percentages in both systems are about pipe blockages and the need to replace lamps or electrical parts. They represent over 60% of the complaints about hydro-sanitary and electrical installations.

The problem of blocked pipes problem may be related to inappropriate use of the hydro-sanitary equipment. Through discussions with staff from the projects' funding agencies, it was



confirmed that many of the complaints about blockages had to do with solid objects thrown in the toilet bowl and with grease and solid waste discarded in sinks and washing stands' drains. The action of users for the proper maintenance of the buildings is encouraged through social work undertaken before the occupation of the projects. Hence, it should be questioned whether the social workers, through the funding agency, are meeting their goals or whether the complaints are associated with inappropriate behaviour on the users' part.

With regards to the frames, the most affected elements were doors and windows, representing 70% and 30%, respectively, of the complaints about windows and doors systems. However, the most frequent complaint is the same in both elements: loose, broken or missing window glass.

In discussions with the housing projects' managers, held at facilities' managing company A, they highlighted inappropriate use of common spaces, as well as the poor quality of the aluminium window frames, which means window panes are easily broken. The biggest problem is the frailty of the frames, which, for the most part, do not have aluminium sidelite patches in the lower part of the doors, leading to broken and damaged glass. Putting sidelite patches in the lower section of the doors, reinforcing the aluminium profiles or replacing the material of the frames in the common areas can contribute to reduce the number of complaints.

In the case of complaints about blocked pipes and broken glass, it was verified that the problems indicated may not be directly related to the performance of the facilities' management, but may be due to the poor quality of materials, inappropriate use of the project and its installations, as well as damage caused by acts of vandalism. Hence, if the cause of the problem is not related to use management, it is necessary to focus efforts on other stages of the development process of housing developments.

In the case of Residential Leasing Program, technical social work is done with the users before and/or during the first year of occupation of the projects. In this phase, users receive instructions for good maintenance of the facility, which can influence complaints about maintenance problems. In order to understand this relationship, a t-test with independent samples was carried out with the main complaints about building failures for the projects with at least three years' occupation. The aim was to find out whether the technical social work influences the occurrence of complaints about the main maintenance problems.

First, this analysis considered the maintenance problems that may have occurred due to lack of maintenance by users or due to their behaviour [10], which may have damaged components or equipments in the housing projects. Subsequently, the average of all problems related to the undertaking of social work was calculated.

The test confirmed the hypothesis that the social work influences the incidence of complaints about maintenance problems ( $p$  value  $<0,00$ ), with the projects where that work was undertaken presenting lower averages of complaints /hu.

Although the test revealed a significant relationship between the dependence of the variables technical social work undertaken and maintenance problems, it is believed that such problems can also be related with other stages in the process, such as inefficient facilities management. However, the data analysed concern only one facilities' management company, and due to that limitation it was not possible to compare processes of different management companies.

## 5. Conclusions

The registration of housing projects' users' complaints has great potential to generate information that can help decision makers in housing provision. Several stages of the development process of social housing projects can use feedback of indicators generated from the processing and analysis of that information, helping the decision making of the stakeholders involved. In this study it was possible to identify how information can be useful in the design, execution and facilities management, as follows:

- Design: identification of behavioural problems that are related to design solutions; identification of the most frequent building failures that may be originated in the design; identification of the main maintenance problems in order to specify more durable materials or to find design solutions that minimise such problems;
- Execution: identification of the contracted building companies that are subjected to largest number of complaints; identification of the constructive systems that generate the largest number of complaints; evaluation of the company's complaints average; comparison of the company's performance with the others' through the complaints averages;
- Facilities management: identification of the main failures, subsystems and building systems that generate the largest number of complaints; evaluation of the complaints averages of the company; comparison of the company's performance with the other companies' performances through the complaints' averages.

The study allowed the formulation of a set of indicators that can be used as an aid in the decision making process, including the definition of building typology, the contracting of building companies and the style of operation management and maintenance by the facilities' management services. One of the greatest limitations of this study is the analysis of complaints of only one facilities' management company, which did not allow a deeper analysis of the maintenance problems nor a comparison to be made between the management practices of the facilities' management companies. Another limitation of this study is that the housing projects have between 3 to 5 years of occupation and projects with longer occupation times can present a different set of complaints.

The understanding of the usefulness of complaints for the building industry is crucial for the sector, since these data are a relatively cost-effective source of feedback for the product development process. This highlights the importance of continuing to undertake studies on complaints in the building industry, particularly concerning the study of complaints of users of social housing projects, where quality problems have proved more frequent.

## References

BARLOW, J.; MOLLER, C. *Reclamação de Cliente? Não tem melhor presente: usando o feedback do cliente como uma ferramenta estratégica*. São Paulo: FUTURA, 1996.

BLANCO, Alejandro Toro; MARTÍNEZ, Paola Jirón; JARPA, Luis Goldsack. Análisis e incorporación de factores de calidad habitacional em el diseño de lãs viviendas sociales em Chile. Propuesta metodológica para um enfoque integral de la calidad residencial. *Boletín INVI*, v. **18**, n. 46, pp. 9-21, jan. 2003.

CAIXA ECONÔMICA FEDERAL. Termo de Referência Programa de Arrendamento Residencial – GEPAD/DIDUP. Brasília, 2003.

CALLEGARI-JACQUES, SIDIA M. *Bioestatística: princípios e aplicações*. Porto Alegre: Artmed, 2003. 255p.

DAY, R. L.; LANDON, E. L. (1977). Toward a Theory of Consumer Complaining Behavior. In: WOODSIDE, A.; SHETH, J.; BENETT, P. *Consumer and Industrial Buying Behavior*. (p. 425-37) New York: North-Holland.

FERNANDES, D. H. *O comportamento de retaliação do consumidor e seus antecedentes*. 2008. 130 f. Dissertação (Mestrado em Administração) – Escola de Administração, Universidade Federal do Rio Grande do Sul, Porto Alegre.

FUNDIN, A. P.; BERGMAN, B. L. S. Exploring the customer feedback process. **Measuring Business Excellence**, v. 7, n. 2, pp.55-65, 2003.

HUPPERTS, J. W. Firms' complaint handling policies and consumer complaint voicing. *Journal of Consumer Marketing*, v. 27, n. 7, pp. 428 – 437, 2007.

JAMBEKAR, A. B.; PELC, K. I. A model of knowledge processes in a manufacturing company. *Journal of Manufacturing Technology Management*, v. 17, n. 3, pp. 315-331, 2006.

KIM, Chukmin. The effect of attitude and perceptions on consumer complaint intentions. *Journal of Consumer Marketing*, v. 20, n. 4, pp. 352-372, 2003.

LAY, Maria Cristina Dias; REIS, Antônio T. L. Habitação social: diferenças no papel de espaços abertos segundo tipos habitacionais. In: Encontro Nacional da Associação Nacional de Pós\_graduação e Pesquisa em Planejamento Urbano e Regional – ANPUR, 2005. Salvador, BA. *Anais...* ANPUR, 2005.

LAY, Maria Cristina Dias; REIS, Antônio T. L. *Análise quantitativa na área de estudos ambiente-comportamento*. Ambiente Construído (Online), Porto Alegre, v.5, n.2, p.21-36, abr./jun. 2005.

LYNCH, Kevin. *The image of the city*. Cambridge: M. I. T. Press, 1960.

ROZENFELD, H.; FORCELLINI, F. A.; AMARAL, D. C.; TOLEDO, J. C.; SILVA, S. L.; ALLIPRANDINI, D. H. & SCALICE, R.; K. *Gestão de desenvolvimento de produto: uma referência para a melhoria do processo*. São Paulo: Saraiva, 2006.

SINGH, J. Consumer Complaint Intentions and Behavior: Definitional and Taxonomical Issues. *Journal of Marketing*, v. 52, n. 1, p. 93-108, 1988.

YIN, R.K. *Case study research: design and methods*. Londres, Sage, 1994. Applied Social Research Methods Series, v.5.

VOS, J. F. J.; HUITEMA, G. B. How organisations can learn from complaints. *The TQM Journal*, v. 20, n. 1, pp. 8-17, 2008.

---

[1] Retaliation can be understood as a revenge, retaliation or amendment and it occurs at a moment of tension, dispute, where one of the parties strategically tries to recover a loss (FERNANDES, 2008).

[2] The PDP concept proposed by Rozenfeld et al. (2006) is defined as the conception, design, production and monitoring of a product after its final delivery to the client. In view of the fact that building projects are developed following the same stages, it is considered that a building project can also be understood as PDP.

[3] The handling of complaints includes operation actions of receiving complaints and also the planning and analysis of internal and external failures in the process of the company, as well as indicating the basic needs or expectations that have not been met (VOS; HUITEMA, 2008),

[4] The company analysed manages 72% of the social housing projects in the Residential Leasing Program in the state of Rio Grande do Sul.

[5] The complaints related to pathological manifestations or failures occurred in the design and building stages are considered building failures (BRITO, 2009).

[6] Complaints related to residents' actions that could cause conflict related to human behaviour such as arguments between residents and facilities' management companies' employees, disrespecting other users of the project, disorder caused by violent reactions by the residents, such as fights, aggression incidents and exchange of abusive words are considered behavioural problems. (BRITO, 2009).

[7] Maintenance problems are the complaints related to failures occurred due to inappropriate use of the facilities and its installations, as well as damage caused by acts of vandalism (BRITO, 2009).

[8] In the Residential Leasing Program, as in other Brazilian housing programs, technical social work (TTS) with the residents is a compulsory component of the programs. The work consists in developing informative and educative actions that start before occupation, with the aim of creating mechanisms that can enable the participation and organization of residents, promoting integration of the lessees with each other and with their home, stimulating commitment with the conservation and maintenance of the properties through explanations about the correct occupation of the collective spaces, conservation of the building and fulfilment of payments (CAIXA, 2003).

[9] The One-way ANOVA analysis is available on the software SPSS version 13.0 for Windows.

[10] The following complaints were considered in the analysis: blocked pipes, woodworm in the doors and doorframes, motor of gate / automatic gate / electric fence not working, damaged parts in the hydraulic installations, and spills from water pipes.

# User's needs, desires and experiences: A comparative study of way-finding design in shopping malls

**Goksenin Inalhan**

Istanbul Technical University  
inalhang@itu.edu.tr

**Marina Temel**

Istanbul Technical University  
marina\_temel@hotmail.com

## Abstract

Although access to goods and services is of vital importance to all members of a community, the recent trends indicate that mall patronage is declining. This is due to too many look-alike malls and the fact that shopping experience offered by such malls can often be unpleasant (unsatisfactory) for customers. Shoppers' way-finding problems may also contribute to this sense of dissatisfaction. Even though way-finding has been shown to be one of the most irritating aspects of the shopping process, it remains under-researched. Therefore, this research addresses the influence of way-finding design on the shopping experience in shopping malls and seeks to obtain a better understanding of how way-finding design influences emotions and behavior so as to improve the knowledge on designing future shopping malls. The study is based on the comparative study of users' behaviors in two shopping malls that were constructed within the same period of time in Kayseri. It seeks to establish the role played by way-finding design principles on behavioral settings and the shopping experience of its users and users' preferences of these facilities. In this research the consumer behavioral setting is examined in two parts: the features and the motivations of the users and the features belonging to space (spatial organization). These variables and their influence on each other are tested in a comparative study. Both qualitative and quantitative research methods have been utilized in this study. The qualitative research data consist of interviews with consumers and behavioral/cognitive mappings at both shopping malls. The quantitative research data were gathered by means of questionnaires to users of both shopping malls. The use of such a method demonstrates our belief in the importance of cultivating an ability to recognize, listen, and respond to how people feel about their environment and their experiences within the built environment. The aim is that this study will contribute to the design of shopping malls and will assist in ensuring that the design is as inclusive and universally accessible as possible and addresses the requirements of a wide range of physical, sensory, and cognitive abilities and needs of their users. Understanding the experiences, space use, and needs of users may also contribute to user-centered facilities management, planning and design of spaces that function effectively, accommodate the wider user needs, and reduce the time and stress in accessing those environments.

**Keywords:** shopping malls and centers, behavioral settings, consumer behavior, way-finding, comparative study

## 1. Introduction

Retailers and shopping mall developers who often seek to learn how and why people shop are currently being challenged with a recent trend in retail industry. Although shopping malls were a popular destination for shopping and recreation in 80s and 90s (Kowinski, 1985, Wakefield and Baker, 1998), recent trends indicate that mall patronage is declining. Moreover, despite the decrease in mall sales, there is a concurrent growth in retail mall space (Ashley, 1997; Wakefield and Baker, 1998).

Wakefield and Baker (1998) suggest three reasons for this decline in mall patronage:

- (1) There are too many malls that look alike, with too many stores offering too much of the same merchandise (Ashley, 1997; Templin, 1997; cited in Wakefield and Baker, 1998).
- (2) Busy consumers are making fewer trips to the mall. Because they are time-pressed, consumers seek to maximize their shopping time (Ashley, 1997; cited in Wakefield and Baker, 1998).
- (3) Fewer consumers are saying they go to the mall because they enjoy the experience (Berry, 1996; Chandler, 1995; cited in Wakefield and Baker, 1998).

Tauber( 1972) stresses that if we assume that shopping trips are evaluated exclusively on the merit of any goods or services acquired, we fail to recognize numerous intangible and emotional costs and benefits that must be examined before we can understand this consumption activity fully (Tauber,1972, Holbrook 1986, Babin et al, 1994).

Kotler (1973) was one of first to recognize diversity in the retail bundle, rather than the product alone, when he stated, “One of the most significant features of the total product is the place where it is bought or consumed. In some cases, the place is more influential than the product itself in the purchase decision” (Kotler, 1973; cited in Diep and Sweeney, 2008).

From a retailing perspective, Harnett (1998) emphasizes that, “When retailers satisfy people-based needs, they are delivering value, which puts them in a much stronger position in the long term” (Harnett, 1998; cited in Diep and Sweeney, 2008). Place is important in the extent to which it satisfies and facilitates needs. Stokols and Shumaker (1981) suggest that the degree to which a particular setting satisfies the needs and goals of an individual determines his or her judgment of its value. This value judgment regulates the frequency of usage of the place. While psychological factors of people determine the cognitive process of attachment to place, the needs of people establish the emotional and symbolic content of the bonds (Inalhan, 2006).

The recent move toward treating the retail environment as a setting for delivering memorable, relevant, and valued experiences is spreading globally (Diep and Sweeney, 2008). Mall developers, along with facility managers, are attempting to allure customers by creating an

exciting shopping experience designed to attract and keep them at the mall (Cockerham, 1995; Wakefield and Baker, 1998). However, the development of new products and services should be based on a better understanding of customer needs and their shopping value within the context of behavioral setting (the shopping mall). Facility managers require this knowledge to develop strategies to differentiate from the competition.

Wakefield and Barker (1998) say that consumer studies and marketing research have revealed that many consumers are apt to make a decision regarding where to shop on the basis of their attitude toward a mix of stores and the mall or shopping center environment (Finn and Louviere, 1990, 1996; Gentry and Burns, 1977). Yet, to date there have been limited empirical studies on way-finding and orientation in buildings, which are an important criteria for environmental behavior (Dogu and Erkip, 2000).

Way-finding has been shown to be one of the most irritating aspects of the shopping process to the point that it negatively affects the people's general attitude towards the setting and likelihood of buying the items searched for (D'Astous, 2000; Hackett et al., 1993). Shoppers' way-finding is an increasingly important problem in the management of shopping malls (Chebat et al., 2005). It is an issue that is not considered sufficiently during the design process as well.

O'Neill and Jasper (1992) suggest that research carried out on consumer spatial cognition and way-finding can be better understood when it is analyzed in environment and behavior contexts. Therefore, this study addresses the factors that affect the way-finding behavior of individuals in a shopping mall and how people's behaviors are influenced by factors such as building configuration, spatial layout and architectural features of the shopping mall. This research differs with others in the sense that it is framed within the transactional paradigm of environmental psychology, which assumes the transactional unity of the bi-directional nature of environment and behavior relations. Within this study, environmental and behavioral relations are evaluated along four dimensions: (1) the degree to which research incorporates the notion of the physical environment, (2) the degree to which research addresses person-based (individual difference) variables, (3) the use of behavioral outcome measures, and (4) the relationship between those variables.

The objectives of the study are:

- to utilize the effect of the spatial layout and architectural features of the shopping malls on way-finding
- to evaluate the specific characteristics of the way-finding processes and strategies followed by several types of shoppers (individual differences)
- to evaluate consumer spatial behavior by understanding the way-finding experiences, space use, and needs of users and their relationship between patronage preferences of shopping malls.

This article includes the following sections: Following the introduction as the underlying basis of our study, the subsequent section details consumer behavior as demonstrated by previous studies, customer shopping values, and way-finding in shopping malls. Having examined the literature and identified the key areas of concern of our study, the next section introduces the comparative case study of the two shopping malls constructed within the same period of time in Kayseri, Turkey. The final section derives implications for research, design and managerial actions.

## 2. Literature review

A review of consumer behavior research literature reflects its multifaceted nature (Babin et al., 1994). A number of theories of buying behavior have been postulated and considerable progress has been achieved in identifying the behavioral dimensions of buying. However, less is known about the determinants of consuming and shopping, which are also of substantial theoretical and managerial importance (Tauber, 1972).

Having set the underlying basis of the study, this part addresses the previous studies on shopping setting (atmosphere), shopping motivations of shoppers, way-finding and consumer spatial behavior models, which are recognized as the determinants of shopping.

### 2.1 Shop atmospherics

Consumers prefer to shop where they believe they will receive the most satisfaction and value from the store and the merchandise acquired (May, 1989). Kotler (1973) argues that, in their purchase decisions, people respond to more than just the tangible product or service and that elements of the store, such as store atmospherics, may be more influential than the product itself (Diep and Sweeney, 2008).

Atmospherics, which involves the conscious design of an environment's space to influence shoppers (Kotler, 1973; Bitner, 1992), is typically conceptualized as a way to enhance shoppers' emotional responses, which are then expected to positively impact their attitudes, perceptions, and shopping behaviors (Bellizi and Hite, 1992; Chebat and Morrin, 2007). Substantial research in marketing has examined the impact of store atmospherics on retail store patronage (Baker et al., 2002; Turley and Chebat, 2002; Michona et al., 2005; Raajpoot et al., 2008). Previous research demonstrates how ambient conditions, including store layout, design and signage, and employee and customer appearance, evoke varying levels of emotions among patrons (Baker; Bitner and Darden, 1996), and that these emotions impact store shoppers' approach/avoidance behaviors (Donovan and Rossiter, 1982), willingness to buy (Baker et al., 1992); price perceptions (Grewal and Baker, 1994); perceived value (Babin et al., 1994); current period purchase behavior and customer satisfaction (Babin and Darden, 1996). Mall atmospherics can have significant effects on shoppers' perceptions, not only of their environment but also of the quality of products sold in the environment. Researchers recognize that the effect of



atmospheric on consumers' perceptions is driven largely by cognitive rather than, or in addition to, affective mediational routes (Chebat and Morrin, 2007)

## 2.2 Shopping Values

Baker et al. (2002) suggest that the most important role of a store is its ability to facilitate consumer shopping. Yet the goals of all shoppers are not the same. For some convenience shoppers, getting in and out of the store quickly and ease of finding the merchandise they seek may be very important, while for the more serious shoppers, information and demonstrations may be more critical (Raajpoot et al., 2008). Previous research supports the concept that shopping trips provide both hedonic and utilitarian value (e.g., Babin et al., 1994; Jones et al., 2006).

While utilitarian shoppers focus mainly on completing a task of finding items in a rational and efficient way, hedonist shoppers primarily enjoy the very process of shopping. Utilitarian shoppers' strategies are geared at solving problems efficiently, based on landmarks and/or other persons. Hedonist shoppers' strategies are meant to enhance enjoyment through experiencing the shopping space and sensorial excitement. In this regard, the layout of the mall can act as a design cue that influences consumers' expectations of efficient movement through a store (Titus and Everett, 1995).

## 2.3 Way-finding

Way-finding is defined by Passini (1977, 1984, 1995, 1996) as a multifaceted spatial problem-solving that is composed of three different processes: (1) Cognitive mapping is the process of acquiring, forming, and maintaining spatial information and spatial knowledge. This process leads to forming cognitive maps (2) Decision-making is the stage at which individuals make choices among the possible courses of action.(3) Decision-execution is the ultimate stage at which individuals transform their decision into actions.

Since Passini's (1977, 1984, 1995, 1996) seminal studies, there have been number of studies examining the factors affecting way-finding. These factors have included the use of maps (Gerber and Kwan, 1994), subjects' navigational aptitude (Holscher et al., 2007; Kato and Takeuchi, 2003), familiarity with the environment (Chebat et al., 2005; Holscher et al., 2007), the layout of the environment (Holscher et al., 2007) and way-finding in the context of shopping (Chebat et al., 2005; Dogu and Erkip, 2000; Titus and Everett, 1996). Findings from these studies have agreed with Passini's (1981, 1984) model, and have helped to identify the use of a number of additional way finding strategies (Gerber and Kwan, 1994; Holscher et al., 2007; Kato and Takeuchi, 2003; cited in Spiers and Maguire, 2008)

Only a few of the consumer studies have explored the cognitive processes followed by shoppers in shopping environments (such as stores or shopping malls). Of particular importance are the

two studies by Titus and Everett (1996), which aim at understanding navigation processes in a supermarket, and Dogu and Erkip's (2000) study that focuses on the way-finding processes in a Turkish shopping mall.

Titus and Everett (1995) make a series of theoretical propositions and suggest that way-finding processes could reflect shopping values, as defined by Babin et al. (1994). For Titus and Everett (1995), utilitarian shoppers use way-finding strategies differently from those of hedonist shoppers. The utilitarian shoppers are hypothesized by Titus and Everett (1995) to have specific behaviors, such as moving rapidly, not changing their way, not stopping, and limiting their contact with the environment to persons and things essential to their problem solving. On the other hand, hedonist shoppers are hypothesized to move more slowly, to stop frequently, and to change their routes. It may be argued that hedonist shoppers enjoy browsing through the stores, which enhances their experiential pleasure of shopping. Quite the opposite, the legibility of the environment affects the utilitarian shoppers' strategies more than those of hedonist shoppers.

This study proposes that individual differences, familiarity, and shopping values impact way-finding processes and strategies. The preference of shoppers to shop is influenced by their way-finding strategies. The methodology employed in the study aims at understanding this under-researched question, that of how shoppers find their way in malls and how way-finding contributes to the preferences of shopping malls.

## **2.4 E-B Models for predicting consumer behavior**

In the field of environmental psychology, environment and behavior models have a number of qualities that make them uniquely suited to conducting this research. Environmental psychology is an area of psychology that studies the transactions and interrelationships between experiences and actions of people with their socio-physical surroundings. This field studies how people perceive and interact with their environment, as well as examines the ways in which people can develop more compatible relationships with the environment (Russell and Snodgrass, 1987; Stokols and Altman, 1987; Cassidy, 1997; Bell, Fisher, Baum and Greene, 1990).

Environmental psychology deals with "environment" at two different levels. On the one hand, environmental psychology is concerned with environments as the context of behavior. Our moods and behaviors are meaningful only if they can be understood in terms of their context. In this sense, the environmental features (affordances) are possibilities provided by an environment are strong determinants of behavior, such as you cannot sit unless there is a chair (Cassidy, 1997).

At a second level, environmental psychology is also concerned with the consequences of behavior on the environment. Environmental psychology incorporates both of these levels of

environmental influence and in studying how people interact with specific concerns determines how environments influence people and how people influence environments (Cassidy, 1997).

In an environment-behavior model, a relationship between objective features of the physical environment, the person (individual differences, perceived attributes of the environment, cognitive processes), and the outcome behaviors are specified (Figure 1) (O’Neill and Jasper, 1992).

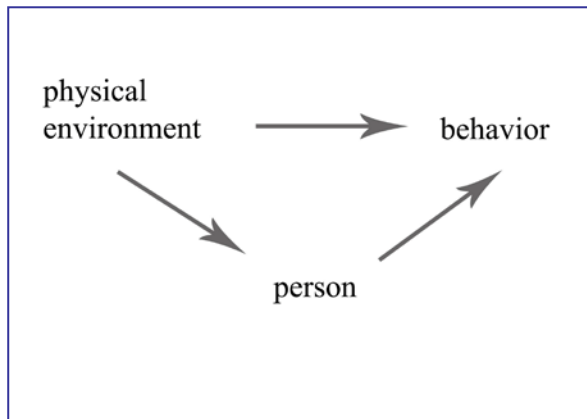


Figure 1: Elements of the Environment-Behavior Model (taken from O’Neill and Jasper, 1992)

In their overview of models of consumer spatial behavior in the context of environment-behavior paradigm, O’Neill and Jasper (1992) point out that there is a lack of a larger framework (model) in which to understand the relationships between the variables (individual, environmental and psychological) on spatial cognition and way-finding.

Specifically, a cognitive representation model that employs the notion of cognitive maps as a predictor of spatial behavior can be useful in examining mall selection (preference) and patronage as the outcome variable. The physical variables of shopping environment such as layout, gates, store atmospherics...etc. are then determined and related to people’s cognitive structure (cognitive maps) (Figure 2)

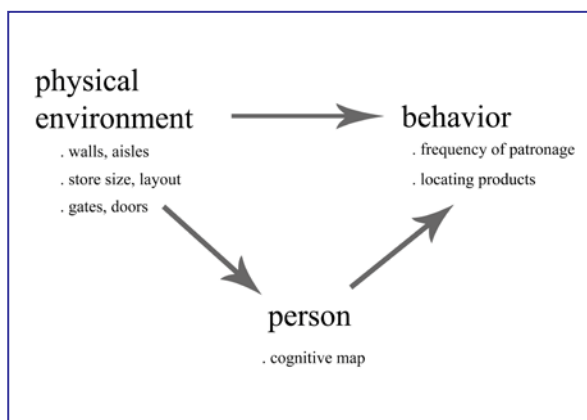


Figure 2: The Cognitive Representation Model (taken from O’Neill and Jasper, 1992)

Despite its problems, consumer spatial models have the potential of enhancing research on spatial cognition and way-finding. It has been suggested by O'Neill and Jasper (1992) that spatial cognitive behavior models could be extended if additional explanatory variables taken from the consumer literature are incorporated.

Therefore, this research addresses the influence of way-finding design on the shopping experience in shopping malls by broadening the model of spatial cognition and way-finding (the cognitive representation model) through the addition of variables (individual differences-user shopping values) used in consumer research. It explicates the relationships between environmental, personal and behavioral variables acting on way-finding design. A better understanding of how way-finding design influences emotions and behavior may improve the knowledge on designing future shopping malls. In the next part, the research strategy and the methodology adopted for the research is explained and the field study is presented.

### 3. Research Design

This study seeks to establish the role played by way-finding design principles on behavioral settings, the shopping experience of its users in shopping malls and users' preferences of these facilities. A field study method was chosen in order to gain information directly from individuals within the retail shopping setting. As such, customers' perceptions and feelings about the shopping environment (i.e., ambience, layout, & design), tenant variety (Dawson et al., 1990), shopping values (Babin et al., 1994) and their way finding strategies (Passini, 1977, 1996) were the focal points of the study.

An opportunity arose to study two shopping malls that were constructed within the same period of time (in 2006) within the same neighborhood (same proximity) in Kayseri, Turkey. Although these two shopping malls have similar layout design and square footage, prior observations and chats with local people indicated that only one of them is considered favorably, leaving the other less visited. The comparative research study method can provide the opportunity for a field experiment, lead to fresh, exciting insights and a deeper understanding of issues that are of central concern in two different shopping malls' frequency of usage and patronage. Therefore, these two shopping malls were chosen for a comparative research study in order to seek explanations for similarities and differences and assess diversity of users' behaviors. The aim of such a comparative study was to identify and illuminate similarities and differences, not only in the observed characteristics of the selected shopping malls, but also in the search for possible explanations in terms of likeness and unlikeness and how these affect shoppers' preference of shopping.

The comparative research approach combines methods such as surveys, secondary analysis of data, and also personal observation and an interpretation of the findings in relation to their wider social contexts (Hantrais, 1995). In this research the consumer behavioral setting was examined in two parts: the features and the motivations of the users and the features belonging to space (spatial organization). These variables and their influence on each other were tested in a comparative study. Both quantitative and qualitative research methods were utilized in this

study. Quantitative research data were gathered by means of questionnaires to users of both shopping malls. We felt that it was important to cultivate an ability to recognize, listen, and respond to how the people feel about their environment and their experiences within the built environment; therefore, we used qualitative research data consisting of interviews with consumers, while behavioral mappings at both shopping malls were also introduced to the study.

### **3.1. Field Setting-Sample-Questionnaire**

In order to test the hypothesis, the shoppers were surveyed in two enclosed shopping mall (i.e., each containing three branch department stores with reduced square footage, a major discount store, and 20 smaller stores serving an immediate area of about 20,000 residents). These two malls represent the primary source of clothing, shoes and electronics within a 2-3 mile radius of the community.

Data were collected from mall patrons during peak hours (11:30am -9:00pm weekdays; 10am-6pm weekends) over the course of two weeks by a survey administrator located near the mall entrances. The survey administrator identified herself with the mall management. Overall, 100 surveys were collected and all of the items were completed and were therefore useable for the analysis.

A three-part questionnaire was administered to the shoppers. The first part of the questionnaire consists of questions related to shoppers' age, gender, educational level, and familiarity with the mall (frequency of their visits). The second part utilizes the 'shopping values' scale developed by Babin et al. (1994), and adapted by Chebat et al., (2005). This scale is made up of ten attitudinal statements that reflect and measure the values that the shoppers of this study attribute to shopping in general, not specifically to the shopping trip involved in this study. In the third part a synthesis of attitudinal questions and behavioral questions are in the form of five-point scales labeled either "strongly agrees" to "strongly disagrees." These aim of these questions is to measure attitudes towards specific way-finding issues (Passini, 1977, 1996) in the two shopping malls.

### **3.2 Observations-Behavioral Mapping-Cognitive Mapping**

The most frequently used methods in way-finding design are behavioral maps and cognitive maps. In the initial stage of the study, the observational data from behavioral maps are used for the purpose of description of settings, activities, people, and the meanings of what is observed from the perspective of the participants. It is important to acknowledge that 'observation' is more than just recording of data from the environment; it also involves the interpretation of that sense data (Zeisel, 1981; 2006). However, as this study aims at understanding an under-researched question, that of how shoppers find their way in malls and what strategies they develop while navigating the mall, behavioral maps would be insufficient, since consumers would have difficulties expressing their behaviors and the consequences of their behavior

would thus go unnoticed. Therefore, shoppers were asked to produce their cognitive maps to us. Specifically, the shoppers were instructed to find a store predetermined by the researchers. They were further asked to describe their own behavior while finding that store within the mall. They were asked to express their actions and their thoughts at the very moment when they came to their mind. They were followed by the researcher throughout the process. More precisely, shoppers were asked:

(1) to say what they are doing (e.g., I turn left ).

(2) to say why they are doing what they decided to do (e.g., I made a mistake, I have to come back ).

This approach focuses not on the observation of what shoppers do, but on all the thoughts that lead them to act as they do. For instance, simple observations cannot tell why shoppers decide to turn back, or what information they ask a passer-by. This method is also different than a self-report after the fact, i.e., shoppers describe what they have done and thought to find their way once the whole way-finding process is over. These self-reports imply some problems, such as rationalization after the fact and loss of memory of certain steps in the process followed by shoppers (Chebat et al., 2005).

## 4. Conclusions

The most important role of a store is its ability to facilitate consumer shopping (Baker et al., 2002). In order to generate the best shopping experience, every mall should provide something unique (Allard et al., 2009). Facility managers must seek ways to not only meet the consumer's objective and functional needs but also to enhance the purchasing experience by making the store a more enjoyable place to be. Way-finding and orientation in buildings can serve as tools for triggering the desired environmental behavior in shopping malls.

Though the study is in its initial stages of data analysis, it is possible to draw some tentative, but potentially important, conclusions from this research. Way-finding is an important issue in the management of shopping malls. It deserves more attention from the shopping mall managers, since it directly affects the non-monetary costs of shopping (Chebat et al., 2005). The results of the study can offer facility managers of shopping malls a greater understanding of consumers' perceived values in terms of products, stores, and the shopping experience and thus suggest new ways to make an overall shopping experience more experiential and exciting for customers by means of way-finding design. Thus understanding the experiences, space use, and needs of users may contribute to the user-centered facilities management, planning and design of spaces that function effectively, accommodate the wider user needs, reduce the time and stress in accessing those environments.

## 4.1 Limitations and directions for future research

An essential part of way-finding is the development and use of a cognitive map. A cognitive map is a mental representation of an environment. It has been called a “picture in the head” although there is significant evidence that it is not purely based on imagery but rather has a symbolic quality (Darken and Peterson, 2001). Future studies can address this symbolic quality.

The literature on way-finding is dominated by a cognitive problem-solving process, though it also involves an emotional relation with the environment. Some cues of the environment could be charged emotionally and affect the navigation process. The emotions triggered by way-finding experience should also be taken into account.

The sample size in this study precludes any generalization. Future studies could be undertaken in shopping malls with bigger samples where age and diversity of people (such as old and handicapped people) could be also varied. The experimental procedure used in the study imposes a limitation. The very fact of asking respondents to find a specific store puts them in a utilitarian attitude toward the trip to the mall. Future studies could develop a methodology that encompasses this bias.

## References

- Allard T, Babin B J and Chebat J C (2009) When income matters: Customers evaluation of shopping malls' hedonic and utilitarian orientations, *Journal of Retailing and Consumer Services*, (16): 40-49.
- Ashley B (1997). "Are Malls in America's Future?" *Arthur Andersen Retailing Issues Letter*, 9 (6), Texas A&M University Center for Retailing Studies.
- Babin B J and Darden W R (1996) "Good and Bad Shopping Vibes: Spending and Patronage Satisfaction," *Journal of Business Research*, (35):201-206.
- Babin B J, Darden W R, and Griffin M (1994) "Work and/or Fun: Measuring Hedonic and Utilitarian Shopping Value," *Journal of Consumer Research*, (March): 644-657.
- Baker J, Grewal D, and Levy M (1992). "An Experimental Approach to Making Retail Store Environmental Decisions," *Journal of Retailing*, 68 (Winter): 445-460.
- Baker J, Parasuraman A, Grewal D and Voss G B (2002) The influence of multiple store environment cues on perceived merchandise value and patronage intentions, *Journal of Marketing*; 66:120–41.
- Bell P, Fisher J, Baum A and Greene T. (1990), *Environmental psychology*, Fort Worth, TX: Holt, Rinehart and Winston, Inc.
- Bellizi JA and Hite RE (1992) Environmental color, consumer feelings and purchase likelihood, *Psychology of Marketing* 9(5):347–63.

Bitner M J (1992) "Servicescapes: The Impact of Physical Surroundings on Customers and Employees," *Journal of Marketing*, 58 (April): 57-71.

Cassidy T (1997), *Environmental Psychology*, Taylor and Francis: Hove.

Chandler S (1995) "Where Sears Wants America to Shop Now," *Business Week*, (June 12): 39.

Chebat J C, Gelinac-Chebat C and Therrien K (2005) Lost in the mall, the effects of gender, familiarity with shopping mall and the shopping values on shoppers' way finding processes, *Journal of Business Research* 58, 1590–1598.

Chebat J C, Morrin M, (2007) Colors and cultures: Exploring the effects of mall décor on consumer perceptions, *Journal of Business Research* (60): 189 – 196.

Cockerham P W (1995) "Homart Revives Virginia Mall with Renovation and Remarketing," *Stores*, (October): 16-18.

D'Astous A (2000) Irritating aspects of the shopping environment, *Journal of Business Research*; 49:149– 56.

Darken R P and Peterson B. (2001). *Spatial Orientation, Wayfinding, and Representation* in Ed. Stanney, K. *Handbook of Virtual Environment Technology*.

Dawson S, Bloch P H and Ridgway N M, (1990) Shopping Motives, Emotional States and Retail Outcomes. *Journal of Retailing* 22 Winter: 408–427.

Diep V C S, Sweeney J C (2008) Shopping trip value: Do stores and products matter? *Journal of Retailing and Consumer Services* (15): 399–409.

Dogu U and Erkip F (2000) Spatial factors affecting wayfinding and orientation: a case study in a shopping mall. *Environ Behav*; 32(6):731– 55.

Donovan R J and Rossiter J R (1982) Store atmosphere: an environmental psychology approach. *Journal of Retailing* 58: 34–57.

Finn A and Louviere J (1990) "Shopping Center Patronage Models: Fashioning a Consideration Set Segmentation Solution," *Journal of Business Research*, 21 (November): 259-275.

Finn A and Louviere J (1996) "Shopping Center Image, Consideration, and Choice: Anchor Store Contribution," *Journal of Business Research*, 35 (March): 241-251.

Gentry J W and Burns A C (1977-1978). "How 'Important' are Evaluative Criteria in Shopping Center Patronage?" *Journal of Retailing*, 53 (Winter): 73-86, 94.

Gerber R and Kwan T (1994) A phenomenographical approach to the study of pre-adolescents' use of maps in a wayfinding exercise in a suburban environment, *Journal of Environmental Psychology*, 14, 265–280.

Grewal D and Baker J (1994) Do Retail Store Environmental Factors Affect Consumers' Price Acceptability? An Empirical Examination, *International Journal of Research in Marketing*, 11.



Hackett P M W, Foxall G R and Van Raaij W F (1993) Consumer in retail environments, *Environment and Behavior*; 27:378–99.

Hantrais L (1995) Comparative Research Methods, in *Social Research Update*, Issue 13.

Harnett M (1998) Shopper needs must be priority. *Discount Store News* 37 (May), 21–22.

Holbrook M B (1986) Emotion in the consumption experience: toward a new model of the human consumer. In: Peterson Robert A, Hoyer Wayne D, Wilson William R, editors. *The role of affect in consumer behavior: emerging theories and applications*, Lexington, MA: D.C. Heath.

Holscher C, Meilinger T, Vrachliotis G, Brosamle M, and Knauff M (2007) Up the down staircase: Wayfinding strategies in multi-level buildings, *Journal of Environmental Psychology*, 26(4): 284–299.

Inalhan G (2006) “The role of place attachment on employees’ resistance to change in workplace accommodation projects”, unpublished PhD thesis, Reading University, Reading.

Jones M A, Reynolds K E and Arnold M J (2006) Hedonic and utilitarian shopping value: investigating differential effects on retail outcomes, *Journal of Business Research* 59: 974–981.

Kato Y and Takeuchi Y (2003) Individual differences in wayfinding strategies, *Journal of Environmental Psychology*, 23: 171–188.

Kotler P (1973) Atmospherics as a marketing tool, *Journal of Retailing*, 49: 48–64.

Kowinski W S (1985) *The Mailing of America*. New York: William Morrow and Company Inc.

May E G (1989) A retail odyssey, *Journal of Retailing* 65 (3): 357–367.

Michon R, Chebat J C, Turley L W (2005) Mall atmospherics: the interaction effects of the mall environment on shopping behavior, *Journal of Business Research* 58: 576–583.

O’Neill M J and Jasper C R (1992) An evaluation of models of consumer spatial behavior using the environment-behavior paradigm, *Environment and Behavior*, 24, 411-440.

Passini R E (1977) *Wayfinding: a study of spatial problem solving with implications for physical design*, unpublished PhD thesis, The Pennsylvania State University, Environmental Science, USA.

Passini R (1984). *Wayfinding in architecture*. New York: Van Nostrand Rienhold.

Passini R (1995). Spatial representations: A wayfinding perspective. In T. Garling (Ed.), *Urban Cognition* (pp. 139-150). London: Academic Press.

Passini R (1996) Wayfinding design: Logic, application and some thoughts on universality, *Design Studies*, 17, 319-331.

Raajpoot N A, Sharma A, Chebat J C (2008) The role of gender and work status in shopping center patronage, *Journal of Business Research* (61) 825 – 833.

Russell J A and Snodgrass J (1987), Emotion and the environment, In D. Stokols and I. Altman (Eds.), Handbook of environmental psychology, Toronto: John Wiley and Sons.

Spiers H J and Maguire E A (2008) The dynamic nature of cognition during wayfinding, *Journal of Environmental Psychology* 28: 232–249

Stokols D and Altman I (Eds.) (1987), Handbook of environmental psychology, Volume 1 and 2. New York: Wiley (Reprinted by Krieger Publishing Company: Malabar, FL, 1991).

Stokols D and Shumaker S A (1981), People In Places: A Transactional View of Settings, In J. Harvey (Ed.), Cognition, Social Behaviour And Environment, Hillsdale, Nj: Erlbaum.

Tauber E M (1972) Why do people shop? *Journal of Marketing* 36:46–59.

Templin N (1997) "Mall Designer is Master of (Ersatz) Regional Flavor," *The Wall Street Journal*, (December 31): B1.

Titus P A and Everett P B (1995) "The Consumer Retail Search Process: A Conceptual Model and Research Agenda," *Journal of the Academy of Marketing Science*, 23 (2): 106-119.

Titus P A and Everett P B (1996) Consumer wayfinding tasks, strategies, and errors: an exploratory field study, *Psychology of Marketing*, 13(3):265– 90.

Turley L W and Chebat J C (2002) Linking retail strategy, atmospheric design and shopping behaviour. *Journal of Marketing Management* 189 (1/2): 125–145.

Wakefield K L and Baker J (1998) Excitement at the mall: determinants and effects on shopping response, *Journal of Retailing*, 74 (4).

Zeisel J (1981) *Inquiry by design*, Monterey, CA: Brooks/Cole.

Zeisel J (2006) *Inquiry by design*, revised edition, W. W. Norton and Company Inc, New York.

# Adding value to users in hospital facilities management: a Brazilian experience

## **Daniella Kulaif Safatle**

Architect, MBA Candidate, Escola Politécnica – São Paulo University.  
daniella@afasa.net

## **Rogério Santovito**

Civil Engineer, MBA, M.Eng, PhD researcher.  
Real Estate Research Group at Escola Politécnica – São Paulo University  
rogerio.santovito@poli.usp.br

## **Abstract**

### **1 Aim:**

Hospitals have become aware of the increasing demand for high quality and complex medical and hospital services, thereby prompting the adaptation to a new reality, of competitive markets, wherein quality of service is crucial for an organization's success.

The skills of the physicians and his team and the hospital's cleanliness are no longer enough to satisfy the demands of the new user profile of Brazil's private hospitals.

Patients demand science, technology, comfort and safety alike. They expect their fears to be minimized by means of a visually pleasant environment which is far from the cold, conventional ambience of traditional hospitals. Patients want to be connected with the world not only through the telephone, but also via newspapers, magazines, television and the Internet. They do not want to feel like outcasts, and demand a pleasant and humanized environment, even within the complex framework of a hospital.

### **2 Methodology or approach:**

This paper is the result of research carried out at the most important private network hospitals in Brazil, whose objective was to identify changes implemented in the organizations, in order to provide patients with more efficient and satisfactory assistance. It is also based on the literature published on the subject matter.

The methodology confined the scope of the research to survey data from healthcare organizations accredited both by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and by the *Consórcio Brasileiro de Acreditação* (CBA) (the Brazilian Accreditation Consortium).

### **3 Conclusions:**

The offer of more user-centred services has significantly increased in several Brazilian cities, thus providing for more and better options. This is due to the increase in the demand for better services, the pursuit of different qualifications in relation to the existing competition between the healthcare organizations and because of the growing interest in hospital tourism.

### **4 Limitations of the Research:**

In addition to the scarcity of available literature, Brazilian hospitals provide several randomly implemented services according to their structure and needs, instead of the full array of existing possibilities, although some of these hospitals have realized their status has changed based on the added value these services bring to their product.

### **5 Practical applications:**

The role of the hospital manager has been adapted to this new demand. Many hospitals offer new and diversified services to create an image of trust with their public, so as to meet not only their clients' needs, but also their own expectations.

**Keywords:** Hospital, accreditation, health care services, facilities, hotel services.

# 1. Adding value to users in hospital facilities management: a Brazilian experience

## 1.1 Introduction

The service industry not only accounts for the biggest share of the global GDP, but is also the fastest-growing industry in comparison to the other economic sectors. This growth can be attributed to several reasons; in the context of this paper, it is important to emphasize the population's demographic growth, consumers' increasing sophistication and the exponential technological progress. In this scenario, hospitals – given the nature of their activity – are defined as one of the most complex human organizations that have ever been created. In addition to requiring increasing and specific investments, hospitals are among the fastest growing institutions in the world.

To meet this growing demand, new equipment and techniques stemming from advances in medicine and technology have been incorporated into the daily life of these institutions. Because of increased medical knowledge and the development of new equipment, patients are more accurately diagnosed, recover faster and stay for shorter periods of time at the hospital, despite the fact that some patients remain hospitalized for long periods of time because of the seriousness of their clinical condition. It is the responsibility of hospital administrators to keep up with this evolution, so that all parties involved – especially health care managers at all levels – be required to rationalize the available resources and use them efficiently.

The profile of users who avail themselves of hospital services has become significantly diversified throughout the years, in view of the growing demand for cosmetic and reconstructive plastic surgery and for high quality hospital services. On account of these changes, hospitals in Brazil have been looking for a new identity, far from the image of a cold and impersonal institution that is traditionally linked to this kind of facility. Many hospitals have taken on a new attitude in the sense of enhancing patients and human capital, because of the risk of becoming stagnated or outdated when compared to their competitors.

Nonetheless, the administration of most hospitals in Brazil is still characterized by conservative standards as regards attitudes and management. There is strong resistance to new behaviors and new administrative trends within these organizations, especially at public hospitals, where the overriding fear is that the hospital will lose its traditional characteristics if it embraces new tendencies. These paradigms have been gradually breached by private hospitals which, like everything else in the market, seek to be outstanding among their competitors and aim at achieving a 100% occupancy rate at their facility. To this end, hospitals implement unique features to increase their competitiveness and strengthen their position in the sector.

The responsibility of a hospital facility is not only pegged to patient's satisfaction; it is also pegged to the maintenance of an even more important asset, which is human life. The concern in relation to a human being's well-being during a hospital stay should begin at the moment the hospital is being created, even before it goes into operation. This humanization must exist during the entire development of the facility, ranging from the time the hospital site is chosen to the time the architectural project is being conceived. The focus must be on taking the utmost advantage of the available natural resources; the focus must also be on the construction and on the operation of the facility. Natural illumination, adequate ventilation, greenery and available gardens, appropriate insulation, open areas and spaces that provide adequate circulation, efficient accessibility, and resting areas, among other features, are factors that contribute to the conception of a hospital facility that satisfies its users and makes the hospital stay less distressing for the patient and his or her family members.

The level of trust established between the patient and the hospital is defined right from the start by the physical and structural features, the promptness of the hospital staff, speedy and efficient services; in short, by the level of hospitality offered to the patient. This hospitality is linked to the entire hospitalization process, to the patient's improvement and to the satisfaction of the patient's family and friends. It can be the decisive factor for the success or failure of this kind of business venture.

In order to do so, it is necessary to train a multidisciplinary team led by the manager of the facility. Such a team must be comprised of architects, engineers, biologists, physicians, nurses and other health care professionals, who keep track of the service flow and focus on the layout of the spaces for the installation of equipment, for appropriate electric, hydraulic and biosafety support, all of which will produce more satisfactory results.

## **2. Hospital Accreditation in Brazil**

Accreditation is considered as an element of strategic importance, as it is linked to the concept of compliance with established standards. This represents a guarantee for clients/patients and for health care professionals who work at the facility. The main objectives of accreditation are to improve the quality of patient care and that of their escorts and provide a hazard-free environment for all the people who circulate on the premises, in line with internationally acknowledged standards of excellence.

The hospital accreditation process is viewed as an efficient criterion in the comparative evaluation of institutions, as it indicates that the services comply with previously established reference standards; this compliance is attested to through the monitoring of performance indicators, procedures, rules, standards, and recommendations. Each country follows a model or an institution, adopted according to the country's needs and reality.

The Joint Commission on Accreditation of Health Care Organization – JCAHO is the world’s oldest hospital accreditation organization. JCAHO, which relies on the on-going advisory services of its subsidiary, the Joint Commission International – JCI, was founded in 1951 by a group of medical associations from the United States and Canada. It is a non-profit, non-governmental association whose mission is to foster a culture aimed at the continuous improvement of the quality of medical care, based on the premise that health care services have to be provided at facilities that are safe for health care professionals and patients, provide adequate health care and the opportunity for patients to improve or recover. This organization has evaluated hospitals, laboratories, home care services and other health care organizations on a regular basis in the United States. JCAHO has accredited approximately 18,000 institutions, corresponding to approximately 85% of the American market.

The accreditation process entails verifications based on established standards, which evaluate the compliance of the structure, the processes, and the results achieved by the institution. This information is compiled by the accreditation agency which then prepares a preliminary decision report, followed by approval and granting of the accreditation. The accreditation is re-evaluated every three years.

In Brazil, hospital accreditation was instituted in September 2000, through an international accreditation agreement signed by the JCI and CBA/ Consórcio Brasileiro de Acreditação (Brazilian Accreditation Consortium), the exclusive representative of the Joint Commission International in Brazil. The JCI develops the methodology for the International Accreditation of Health Care Systems and Services.

According to the *Consórcio Brasileiro de Acreditação* – CBA (Brazilian Accreditation Consortium) or the *Associação Brasileira de Acreditação de Sistemas e Serviços de Saúde* – ABA (Brazilian Association for the Accreditation of Health Care Systems and Services), Brazil currently has approximately twenty hospitals that have been accredited at least once. Twelve of these hospitals are located in the city of Rio de Janeiro, state of Rio de Janeiro; seven in the city of São Paulo, state of São Paulo, and one in the city of Porto Alegre, state of Rio Grande do Sul.

In addition to the possibility of conducting an objective diagnosis on the performance of its processes, including direct patient care and processes of an administrative nature, hospital accreditation in Brazil promotes the actual improvement of the institution’s performance, encompassing all the existing services and segments, demanding the on-going qualification and training of the health care professionals, thus significantly improving the level of reliability of the attributions of each professional category.

Accredited hospitals have significant global exposure, which helps attract medical tourism patients. These patients come to Brazil in search of hospital facilities that offer special services focused on the continuous fostering of quality improvement actions to reduce

hazards to patients and health care professionals. Brazil has an internationally renowned tradition of welcoming foreigners with the utmost hospitality. Thus, medical tourism has specific characteristics which makes this new market niche highly attractive to hospital entrepreneurs, and has led many hospitals to seek accreditation, driven by the improvement of the quality and variety of the services they provide.

Once it is certified, an accredited hospital joins a select international network that allows for exchange and benchmarking among institutions. High-quality benchmarks are resorted to and clinical and management indicators are established. In the specific case of medical tourism, the absence of seasonality in the search for medical/hospital treatment and services results in year-round medical tourism, no matter what season of the year it is. The primary focus is the patient's recovery, which often implies immediate medical care.

According to the *Associação Nacional de Hospitais Privados* – ANHP (National Association of Private Hospitals), Brazilian medical care plans account for 95% of the annual revenues obtained by hospitals; only 5% of these revenues come from private patients. In this case, hospital accreditation places the institution at a higher level in the financial classification of reimbursements paid out by health insurance companies, which resort to a specific price list applied only to accredited institutions. Thus, the necessary investments in the accreditation process provide returns in the short term.

In addition, International Accreditation provides institutions with access to a variety of resources and services, such as an international quality evaluation system based on benchmarking among institutions that participate in the program; strategies for risk reduction and tactics to prevent adverse events; access to a data base on good practices; international newsletter published by the JCI and the institution's inclusion in events promoted by JCI and its partners around the world.

### **3. Hospital Administration**

In the last few years, a number of management techniques have been experimented at or applied in hospitals with the objective of maintaining or improving service standards, in order to detect the treatment with the best cost-benefit ratio for patients, by means of an efficient administration that seeks to achieve quality, cost reduction and optimization of resources.

By adopting policies, procedures, routines, and health care protocols backed by the hospital accreditation process, the hospital can ensure the excellence of the medical care provided to patients and their families. In this case, the demand to adapt the structures that comprise the physical environment of the facility to the legal requirements established in Brazilian laws, including the management of safety requirements related to the prevention and



control of emergency situations, ensures the safety of the services provided to clients/patients, escorts and visitors.

The accredited institutions establish an open relationship of trust with patients. This relationship understands and protects patients' cultural, psychological, social and spiritual values. Patients are informed of their rights and how to act in relation to their rights. The professionals are prepared to understand and respect patients' values and beliefs, to treat them with respect and consideration, protecting their dignity.

The basic functions of the hospital administrator comprised the general supervision of the institution by means of the analysis of the facility's performance indicators, financial and accounting supervision and analysis, planning and follow-up of projects, management of energy resources and the sustainable discarding of residues, materials and assets, building maintenance, medical equipment maintenance and compliance with the laws in effect. When hospitals began to show concern about the quality of the services, humane services became a highly important matter. Due to the need for a unique approach to the communication between people with health problems and the staff members involved with the health care services, it is crucial for health care professionals to constantly participate in special training programs. Consequently, new attributions were aggregated, linked or not to the accreditation process, such as the application of quality management principles and techniques, the implementation of humane programs and the expansion of the range of services offered to patients and their escorts.

The hospital administrator's efficiency is measured according to the hospital's capacity to provide high-quality services that are constantly available, and is related to the competence with which the administrator conducts his activities, always based on the costs generated by the institution.

#### **4. Hotel Services at Hospitals**

Hotel services at hospitals complement the hospital humanization programs and improved medical care services, resulting in acceptance and credibility. Hotel services at hospitals are a unique feature that have attracted the market's attention to hospital stays and have resulted in patient loyalty. Unique hotel service techniques, procedures and services have allowed hospitals to provide patients, their family members and collaborators with social, physical, psychological and emotional benefits. Hotel services at hospitals are a strategic competitive differential.

The acceptance of this concept is directly related to the purchasing power of each user or to the behavior patterns of each country that offers such services. In Brazil, the existence of hotel services at hospitals has become a basic feature required by higher-income patients. Many

private medical plans entitle higher income patients to these services, and these patients no longer waive this convenience.

At present, the hospitals' premises closely resemble hotel premises. Hospitals, like hotels, have a laundry, kitchen facilities, a storage room, and a reception, among others. Recently, hospitals have added such conveniences as shops, restaurants, flower shops and exclusive hotel services with the objective of increasing patients' comfort and satisfaction. New areas have been created or refurbished to improve the quality of the services provided to patients and ensure their satisfaction. These additions do not necessarily result in the need to hire more staff. More than 30 professional categories are involved in operating and support functions, including laundry staff, cleaning and gardening crews, etc.

Brazil now has a select group of hospitals offering high-quality standards and services for patients and their escorts. These hospitals offer exclusive hotel services and sophisticated environments to meet patients' high expectations.

The rooms are equipped with LCD television sets, cable TV, piped-in music, mini-bars, air conditioning, unique interior decorating, indirect illumination, electronic safe, desks, easy chair with foot stool, electronically regulated hospital bed, telephone, microwave oven and internet access. At most hospitals, this technology is controlled by a sophisticated remote control automation system or digital touch screen (GODOI, 2004). Some hospitals also provide independent entrance halls equipped with a meal room, bathroom and closet for the patient's escort.

Some hospitals employ hotel managers and chefs with international training as part of their staff. The chefs cook special meals, because many patients, especially those who undergo cosmetic surgery, do not have any diet restrictions. Staff members also include doormen, parking lot valets and busboys with hotel luggage carts.

The former receptions were turned into huge lobbies furnished with easy chairs. Shops, mini shopping malls, small museums and art galleries are located in these lobbies. Musical performances and unique landscaping help patients and visitors forget that they are in a hospital.

Brazilian hospitals have meditation rooms, libraries, helipads, book stores, sophisticated restaurants, special suites with waiting rooms, teleconference rooms, bars, playrooms for children, water aerobics facilities, hair salons, and recreation rooms. Patients can attend lectures and courses, theater skits and musical performances when they leave their rooms. Long hospital stays can be relieved by such activities as painting and fine arts classes, drawing classes, singing lessons, art history courses, music classes, games, literature, physical fitness exercises, and arts and crafts. Patients can also avail themselves of the services offered by non-governmental organizations, such as the *Doutores Alegria* and *Projeto Carmim*, whose

volunteers dedicate their time to activities that focus on patients' improvement and well-being (GODOI, 2004).

In addition to their potential to aggregate new services, hospitals currently employ professionals who would have been unheard-of in hospital environments, in order to establish new behavior and service standards for their patients. These new professionals include bilingual receptionists, hotel coordinators, architects, concierges, event organizers, and food and beverage managers who provide support to the dietetician staff.

As part of the support structure, some hospitals offer city tour transportation services for patients' family members and couriers to meet patients' needs. These services provide comfort and safety.

A number of hospitals in Brazil offer many of the services referred to above. The problem is that most of the hospitals implement one or two such services, instead of implementing the entire range. However, some hospitals have already perceived that they can aggregate value to their product by offering all or most of the referred services.

## 5. Medical Tourism

The benefits enjoyed by accredited hospitals include the proceeds from medical tourism. Hospitals that belong to this group have invested in the potential of this new and lucrative business modality by creating special teams that welcome the foreign clients who come to Brazilian hospitals through referrals in their native countries. These institutions provide all kinds of assistance, including the translation of doctor's appointments and medical records, support for family members' transportation around the city, hotel reservations, assistance in regard to the requirements of immigration authorities, and international medical care plans, among other services. Foreign patients do not have Brazilian medical care plans and pay for their own expenses.

Another reason why patients leave their native countries and travel to other countries for medical treatment is the fact that the prioritization of medical treatments varies according to each country's level of development. In developed countries such as France and Germany, for example, public health is based on preventive and diagnostic medicine, with focus on patient recovery and mitigation of the risk to the patient's life. In these countries, public and private hospitals are maintained by the government, and the treatments are aligned with these concepts. Hence, elective treatments – scheduled procedures which are important for patients but do not imply in risk to the patient's life – are conducted at the patient's expense. This is why patients who want elective treatments choose to travel to countries that offer these services at more affordable prices. In addition, patients often aggregate tourism to their hospital stay and

therefore choose hospitals and medical staff located in places that offer tourist attractions. This has led to the development of hospital complexes in developing countries.

## 6. Final Comments

In Brazil, private medical care is referred to as supplementary health care, with focus on the complementation of medical care. Public health care does not have the means to provide the necessary number of hospital beds for the population. Private medical care is based on purchasing power and tends toward the concept of elective medicine where, with the exception of more serious cases, the patient tends to choose the hospital where he wants to go and the treatment he needs or intends to undergo.

In this scenario, given that the hospitals' technological facilities are equivalent and given the relationship of trust established with the medical staff, the patient's selection criterion to choose the hospital is based on the evaluation of these hospitals' support services. Thus, the hospital facilities are a strategic differentiation and the central point around which the competencies existing at Brazilian hospitals revolve.

The quality of a hospital's accommodations and services determines the profile of the hospital's clients. Comfort is one of the factors that differentiates and enhances an institution, because these two elements are linked to the patient's expectations, moods and emotions. The transformation of a hospital room into an extension of the patient's home mitigates the impacts caused by the hospitalization.

The hospitality offered to patients can be an agent that fosters human warmth, in contrast with the sterility and coldness of the traditional hospital environment. The suffering undergone by patients and family members can be considerably minimized at times of pain and fragility, even though at times of extreme stress or physical and emotional frailty, human judgment is hampered, which often prevents the perfect evaluation or enhancement of the service rendered.

The pursuit for client/patient satisfaction, based on the differentials of rendered services, directly influences the attractiveness of the hospital/healthcare facility. From the perfect maintenance and working conditions of the equipment to the search for new services tendencies that may add value to the competitions between institutions, the hospital system must inevitably work in perfect synchrony with medical disciplines and that the constant changes in the sector be followed up. These strategic roles may only be delegated to a professional who has all these skills, so that - given the Brazilian reality - the role of hospital facilities manager in this type of institution is truly relevant.

## References

MALIK, Ana Maria; SCHIESARI, Laura Maria Cesar – Qualidade na gestão local de serviços e ações de saúde. Saúde e Cidadania, São Paulo: Fundação Peirópolis, 1998.

GODOI, Adalto Felix – “Hotelaria hospitalar e humanização no atendimento em hospitais” São Paulo: Ícone Editora, 2004.

CORRÊA, Henrique L.; CAON, Mauro – “Gestão de Serviços – Lucratividade por meio de operações e de satisfação dos clientes” São Paulo: Atlas, 2002.

MOURA, Anísio de; VIRIATO, Airton – “Gestão hospitalar – da organização ao Serviço de Apoio ao Diagnóstico e Terapêutico” Barueri/SP: Manole, 2008.

QUINELLO, Robson; NICOLETTI – “Gestão de Facilidades” São Paulo: Novatec Editora, 2006.

DIAS, Maria Antonia – “O novo conceito na hospedagem do cliente” São Paulo: Notícias Hospitalares, número 42, ano 4, 2003.



## Session 2 - Conceptual Models in FM

**Prof. Danny Shiem-Shin Then<sup>1</sup> & <sup>2</sup>Rogério F. Santovito, Research Fellow**

<sup>1</sup>The Hong-Kong Polytechnic University - Hong Kong/China

<sup>2</sup>EPUSP Escola Politécnica, University of São Paulo - MBA/USP FM - São Paulo/Brazil

<b>Facilities Manager = Innovation Manager?</b>	<b>89</b>
MOSS, Qi Zhou School of the Built Environment, University of Salford, UK	
<b>A Model For Assessing the Maturity of Facility Management as an Industry Sector</b>	<b>99</b>
BANYANI, Maulidi Abdallah; THEN, Danny. S.S. The Hong Kong Polytechnic University, Hong Kong SAR, China	
<b>The Business Process Outsourcing Strategy in Facilities Management</b>	<b>111</b>
MACEDO, Carlindo Martins Escola Politécnica da USP	
<b>Innovative Procurement and Partnerships in Facilities Management</b>	<b>123</b>
JENSEN, Per Anker Technical University of Denmark	
<b>A Conceptualisation for the Future Health Care Sector in Western Economies and its Relationship to Facilities Management</b>	<b>139</b>
HOFER, Susanne; DETTWILER, Paul Institute of Facility Management, Zurich University of Applied Sciences	
<b>The interfaces and impacts of designs, design management and scope at the facilities management</b>	<b>151</b>
MANESCHI, Karen; B. MELHADO, Silvio Escola Politécnica - USP - Construction Engineering Department	





## Facilities Manager = Innovation Manager?

**Qi Zhou Moss**

School of the Built Environment, University of Salford, UK

q.moss@salford.ac.uk

### Abstract

**Aim:** The Facilities Management industry, largely perceived as a service industry, has generally been recognised as lack of innovation and slow take up of new technologies. Many client organisations rely on the supplier's input as innovative ideas. This paper aims to look at facilities managers' roles in supporting organisation's demands in a constantly changing business environment. It argues that facilities manager should act as innovation managers and take the leadership in the innovation process.

**Methodology:** This paper is mainly based on literature review on innovations in the FM field. It also includes a small scaled questionnaire with the group of Facilities Managers who are taking part in the distance learning course at University of Salford.

**Conclusions:** An advertisement slogan for a major mobile phone company boasted that their new model has created "a holistic experience that is based on putting people at the centre". This is actually what facilities management should be. But to achieve that, facilities managers should play the role of "innovation champions", to raise the awareness of the need to innovate, to carry out experiment with new service concepts, new processes and new technologies, in order to craft an innovative workplace that creates stimulating and engaging experiences for all stakeholders.

**Limitation of the research:** The main limitation of the research is that it is mainly conceptual. None of the facilities managers in the recent MSc's course are active innovation managers. However, changes are already happening as some of them have designed innovation plans that were approved within their organisations. Therefore, it is possible for facilities managers to act as innovation manager in reality.

**Practical applications:** This paper calls for more facilities managers to play an active innovator role, to create and experiment with new ideas, in addition to add value to the core business by creating a holistic and innovative workplace.

**Keywords:** Innovation, innovation champions, innovative workplace

# 1. Introduction

## 1.1 The concept about innovation

“Innovation” is a buzz word that have widely used in modern society. However, when asked what “innovation” is, few would give the same answer. The first person who introduced the concept of “innovation” is Joseph Schumpeter (1934), who defined it as:

*“New combinations that are economically more viable than old ways of doing things.”*

He also categorised innovation as:

- Product innovation
- Process innovation
- Market innovation
- Input innovation
- Organisational innovation

The first two, especially product innovation, tend to dominate current researches and understanding about innovation. The innovation concept used in this paper will be focused on product and process innovation.

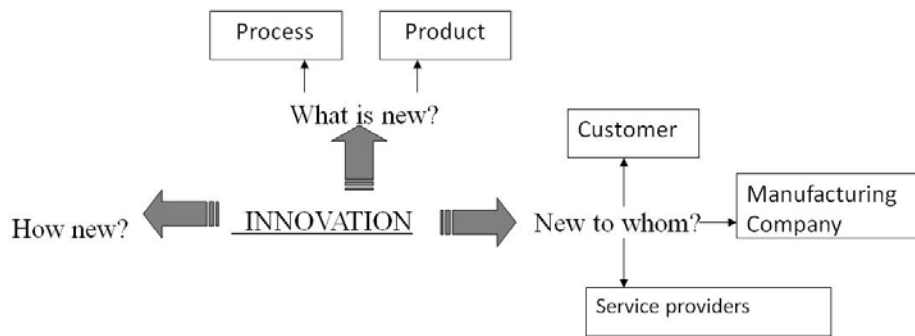
Whereas in UK, the most widely used definition of innovation is by DTI (2003):

*“Innovation is the successful exploration of new ideas.”*

Both definitions have differentiated innovation from invention. If we refer invention as “laying of an egg”, then innovation is “laying and hatching an egg”. There is no shortage of new ideas and inventions in the world. The challenge is to turn inventions successfully into products or processes. The key words here is “successful”- innovation needs to be associated with benefits, either “economically more viable”, better productivity or better quality. Therefore, when we hear the saying such as “80% of the innovation fail”, it should be restated as “80% of the exploration fail”.

The second main difference between innovation and invention is the “newness” concept. Invention is the creation of something that doesn’t exist before. In comparison, innovation could be a product or a process that is new to organisation A, but not necessarily to organisation B. As demonstrated by Johannessen (et. al. 2001) in Figure 1, innovation is more about the perception of being new.

This then leads into the degrees of innovation, which commonly been put into three types:



*Figure 1: The nature of newness in innovation (Johannessen et. al., 2001)*

- Incremental innovation - continuous, evolutionary
- Radical - revolutionary
- Disruptive - totally changed the way people behave

Incremental innovation improves on the current product or process. It is the most common type among the three, and it happens all the time. Radical innovation refers to the development of new businesses, products and/or processes that transform the economies of a business. It tends to involve technological break-through and could be a result from a series of incremental innovation. Disruptive innovation is the rarest amongst the three. It creates unmistakable challenges for established organisations, since it destroys the usefulness of their existing capabilities hence the disruption.

## 1.2 Characteristics of FM innovation

Facilities Management (FM) is largely seen as a service industry, therefore, it is more likely to have process innovation rather than product innovation. It is also more likely to have incremental innovation rather than radical or disruptive innovation, because it tends to undertake an adaptor approach rather than creator approach. As an industry, FM invests very little in R&D in comparison to manufacturing or pharmaceutical companies. As a result, it is quite often being perceived as lack of innovation and slow taking up of new technologies.

The DTI report “Innovation in Services” (2007) has pointed out that traditionally policies and measures of innovation have all been focused on the manufacturing sectors and that service sector has been neglected. This is worrying because the diverse range of services generates more than 75% of UK’s economy. Despite the common perception that services were not expected to perform R&D, when beginning to measure it, it appeared that they do (NESTA<sup>1</sup>, 2008). For example, according to the NESTA’s report, 24% of service firms introduce new products or services to the market. Although this is lower than 36% for manufacturing, it has to be taken into consideration that services R&D is different from manufacturing R&D and that

<sup>1</sup> National Endowment for Science, Technology and the Arts

services innovation is not just a matter of R&D. Services, in fact, spend a greater share of innovation expenditure than manufacturing firms on extramural R&D and external sources of knowledge (NESTA, 2008). The same report also shows that services actually spend more on innovation per head than manufacturing. Indeed, the DTI white paper has addressed service innovation as:

*“everything and anything that businesses do simply to survive”*

As an industry, FM has evolved rapidly in the past 30 years. From basement operations and outsourcing of basic support services, to board level involvement, delivery of 37-year contract and market value of more than £100bn (Intel, 2009), FM has to be innovative to continuously coming up with new services, new delivery models and new solutions to meet the changing demand of the clients. This is justified by Cardellino and Finch (2006), whom by looking at the 11 BIFM case studies, have believed that UK FM organisations are highly innovative.

On a daily basis, FM faces different challenges and pressures that are coming from both existing and new technologies in facilities and workplace. It is also the interface between businesses and its employees through supporting employees' activities in the workplace. Therefore, each facilities manager has to be adaptive, to respond to change, but also more importantly, to act as a driver of change (Puybaraud, 2006). Indeed, the advocating of facilities manager being innovation manager has already been started by Tony Thomson in 1992. Despite those early calls and some further development (Alexander, 2002), very few facilities managers have ever considered themselves as innovation manager. This paper will try to justify this leadership role by facilities managers from the perspectives of the drivers for innovation.

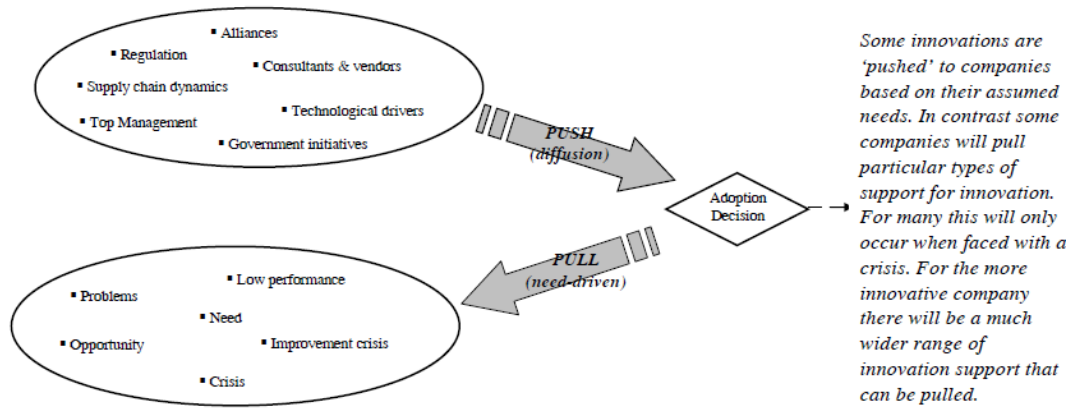
## **2. Drivers of innovation**

Just as any other business, the main sources of innovation in FM are a classic manifesto of push and pull factors. Push is the supply-feed aspect, in which FM suppliers or in-house FM team producing innovative solutions to improve delivery of FM services and strategic fit to the core business. Pull is the demand-driven aspect, in which either the client or the customers want the FM supplier/team to adapt to their needs.

### **2.1 Push**

In terms of supply-feed innovation, provided that innovation has already been differentiated from invention, we can see that one of the main sources for innovation is for the Facilities managers or suppliers to adopt best practice. The DTI report - Innovation Review (2003) has discovered that UK service firms' rate of best practices adoption is poor compared with that of its competitors. In contrast, the capacity to absorb and exploit new knowledge should be one of the critical success factors that UK firms should develop. The much quoted work of Leseure (et.al. 2004) has looked at the evidence on where UK firms had failed to reap the benefits of best practices often due to a failure of execution. They concluded that the overall evidence

could be best interpreted within the so-called technology-push and need-pull (TP/NP) models (Figure 2).



**Figure 2: Adoption drivers**  
 (adapted from Leseure et al., 2004 as quoted by Sexton & Barrett, 2003)

The FM market is very fragmented, with a few dominating international/national FM providers and many SMEs. For most of companies, the main concern is survival. Just as stated the above service innovation definition, they have to be innovative to be able to compete for client and business in order to survive. In other words, they have to improve their absorptive capacity in order to succeed and ensure company growth. The company with high absorptive capacity means that they can learn from their alliances, supply chain and consultants (Sexton and Barrett, 2003). However, this has to be complemented by adoption of a good innovation process, such as those designed by Cohen & Levinthal (1989), Roger (2003), Mudrak et. al. (2005).

So what should the Facilities Manager’s role be in the push process for an in-house FM team? He/she should act as Innovation Champion - individuals with specific types of energy are required to support innovation (Hartmann, 2008). According to Hartmann (2008), there are four types of champions:

- Power champion - using hierarchical position to shield innovation from opposition
- Technology champion - specific knowledge to remove barriers of ignorance
- Process champion - linked the people needed for innovation
- Relationship champion - binds people inside and outside the organisation

The Facilities Manager could act as all four champions:

- He/she has to be an individual who is not risk-adverse (as most facilities managers are) but also sit in a strategic position within the organisation (preferably board level). He/she would then use his/her power to implement the innovation process or drive change project through, thus playing the role of power champion.
- He/she is an individual with high absorptive capacity, who has grasped the newest technology or best practice. He/she can also communicate well with other teams within the organisation in order to implement this new technology/process, thus playing the role of technology champion.
- He/she is an individual who understand the process of innovation, the key people that need to be involved in the process and resources that are needed. He/she understands the needs to evaluate and re-evaluate the FM processes and its results, thus plays the role of process champion.
- He/she is already the interface between end-users and the supply chain by enquiring end-user requirements then matching them with best value services. He/she is also the translator of the organisation's strategic objectives into operational requirements for the FM services. Very often, he/she also directly delivers services to customers by providing the right physical setting. Therefore, he/she binds the suppliers with end users as well as binds the customers with the organisation, hence plays the role of relationship champion.

The importance of innovation champions has also been reflected in the 11 BIFM innovation case studies, in which Cardellino and Finch (2006) has reviewed that the presence of innovation champions in all the case studies are apparent.

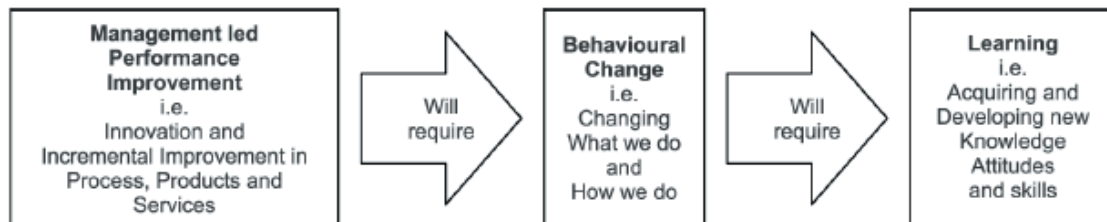
## 2.2 Pull

Now move onto the demand-drive aspect. One of the main reasons for organisation to outsource is innovation. They expect the specialist suppliers to bring in the best technology/process and continuously to deliver improved services. However, many clients have been disappointed in finding out that innovations only tend to happen at the initial stage of the contacts. So what can the client, or in our context, the Facilities Managers do to create the conditions to encourage suppliers to innovate?

First of all, facilities manager needs to be able to articulate the needs and also assess the proposal can satisfy the needs (Heywood, et. al, 2004). This means that he/she understands both implicit and explicit needs of the stakeholders, in addition to forecast their future needs. Service contracts thus need to have certain flexibility imbedded so that the changing needs can be reflected & driving the suppliers to innovate to accommodate the changing demand.

Secondly, facilities manager should set up appropriate performance measurement system. Despite the myth that performance measurement would eliminate innovation due to its rigidity,

research by Pitt and Tucker (2008) has argued that it can actually enhance the innovation process. They've stated that performance measurement system is the key in understanding and optimising learning processes in order to achieve behaviour changes (Figure 3). By assessing performance, decision making process will be guided which will result in incremental improvement in product, process and services. Thus performance measurement becomes one of the drivers for innovation.



**Figure 3: The link between learning and performance improvement**  
(Pitt and Tucker (2008) adapted from Buckler (1998))

Thirdly, facilities manager should create the incentives for innovation from the suppliers. Some of the service contract has an increasing performance threshold. That means, service provider cannot be complacent with their delivered services. They have to continuously come up with new proposals or new solutions that would improve their services. If they do so, they are rewarded by bonuses or contract extension. Incentives for innovation don't necessarily have to financial either. A badge for "innovative supplier of the year", or similar recognition would work just as well.

Fourthly, the management of competitions among the suppliers. Just as different FM suppliers compete with each other in the market, they also compete secretly in a multi-contract situation. Many FM suppliers offer a full range of different services, whilst they might only have contract in one service area. If manages well, the client could manipulate the relationships among different suppliers and manage a healthy degree of competition. Each supplier might feel a certain level of threats from the other suppliers, which would stimulate them to adopt best practice or use better product/process in order to maintain their contracts. This could be done via events such as supplier forum or club. However, the key is for the client to manage the degree of competition and stop it from being disruptive.

Lastly, the establishment of trust and partnership between the client and the supplier. Competitive tendering is very often a lengthy and expensive process. If the client has found a supplier that consistently fulfilling the requirements, it would be mutually beneficial to keep this supplier for a longer period of time and build up trust and relationship between the supplier and the client. This almost sounds like the opposite of the fourth point above. However, the advantage of trust and partnership is the improved level of communication, which is another key to innovation. The supplier will work more closely with the client, so to understand their demands better. The supplier will also be involved in some of the decision making processes,

inputting their expertise in certain area. By working in partnership with the client, the supplier will be more willing to bring in best practice from other clients, adapt/anticipate changing demands of the clients, or even try to fit in the innovation process of the clients, thus increase the level of innovation.

### 3. Conclusion

In this paper, we have discussed the concept of innovation and the role of drivers of innovation by the facilities manager. We looked at how the characteristics of service innovation are different from product innovation. We then investigate both the push and pull factors for innovation and the possible role facilities managers can play. Despite the common perception that FM is a low-innovation sector, we've also found evidence of FM being highly innovative. However, with the author delivering a FM innovation module at the master's level for the past three years, she discovered that none of the students (all UK FM professionals) have undertaken any leadership in the organisation's innovation process. With facilities manager being ideally placed in the interface between supply and demand, he/she should have been more proactive in driving innovation, either 'pull' within the FM team or 'push' from service providers.

An advertisement slogan for a major mobile phone company boasted that their new model has created "a holistic experience that is based on putting people at the centre". This is actually what facilities management should be. On a daily basis, facilities managers offer a productive, effective and efficient working environment for all employees and customers, by creating "enjoyable, valuable and memorable" experiences for stakeholder groups as service recipients. Now it is also time for the FM industry to be as innovative as the mobile phone industry, for facilities managers to act as innovation managers, to add value to the core business by creating a holistic workplace that fully support each individual's needs. Thus this paper calls for more FM professionals to take the lead as "innovation champions" to drive the innovation process within the organisation, to carry out experiment with new service concepts, new processes and new technologies, to in order to craft an innovative workplace that creates stimulating and engaging experiences for all stakeholders.

### References

- Cardellino P and Finch E (2006) "Evidence of systematic approaches to innovation in facilities management." *Journal of Facilities Management*, 4(3):150-66
- Cohen WM and Levinthal DA (1989) "Absorptive capacity: a new perspective on learning and innovation." *Administrative Science Quarterly*, 35:128-52
- DTI (2003) *Competing in the global economy: the innovation challenge* (available online at <http://www.dti.gov.uk/files/file12093.pdf>)



DTI (2007) *Innovation in Services* (available online at <http://www.dti.gov.uk/files/file39965.pdf>)

Hartmann A (2008) “Overcoming resistance to innovation: the integration champion in construction”, Chapter 16 in *Clients Driving Innovation*, edited by Brandon P and Lu SL, Blackwell Publishing

Heywood C, Smith J, Brawn G and Missingham G (2004), “Innovation in facilities management practice using a performance approach”, *Proceedings of COBRA conference*, 7-9 September 2004, Leeds Metropolitan University, UK.

Johannessen JA, Olsen B and Lumpkin GT (2001) “Innovation as newness: what is new, how new, and new to whom?” *European journal of Innovation Management*, 4 (1), 20-31.

Leseure MJ, Bauer J, Birdi K, Neely A, Denyer D (2004) “Adoption of promising practices: a systematic review of the evidence”, *International Journal of Management Review*, 5–6:169–90.

Mudrak, T, Wagenberg, AV, and Wubben, E (2006), “Innovation process and innovativeness of facility management organisations”, *Facilities*, 23 (3/4):103-18

NESTA (2007) *Hidden Innovation*, (available online at <http://www.nesta.org.uk/library/documents/Nesta%20Report%20HiD%20Innov%20final.pdf>)

Pitt, M and Tucker, M (2008), “Performance measurement in facilities management: driving innovation?”, *Property Management*, 26 (4):241-54.

Schumpeter, J (1934), *The Theory of Economic Development*, Harvard University Press, Boston.



## A Model for Assessing the Maturity of Facility Management as an Industry Sector

**Maulidi A. Banyani**, The Hong Kong Polytechnic University, Hong Kong SAR, China, [maulidi.banyani@polyu.edu.hk](mailto:maulidi.banyani@polyu.edu.hk)

**Danny S. S. Then**, The Hong Kong Polytechnic University, Hong Kong SAR, China, [bessthen@polyu.edu.hk](mailto:bessthen@polyu.edu.hk)

### Abstract

Over its three decades of evolution, Facilities Management (FM) has widened its scope of responsibilities from an operational focus to a strategic orientation. The FM role has shifted from a predominantly cost reduction approach to value adding. This shift follows a similar path towards ‘perfection of the processes’ in literature on organisation maturity models. It follows that if FM processes have been perfected then the industry is at its mature stage. However, to date, there is no consensus on developmental levels when assessing FM maturity due to the lack of a common yardstick. This conceptual paper presents an *Integrated Feeder Factors Framework (I3F)*, based on six interlinked factors that are key to the continuous development of the FM Industry which are referred to as ‘feeder factors’. It is argued that FM development depends on the integration of market, research, education, professional bodies, environment and practice. The proposed model identifies four maturity levels based on the links between, and strength of the existing feeder factors. At the highest level, there is Full Maturity Stage (FMS); followed by Developmental Transitional Stage (DTS), Formation Transitional Stage (FTS) and lowest level, Least Mature Stage (LMS).

The paper is based on extensive analysis of literature focusing on industry maturity with particular reference to FM. Content Analysis of existing literature was carried out to identify the potential ‘feeder’ factors. The paper aims to introduce a maturity model that at full development, can provide a consistent basis for evaluating maturity of FM industry. The proposed *I3F model* aims to provide a consistent basis for evaluating maturity of FM industry at national, sector-wise and organisational levels.

### 1. Introduction

The paper proposes a framework for assessing the maturity of Facilities Management (FM) as an industry sector. This is indeed a challenging endeavour due to the nature of FM. In a Delphi study conducted by Price and Green (2000) FM has been regarded to be neither an industry nor a profession. Discussions on whether FM is a profession has been well documented in the past by Grimshaw (2003) and Tay and Ooi (2002). The paper begins by discussing the extent of disagreement regarding FM development and maturity status. It further, explores the legitimacy of

the claim that FM is an industry as a stepping stone into discussing its maturity. The proposed framework is discussed in details in section 4.

Studies by Grimshaw (2003), Payne (2000) and Teicholz (1992), however, can serve to explain the divergence of opinions in terms of the stage of development and level of maturity of FM as an industry sector. Grimshaw (2003) is of a view that FM continues to grow and is recognised as “*a useful function*” in most parts of the developed world. But, the lack of intellectual coherence within the core practice presents particular difficulties for the smooth onward development and for the establishment of a unified FM profession. On the contrary, Payne (2000), studying FM profession development in the United Kingdom observed that it has evolved from an early formative stage, in the late 1980s, through a rapid growth phase which took place during the mid 1990’s and reached maturity in early 2000s. Payne (2000) concluded that the evolving nature of FM and the maturity of its approach which is grounded in the experience of a buoyant and growing profession have begun to ensure that a strategic FM dimension is now a requirement for all successful and forward thinking organisations. In Teicholz’s view the FM profession has, to some extent, become mature in 1990’s (Teicholz, 1992). Inference that can be drawn from the studies is, while Grimshaw (2003) is sceptical of the development of the industry, Payne (2000) and Teicholz (1992) are certain that the profession has matured or “is maturing” since early 2000’s or early 1990’s. The disagreement on the level of development and maturity of the FM industry can also be witnessed in a number of the studies carried out in late 1990’s and 2009:

- It is an emerging industry (Grimshaw, 1999; Green and Price, 2000; Price 2003a; and Ballesty, 2008).
- It is a growing industry (Price 2003b; Then, 2004; Mussa and Pitt, 2009).
- It is a mature industry (Atkin and Brooks, 2001; Barret and Baldry, 2003 and BIFM, 2008)

The word ‘maturity’ with reference to FM was first used at the first EuroFM conference held in Glasgow in 1990. The conference objectives, among others, were set with the aim of developing facility management research and education into a “*more mature activity*” (Alexander et.al, 2004). The above discussion revealed the following:

- The question of maturity in FM industry is neither new nor insignificant; as it can be traced as back as 1990. It has a place in FM industry literature but has not been clearly defined or the ‘word’ has been used loosely.
- It is obvious that current rating of the development and maturity of FM is based on personal judgement rather than based on a scientific approach.
- There is a need for a framework that can be used in assessing maturity of the FM industry as opposed to FM processes.
- Lastly, there is a need to define the development status of Facilities Management.

The objectives of this study are first, to understand if FM has a legitimacy to claim an industry status and second, to identify the contextual meaning of maturity within the FM industry.

## **2. Facilities Management Industry: Justifications**

This section uses materials from different sources to analyse the legitimacy of FM status as an industry. It starts by giving a broad definition of the term ‘industry’ and singles out pre-requisite attributes of an industry. These attributes then are analysed against FM contribution, objectives and functions.

### **2.1 Understanding the term industry**

In generic terms, industries are categorised into four sectors owing to the nature of activities performed. These sectors are primary (dealing with extraction of materials from nature such as mining, agriculture and fishing), secondary (which is devoted to manufacturing), tertiary or service (concerns with the service provision) and quaternary (involved in information business).

The word ‘industry’ is derived from a Latin word ‘*industria*’ meaning “diligent, industrious” (<http://www.wordia.com/industry>). In its simplest form, an industry is an *economic activity* concerned with the production and distribution of goods and services (<http://www.answers.com>). An economic activity has been correlated with employment and aims at creating income to participants (Marcijonas and Paulauskas, 2007). The Organisation for Economic Co-operation and Development (OECD, 2002) defines an activity as a process i.e. combination of actions that results in a certain set of products. Of late, Marcijonas and Paulauskas (2007) argued convincingly that the word ‘activity’ as an economic activity indicates that transactions are performed systematically and in a continuing basis. Neva et.al (2008) expresses the view that an economic activity should be analysed based on resource maintenance, production, distribution and consumptions. Resource maintenance is concerned with the tending to, preserving, or improving the stocks of resources that form the basis of preservation and quality of life (Neva et.al, 2008).

In summary, from the above discussion, it can be inferred that an industry should possess the following attributes:

- It should provide products (tangible items) or services (intangible items);
- As an economic activity, an industry is capable of generating income and provides employment;
- The activity should be conducted systematically with prospects of continuity, and
- Aimed at tending to, preserving or improving the stocks of resources.

These attributes are important in analysing and ascertaining the legitimacy of FM as an industry. The analysis to this effect is carried out in the following section by gauging FM contribution, objectives and functions against the attributes identified above. It is expected that the analysis may provide an understanding of the role played by FM as a sector of economy and an independent industry sector.

## 2.2 Facilities Management as an Industry: Analysis of the Attributes

This section uses the factors identified above in analysing the legitimacy of FM as an industry.

***Proposition 1:*** *An industry should provide products (tangible items) or services (intangible items)*

Facilities Management (FM) is a business of managing work space (McGregor and Then, 1999). In its simplest form, FM deals mainly with technical and operational aspects of providing services necessary to support the core business. The focus at this level is to minimise operational costs associated with the provision and management of work space. At the highest level, it is concerned with appropriate work space strategies and abilities to cope up with the rapid changes in the business environment. The focus at this level is to add value through effective management of facility provision and support services (Then, 2004). The provision of facilities support services to core businesses is a global business measured in billions in terms of major international currencies. Specific responsibilities (services) of the Facilities Manager are summarised in Figure 1:

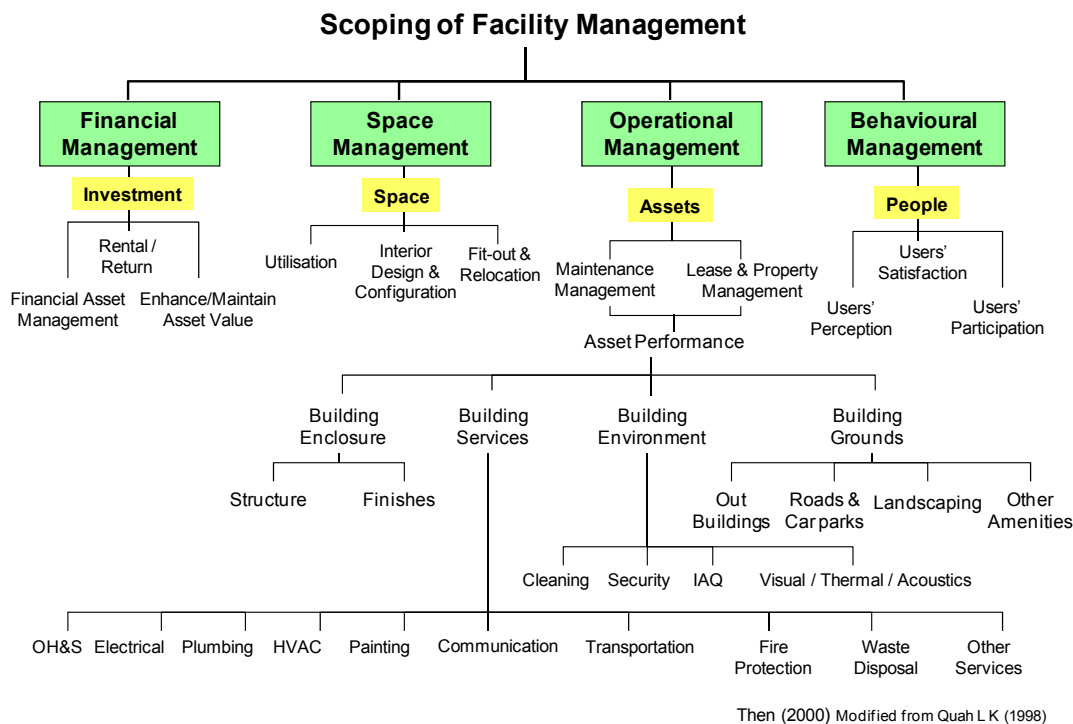
***Proposition 2:*** *An industry should be able to generate income and provide employment.*

Price (2003a) and the International Facility Management Association (IFMA, 2009) estimate the global value of the FM market to be in the tune of US\$100billion. In the UK alone, the British Institute of Facility Management (BIFM, 2009) estimated the FM sector is worth between 40b and 95b pounds. In Germany, the FM market is estimated to be in the region of 55 billion Euros (GEFMA, 2009). FM is the largest contributor to gross national product (Price, 2003b and Ballesty, 2008). Ballesty, (2008) noted that FM in Australia in 2002-03 contributed about A\$12.2 billion of value added, A\$12.4 billion in GDP terms and employed 172,000 persons.

***Proposition 3:*** *An industry should allow for systematic performance of the activities and prospects for continuity.*

Available literature suggests that over the last 30 years FM has evolved from operational focused to strategic orientation. Then, (2004) noted “FM has grown from managing and maintaining corporate property (operational buildings) to strategic management with a deliberate slant towards meeting stakeholders’ expectations”.

The management of work space in modern businesses has become increasingly complex, both at organisational and country level. Workplace is no more defined by four walls of a building. Technological advancement has made it possible for work to be conducted from a variety of locations. Unlike in the past where the functions of the Facilities Manager were to ensure availability of workspace; today’s challenges lie in the provision and management of strategic infrastructure and support services that enable business continuity. The Facility Manager is required to anticipate changes in demand and act swiftly while considering adding value to the core business. FM organisations need to pay attention to strategic issues while considering tactical and operational matters. Lord et.al (2002) has identified that unlike other management fads and fashion, FM has been able to withstand the test of time. Geographical expansion of FM profession is also evidence that the industry is here to stay. Over the last 3 decades, the industry has been able to establish itself in United States of America, Europe, Asia, Australia, Africa and Latin America.



**Figure 1: Scope of Facilities Management responsibilities**

**Proposition 4:** *An industry aims to tend, to preserve or to improve its stocks of resources*

The continuity of FM industry can be reflected in the importance placed on it from a national and business perspective. It must be understood that apart from direct contribution of the FM sector to the economy, it is also entrusted with the crucial function of tending to, preserving and improving important infrastructure resources used to provide crucial services to society. The introduction of public-private partnerships (PPP) and private finance initiatives (PFI) in the United Kingdom have opened up the FM market and created direct relationship between the public sector and the FM sector. Payne (2000) noted that PFI has been used in the UK to fund a wide range of high profile and varied projects such as the Channel tunnel rail link, prisons, hospitals, fire stations, roads and bridges.

Discussion of the objectives and functions above reveals that FM is an industry that provides services to the core business. Suffice to note that from the categories of the industry introduced in section 2.1 above, FM falls within the tertiary industries sector.

### 2.3 Defining the FM Industry

Weck (2005) argues that an industry can be defined in two ways. In a narrow view, an industry comprises only direct competing firms within a sector of economic activities; whereas a broader definition also includes surrounding parties such as suppliers, buyers, producers of related and substitute products as well as the associated legal political and regulatory governances. This research embraces the broader definition of an industry.

In this study the FM industry is defined to mean *“an institution or entity that provides or monitors optimal workplace solutions based on competencies developed within and demand arising from a defined business environment”*.

The definition embraces an institution or entity approach which includes all of the factors and stakeholders that contribute to the formation, development and FM maturity of an industry (see Figure 4). The definition also focuses on the competencies that are developed within a defined business environment. Business environment has been used in this context to mean individual organisations within a defined economic sector or countries. In order to provide optimal solutions, service providers need to be guided by abilities to analyse the business demand. This is best done, when the supplier is competent and able to perform the business demand analysis and benchmark the performance against the business norms or best practices. It is to the benefit of the institution receiving the services to ensure that the services are as per set service levels. In this respect, competent FM experts are required internally to analyse and monitor the performance of the service provider from the clients’ perspective. The definition considers both supply and demand sides of the industry. While the provision of the optimal services is more aligned to supply side, the monitoring is slanting towards the demand side. It is only when these two sides agree on the efficiency and effectiveness of the level of the services provided in response to the business demand that the optimal level can be achieved. Based on this fact the definition includes the needs of the demand arising from within the defined business environment.

The bottom-line in this definition is Facilities Management is a localised industry that provides local solutions to local demand using local competencies. While understanding the local environmental (internalisation) is fundamental the industry can not exclusively isolate the impact caused by globalisation (internationalisation). The FM industry is guided by knowledge and expertise obtained from within and outside the country. The fusion of the internal and external knowledge will determine the development, maturity and sustainability of the industry (Figure 2).

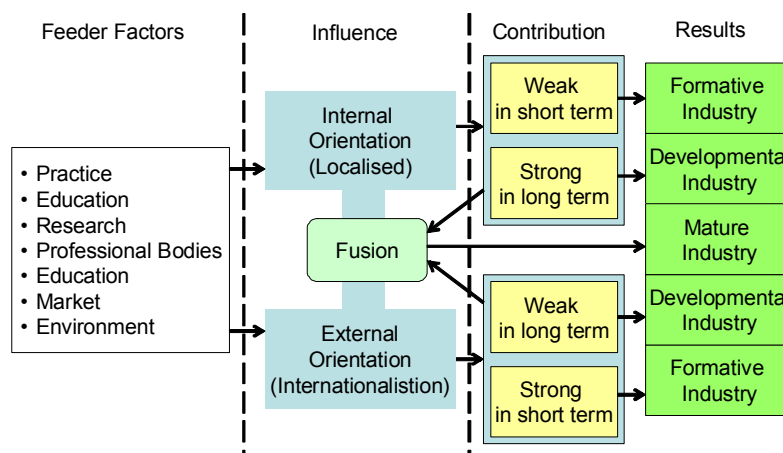


Figure 2: The influence of Internalisation and internationalisation to FM industry

Figure 2 shows that formation of the FM industry at a country level can be influenced by external factors, internal factors or both. Externally influenced industry relies on the feeder factors that are imported from other countries through internationalisation/globalisation. The study hypothesis that imported feeder factors are useful during the formation stage of the industry as experiences from other countries are introduced or brought into the host country. During this time, internally influenced feeders are either non-existent or weak and borrowing a leaf from the developed

counterparts is essential. The evolution of the industry into the development stage goes hand in hand with the development of the local factors to adapt, transform or replace the imported feeders which may not keep pace with local condition. During the development stage, locally developed feeder factors become stronger and are essential in maintaining the performance of the FM industry. For example, locally conducted research in the level of FM market will provide first hand information on the existing situation and be useful to practice, education and professional bodies which in turn will influence environment. It is essential to note however, that the host country may not be able to replace all of the influence of the external feeder factors due to globalisation and the need for knowledge sharing. It is suggested that for the FM industry to be matured and sustainable, fusion between internal and external influences should be encouraged.

### 3. Conceptualising the term ‘Maturity’

Cookie-Davies (2004) has argued that the term ‘maturity’ may not mean the same thing to different professions or industries. He noted that the whole field of capability and maturity models is a semantic mine-field; with specific technical meanings for certain words being very different from the normally accepted breadth of use in common speech. Maturity models embody both different concepts and different suggestions as to the path to maturity and can be defined to mean, fully developed or grown up or perfected (Cooke-Davies et.al 2003).

When considered from a specific area of specialization, maturity has been viewed differently in each one of them. In life cycle models, the term maturity signifies a step before industry decline (Figure 2a). McGahan and Silverman, (2000) noted that an industry hits maturity at the earliest date for which the number of firms grows at a rate less than a fraction of the growth rate in the prior period. In Capability Maturity Models, the term maturity is used in a very technical sense to mean “*the extent to which an organisation has explicitly and consistently deployed processes that are documented, managed, measured, controlled, and continually improved (Cooke-Davies, 2004)*”.

This study is concerned with the development of an assessment tool for maturity of FM industry. It transcends beyond the analysis of FM processes alone. In this way, maturity models that are designed solely for the analysis of ‘internal’ processes falls short of being applied in this study. This elimination leaves the study with one option, the use of general industry lifecycle models. It has been however, considered prudent to evaluate the context within which maturity in FM is construed. The analysis has revealed that unlike in the industry lifecycle models, in which maturity level is a step before decline (see Figure 3a), in FM it signifies a state of perfection, sophistication and development of the industry (see Teicholz, 1992; Payne, 2000 and Alexander et.al, 2004) as shown in Figure 3b. This situation challenges the use of the normal lifecycle industry models.

Figure 3a: Industry Maturity Curve.

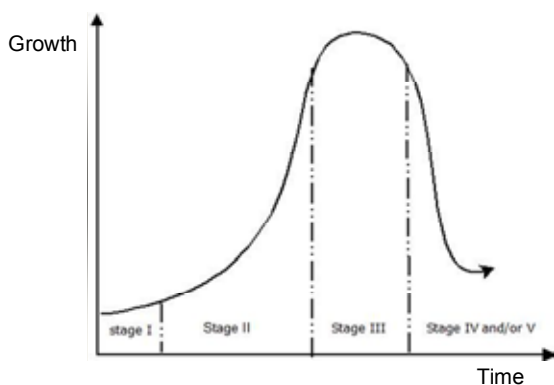


Figure 3b: Process Maturity Model

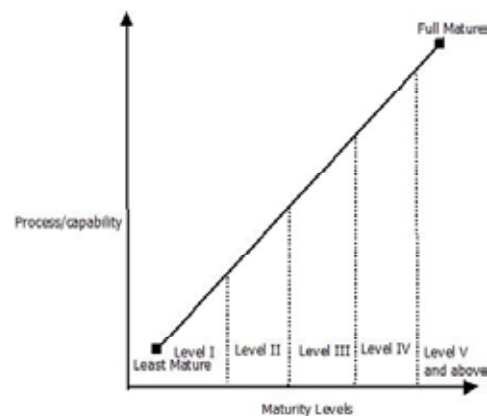


Figure 3: Industry Maturity Curve and Process Maturity Model



It is evident from Figure 3a that after stage III the industry declines. While in Figure 3b it is shown that the perfection of the process is the final stage of development in process maturity.

The next section will provide a brief overview of two categories of models that are popular in analysing industry and process capability maturity: Industry Lifecycle models and Process Capability Maturity models.

### 3.1 Industry Lifecycle Models

These models are useful in analysing the industry and product life cycle based on the assumption that industries and products have a definitive life cycle. Studies have revealed that the fundamentals of industry development can be compared to living creatures, which has its cycle of life. In Tellis and Crawford (1981) views, the product or industry life cycle is modelled on the fixed cycle of birth-growth-maturity-death. Industries pass a number of stages from their inception (Table 2). Each one of these stages signifies a level of capabilities developed within the industry. The life cycle has a significant impact upon business strategy and performance (Hofer, 1975). Although these models are similar in concept, they differ as to the number and names of the stages as shown in Table 1.

Table 1: Industry Development Stages

S/N	Model	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
1	Ferguson and McKillop, (1997)	Nascent	Transition	Mature		
2	Fox, (1973)	Pre-commercialisation	Introduction	Growth	Maturity	Decline
3	Tay and Ong, (1994)	Developing	Mature			
4	Kotler, (2003)	Fragmentation	Shake out,	Maturity	Decline	
5	Hill and Jones (1998)	Embryonic	Growth	Shakeout	Maturity	Decline
6	Anderson and Zeithaml (1984)	Introduction	Growth	Maturity	Decline	
7	Wasson, (1974)	Market development	Rapid growth	Competitive turbulence	Saturation/ maturity	Decline

Source: Authors' compilation (March, 2010)

Product and industry lifecycle models are common in economics and marketing. These models are used to assess and classify the position of the development of industry (Kotler, 2003, Ferguson and McKillop, 1997) and maturity assessment (Tay and Ong, 1994). Revision of these models is essential in indentifying the factors used by other researchers in assessing and classifying industry development. These models also, provide an overview of the perceptions of the term “maturity” as viewed by different disciplines. The definition of the term maturity will be discussed in details in the next section.

### 3.2 Process Capability Maturity Models

These models are useful in evaluating process maturity. The basic idea behind this category of models is the notion of evolution, suggesting that the subject may pass through a number of intermediate states on the way to maturity. Generally, a maturity framework is a measure to aid organisation in gauging their performance relative to industry best practice. Cooke-Davies (2004) noted that maturity models make an assumption of the existence of the perfected end state, whether it is unfolds from within or otherwise (Cooke-Davies, 2004). Furthermore, maturity implies that the processes are well understood, supported by documentation and training is consistently applied in projects throughout the organisation and is continually being monitored and improved by its users (Fraser et.al, 2002). Kerzner (2006) noted that maturity indicates availability of appropriate infrastructure of tools, techniques, processes and even a good culture. In many maturity models some form of best practices act as a core concept for assessment which enables adopting organisations to measure and rate its current abilities in a specific area of knowledge. According to

the Kerzner's (2006) best practices are those actions and activities undertaken by the company or individuals that lead to sustained competitive advantage. The key term in this definition is sustained competitive advantage. In other words, best practice is what makes you different from your competitors.

Process capability models construct tend to depict maturity as a number of successive levels. The first or lower tiers in the model tend to represent the lower level of development or immaturity (Figure 3b). Levels can range from 3 to 10. Similar to life cycle models, the names of the levels can vary depending on the subject (Fraser et.al, 2002). In some situations a model can be constructed using non traditional levels descriptive format such as one used by Facilities management Organisation Model (FMO) in item 3.3.1.

### 3.3 Maturity Models related to Facilities Management

This section discusses two capability maturity models that are relevant to the FM industry. It must be noted that while the second model has been validated and published, the first one was not.

#### 3.3.1 Facilities Management Organisation Model (FMO)

Internet search reveals that IWMSNews.com in America has been hosting a series of articles in Facilities Management Organisation (FMO) maturity model. The model is based on concepts similar to that of the Project Management Institute process model. The FMO model is developed by James Turner and is formed around 11 competencies that are organised at five levels (<http://www.iwmsnews.com/fmo-maturity-model>). The model looks into five questions that are important to identify the competencies required to deal with them (Table 2). The identified areas in the questions are size of portfolio, access to management information, focus and improvement, budget allocation and budget justification. Each of the questions corresponds to a FM maturity level attained by the FM organisation. Unlike common maturity models, FMO does not use identifiers in labelling maturity levels; instead number "1" signifies the lowest level, with "5" representing the highest.

Table 2: Facilities Management Organisation Model

FMO Maturity Model level	1	2	3	4	5
Key Management Question Answered	What am I responsible for managing?	How can I access the management information I need	What improvements should I be focused on now (short term improvements)	What is the best allocation of my budget?	How can I justify a request for a budget increase (long term improvements)?
Core Competencies	Organisation, policy, inventory	Process, systems	Metrics and assessment	Short term planning performance improvement	Mission validation and long term planning

Source: (<http://www.iwmsnews.com/fmo-maturity-model>)

#### 3.3.2 Standardised Process Improvement for Construction Enterprises (SPICE-FM) model

In a more recent development, the Standardised Process Improvement for Construction Enterprises model (SPICE) has been used to assess FM process capabilities in the UK. The model is known as SPICE FM and is primarily concerned with management processes, and its philosophy is that if the management processes are performed well, they will have an impact on the performance of the core processes (Amaratunga, et.al. 2008). The model is organised in five tiers under the headings of maturity levels, Identifiers, process enablers and process areas (see Table 3).

Table 3: Standardised Process Improvement for Construction Enterprises (SPICE-FM) model

Maturity levels	1	2	3	4	5
Identifiers	Initial	Services delivery management	Knowledge Management	Quantitatively improved	Continuously improving
Process enablers (5)	Commitment	Ability	Verification	Evaluation	Activities
Process areas (7)	Service requirements, Service planning,	Service performing monitoring,	Supplier management, Contractor management	Risk management	Service coordination

Source: Amaratunga et.al, 2008

### 3.4 Suitability of the Existing Maturity Models to this Research

The FMO and SPICE FM models like other maturity models such as CMM, OPM3 and CSMCMM are processes, project, object or activity based models. These models are useful in addressing processes within a particular organisation and/or terminable projects. Terminable projects, tasks or activities are objective specific, carried out within stipulated time and budget. They are not lifelong endeavour. Progress of a project and a task can be determined by the efforts by individuals within the team. On the other hand, FM, as an economic activity, is a continuous on-going process and its progress is not determined by internal factors alone. There are external factors that have direct influence on its development and maturity. It is therefore opined that existing maturity models within and from other disciplines and specifically, terminable projects, cannot be directly applied to the FM industry, and defined here in its widest meaning to include not only processes but also external factors. In order to assess the degree of maturity of the FM industry, measures that incorporate and integrate external factors should be adopted. It is evident that process based models concentrates on *practice* only which is only one of the six factors that influence the pace of development and maturity (see Figure 4). The concentration of these models in practice (internal process) limits their application in assessing industry maturity in FM as a unique industry. The following section will introduce the feeder factors and the Integrated Feeder Factors Framework (I3F).

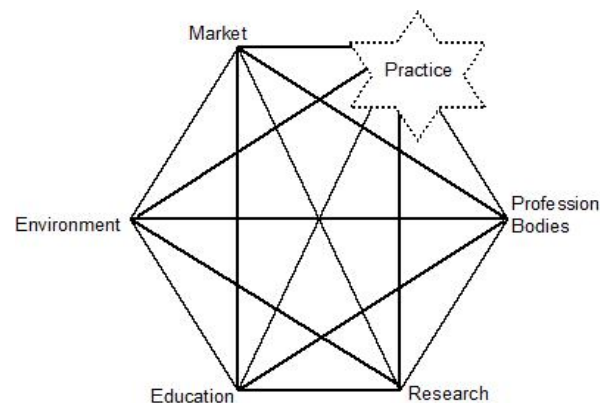
#### 4.1 Identification of Feeder Factors

Feeder factors are six factors, necessary for development and maturity of FM. These factors are mutually dependent on each other and have to be linked in order to realise the perfected industry. The six factors are practice; professional bodies, education, environment, market and research. These factors are further broken down into critical success factors (CSF). The parameters will be used in determining the contribution of each individual factor towards the maturity of the industry. These factors have been identified from Then and Akhlaghi (1992), Lomas (1999), Nutt and McLennan (2000), Lord, et.al. (2002), and Barret and Baldry (2003). This study postulates that knowledge and expertise on one hand and FM development and maturity on the other, results from the contribution of individual feeders into the Integrated Feeder Factors Framework (Figure 4). It is only when each one of these is effective that the industry will develop and reach maturity

#### 4.2 The Integrated Feeder Factors Framework (I3F)

This section introduces the Integrated Feeder Factors Framework (I3F) and provides a discussion on its conceptual development. The proposed I3F Model is a framework of intertwined, interdependent and interrelated (feeder) factors that are necessary for the existence, development and maturity of any industry (Figure 4). Unlike other maturity models, I3F takes into consideration external factors that feed into the development of the industry at an organisational, sector, national and regional levels. It transcends the common norm of focusing only on the internal processes of the practice. The rationale behind this framework is hinged on the fact that the evolution of FM as an industry from

one level to the next depends on the development of each one of these factors, preferable labelled as ‘feeder factors’. Maturity of the industry is dependent on simultaneous growth or co-maturation of each of these feeder factors. Any one of the factors that lagged behind will tend to delay development of the industry, as a whole, to the next stage of maturity level. In this study, the term maturity is defined as the *“The degree of sophistication of the Facilities Management industry within an economy measured by the strength of relational feeder capabilities interface.”* This definition is intended to provide an understanding of the maturity model based on the relationship that is formed by the feeder factors. The relationship will be assessed based on five attributes discussed in item 4.2.



**Figure 4: Proposed Integrated Feeder Factors Framework (I3F)**

The co-maturation of the feeder factors is essential in resisting life cycle ‘industry maturity’ effect. It has been observed from literature that after maturity, industries will tend to deteriorate in performance and decline (see Table 3 and Figure 3a). It is postulated in this study that if all of the feeder factors can attain maturity status at the same time, then the industry maturity effect will not be felt. Since each one of the feeder factors will continue feeding into others and sustain the growth towards maturity. It is envisaged that if evaluation of the level of development, adoption and application of each individual feeder factors is conducted, the proposed model can provide a picture of development and level maturity of the FM industry as a whole.

The study intends to establish the causal linkages between the identified feeder factors shown in Figure 4. The individual links between the feeder factors is a reflection of the strength of their relationship i.e. strong or weak. A strong relationship indicates a situation when the five active feeder factors feed into one active feeder factor at any given time. In this situation the industry is said to be at Full Maturity Stage (FMS). The industry focus is on strategic issues and its influence is high. This ensures the perfection and stability of the industry. However, there are three more possible situations that can exist. In a situation where inactive feeder factors feed into active feeder factors, then the relationship is construed to be at Developmental Transition Stage (DTS). At this stage some feeder factors are active enough to influence the development of others. In the second situation, inactive feeder factors feed into another or other inactive feeder(s); the relationship is regarded as weak and the stage is known as a Formative Transition Stage (FTS). Lastly, is a situation where inactive feeder factor(s) feeds into non-existing feeder factor or factors, the industry is said to be at the Least Mature Stage (LMS). At this level, the existing feeder factors tend to be not closely related. FM activities are often disregarded and misunderstandings between the existing traditional professions are high. The focus is on operational functions.

## 4.2 Assessment of FM Industry Maturity using the I3F

Two assessments are carried out to determine the maturity level of the FM industry. Assessment level one involves verifying the availability of the feeder. This is a straight forward and simple assessment when an assessor is required to only verify the availability of the feeder factors to

ascertain their presence. It is suggested that a yes or no parameters can be used, it is however suggested that the assessor should establish reasons for non-existence of the other factors.

The second assessment is a detailed treatise of the factors after the “yes answer” in the first assessment. This assessment has two levels. Level one, deals with evaluation of individual feeder factors based on the identified critical success factors that define the strength (Table 1). It is expected that each of the parameter will be assigned a unit score of 1 point. The more the factor scores the more active it is. The results of the analysis will be classified as active or in-active. Factors with a score of more than 75% of the parameters will be considered active.

Level two of the assessment looks into the integrated contribution of individual factors into the overall development of the FM industry. In this assessment, the factors will be evaluated based on five attributes. These attributes are *dependability, influence, stability, consistency and trustworthiness* shortly they are referred to as (*DISC-T*). The attributes will reveal a situation to be technically referred to as *relational feeder capabilities interface* which shows a bonding between feeder factors. In order for a relationship to be strong, each of these attributes should be fulfilled. Development of strong relational feeder capabilities interface is essential in the stability and sophistication of the industry. It is regarded that the strength of the relational feeder capability has a positive correlation with the development and maturity of the FM industry. In such a situation, where all feeder factors are active and forming strong relationships, the industry will be strong

## 5. Summary

The study has established that Facilities Management is an industry perceived to be at different levels of maturity based on personal judgement. This situation is due to lack of a tool that can be used in assessing maturity levels. In dealing with this problem, the study proposed the Integrated Feeder Factors Framework (I3F) as a yardstick. Research is continuing and progress will be further reported in the near future.

## References

- Alexander K., Atkin, B., Bröchner J., and Haugen, T.I (2004); Introduction of Facilities Management: Innovation and Performance, Spon Press, Oxon
- Amaratunga, D., Haigh R., Baldry, D., and Sarshar M. 2008, Process improvement in Facilities Management: The Spice Approach. In *Facilities Management Processes*, edited by Alexander K. (Manchester: European Facility Management Network), 90-106.
- Anderson, C.R., and Zeithaml C.P. 1984, Stages of Product Life Cycle, Business Strategy, and Business Performance. *The Academy of Management Journal*, 27, 5-24.
- Atkin B. and Brooks A. 2001, Total Facilities Management, (Oxford: Blackwell sciences).
- Ballesty, S. 2008, Facilities Management Action Agenda: The Australian Government and Industry working together for Improvement in Engineering Asset Management, (London: Springer).
- Barrett P. and Baldry D. 2003, Facilities Management: Towards Best Practice, 2<sup>nd</sup> edition, (Oxford: Blackwell sciences)
- Cooke-Davies, T.J. (2004), Project Management maturity models. In J.K. Pinto and P.W.G Morris (eds.), *The Willey guide to managing projects*, New York
- Cooke-Davies T.J. and Arzymanow A. (2003) The Maturity of project management in different industries: An Investigation into variations between project management models. *International Journal of Project Management*, Vol. 21, pp 471-478
- Ferguson, C., and McKillop, D.G 1997, An Industry Approach to Classifying Credit Union Development, working paper available at <http://www.creditunionresearch.com> retrieved on 19<sup>th</sup> October, 2009.
- Fox H. (1973). “Product Life Cycle-An aid to Financial Administration” *Financial Executive*, 41, pp 28-34.
- Fraser, P., Moultrie, J and Gregory M. (2002); ‘The use of maturity models/grids as a tool in assessing product development capability’ *Proceedings, IEEE International Engineering Management Conference*, Cambridge UK, pp 244-249

- Green A. and Price I 2000, Whither FM? A Delphi Study of the Profession and the industry, *Journal of Facilities*, **18**, 281-292.
- Grimshaw, B., 1999, Facilities management: The wider implications of managing change, *Journal of Facilities*, **17**, 24-30.
- Grimshaw, B., 2003, FM: Professional Interface, *Journal of Facilities*, Vol. 21, No. 3/4, 50-57.
- Hill, C.W.L, and Jones, R.G, 1998, Strategic Management Theory: An integrated approach, 4<sup>th</sup> ed., (Boston: Houghton, Mifflin Company).
- Hofer, C.W. (1975). "Toward a contingency theory of business strategy". *Academy of Management Journal*, Vol. 18. No. 4 pp 785-810.
- International Facilities Management Association (2009) [www.ifma.org](http://www.ifma.org), retrieved on 25<sup>th</sup> October, 2009.
- Kerzner H. (2006). *Project Management best practice: achieving global excellence*. New Jersey: John Wiley & Sons Inc.
- Kotler, P. (2003), *Marketing Management*, Prentice Hall, New Jersey.
- Lomas, D.W., 1999, Facilities Management development in Hong Kong, *Journal of Facilities*, **17**, 470-475.
- Lord, A., Lunn, S., Price, I., and Stephen P., 2002, Emergent Behaviour in a New Market: Facilities Management in the UK. In *proceedings of the ideas that make a Different Conference on Tackling Industrial Complexity*, edited by Richards, H., London.
- Marcijonas A. and Paulauskas A. (2007). Definition of Economic Activity in the Tax Law. *Journal of Law*; Vol. 62. viewed at [www.leidykla.eu](http://www.leidykla.eu)
- McGahan A.M and Silverman B.S. (2000), How Does Activity Change as Industry Mature?
- McGregor, W., and Then, S.S., 1999, *Facilities Management and the Business of Space*, (Elsevier, Butterworth –Heinemann).
- Mussa Z. and Pit M. 2009, An Introduction to facilities management in UK Shopping Centres, A paper presented at *ERES Conference* in Stockholm Sweden.
- Neva, G., Nelson J.A., Ackerman, F., and Weisskopf A. (2008). *Microeconomics in Context*, M.E Sharpe, Publishers, 2<sup>nd</sup> edition.
- Nutt, B., and McLennan, P., 2000, *Facility Management: risks and opportunities*. (Oxford: Blackwell Science).
- Payne, T., (2000). *Facilities Management: A Strategy for Success*, Chandos Publishing (Oxford) Limited, Oxford
- Price, I., 2003a, Facilities Management as an Emerging Discipline In *Workplace Strategies and Facilities Management Building in Value* edited by Best, R., Langston., C. and De Valence, G., (Oxford: Butterworth Heinemann).
- Price, I., 2003b, The development of Facilities Management In *Workplace Strategies and Facilities Management Building in Value* edited by Best, R., Langston, C., and De Valence., G. (Oxford: Butterworth Heinemann).
- Tay P.H., and Ong S.E., (1994). "The Fuzzy Industry Maturity Grid (FIMG): Its Application to the Singapore Banking Industry". *International Journal of Bank Marketing*, Vol. 12. No. 4. pp 32-34.
- Tay, L., Ooi, J.T., 2001, Facilities management: a Jack of all trades? *Journal of Facilities*, **19**, 357-63.
- Tellis G.J and Crawford M. (1981). An Evolutionary Approach to Product Growth Theory. *Journal of Marketing*, Vol. 45 No.4. pp 125-132.
- Then D.S.S., 2004, The Future of Professional Facility Management Education in the Asia-Pacific Region; A paper presented at 'New World Order in Facility Management', Hong Kong.
- Then, S. S., and Akhlaghi, F., 1992, A Framework for Defining Facilities Management Education. In *Facilities Management – Research Directions*, edited by Peter Barrett, (University of Salford).
- Weck, M (2005) The Effects of Industry Life Cycle on the Formation of Inter-Organizational Relationships, *IEEE proceedings*, 2005.
- [www.IWMSNews.com/FMNotes](http://www.IWMSNews.com/FMNotes) from the field. Retrieved on 20<sup>th</sup> October, 2009.

# The Business Process Outsourcing Strategy in Facilities Management

**Carlindo Martins Macedo**

Escola Politécnica da USP - MBA

carlindo.macedo@terra.com.br

## Abstract

Facilities Management (FM) has been growing in importance as a major support activity to the organizations. Besides its suitability to outsourcing, the increasing enhancement of specialized providers in facilities management / services is making feasible the outsourcing option across the globe. Due to these circumstances, a strong trend is being observed in adopting facilities management outsourcing within business transformation strategies. Several outsourcing models such as Business Process Outsourcing (BPO), Offshoring Outsourcing and Shared Services, demonstrate the broad diffusion of this management practice, which has been intensified by globalization and information / communication technology.

This study, made both from the outsourcer's and supplier's perspectives, seeks to demonstrate that truly extended organizations are emerging, with synergy for both parties. In the emerging Brazilian market, the City of São Paulo is increasing as an important global destination for offshoring, showing a great potential for facility management services.

The business process outsourcing models in facilities management are analyzed by the author in its phases, with the risks and benefits of this transformation strategy being properly identified. In addition, due to Brazilian market peculiarities the author proposes a merging of the models examined in this research.

The research methodology adopted was the literature review in which the originality of the text is in the search of a systemic view of the outsourcing process in FM, with the additional intention to contribute further to the appropriateness of this tool to the Brazilian market.

Outsourcing FM is a practice of leverage the results with cost reductions and capability aggregation within the reach of any organization, regardless of their size, industry or life cycle. Companies seize upon this strategy according to various aspects: culture, maturity, positioning. Those who are more successful in this strategy can seize the opportunity to "extend" the company, establishing links with the supply chain and increasing its capillarity in the web of business relationships.

The adoption of the BPO framework models helps the organizations in planning their business process transformation in order to promote both operational and effective strategic changes, and also to reduce risks in adopting an inappropriate model, instead of a best practice.

**Keywords:** BPO-FM, Offshoring, Framework Models, Transformation Strategy

## 1. Introduction

The clear and profound changes that are currently underway in all areas of business due to the revolution in information technology have led organizations of all kinds to restructure quickly. From this observation, one important general nature conclusion may be made based on this research, using observations obtained from several sources. Outsourcing, in all its forms, is growing in importance and scope as transformation strategy adopted by organizations, probably because it has proved synergistic with the systemic philosophy that permeates the human thought today, but what is more relevant is that this emancipation of outsourcing is a function of three considerations: cost, focus on competence, and revenue.

According to Professor Ravi Aron, operation and information management professor at Wharton School, "the boundaries of companies are shrinking in many fields, while they are magnified in others. Aspects before administered inside the company became market transactions. It is emerging an extended enterprise model, where companies relinquish direct control and, instead, bet on monitoring"<sup>1</sup>. The fact is that this new form of organization, "extended and with digital links that go beyond borders", in which activities that were previously managed within companies have become market transactions, is absolutely compatible and coherent with the strategy of outsourcing.

The Facility Management (FM) outsourcing or subcontracting is a practice of leverage results in lowering costs, increasing revenue and aggregation of capability, within the reach of any organization, regardless of its size, industry or life cycle. Companies use this strategy according to various aspects: culture, readiness, maturity, positioning. Those who are most successful in this strategy were able to seize the opportunity to "extend" the company, establishing links with their suppliers and increasing its capillarity in the web of business relationships.

### 1.1 The Latin American and Brazilian Facility Management markets

Trends applied to the Brazilian FM market were identified in the research, which presents a stigmatized situation in the adoption of the outsourcing strategy. The point is that in Brazil mostly service takers do not recognize the added value that outsourcing can provide and the sub-contracting comes up on a superficial level, by simply hiring direct labor for the implementation of support services. Precisely to avoid this "crisis of expectation" and to contribute to the construction of a culture of strategic outsourcing is that the work sought to present the arguments and trends identified in the business literature on the subject. This is certainly the biggest problem existing today in the Brazilian market: the service taker demands value aggregation and business transformation, but doesn't offer broad spectrum of activity, and the service provider, to break entry barriers, accepts fewer functions and end up not presenting innovations due to the imposed restrictions. This entire scenario is still worsened by the predatory competition practiced by the informality of some companies of the sector.

The central hypothesis of the research raised the question of the ability of process integration between the contracting-out organization and its subcontractors and, additionally, the question

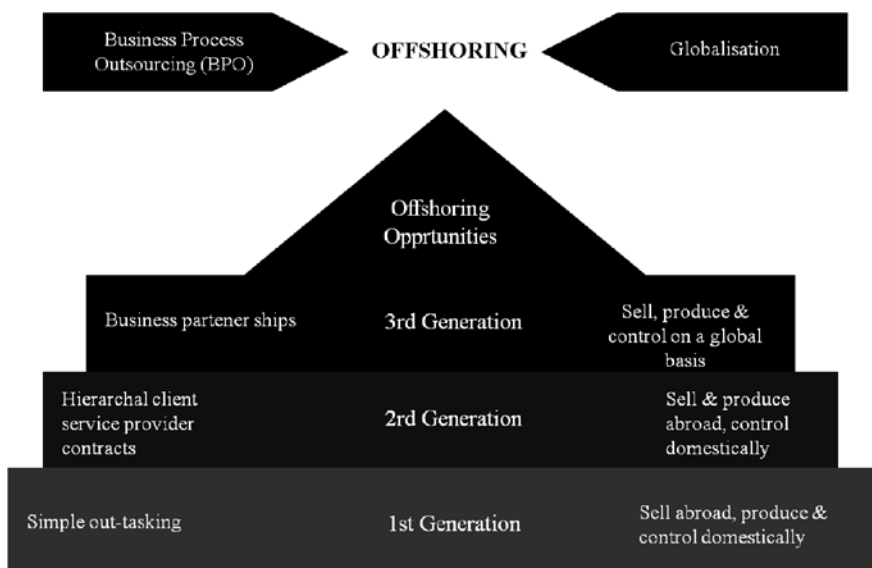


of the need for education of both parties on the characteristics of the process. In an allusion to the marriage, there is a need for a good "prenuptial" preparation to increase the chances of a successful and lasting marriage. Because of its similarity to the concept of outsourcing itself, since these processes are non-core or peripheral to most businesses, FM has a natural vocation for outsourcing.

Among its various forms, deserves notability the outsourcing outside the borders (Offshoring Outsourcing - see figure below), a growing phenomenon in the global economy and a promising market for Brazilian FM, specifically at the city of São Paulo, which was identified as one of the main destinations of the world for this kind of outsourcing.

According to a research from Jones Lang LaSalle (2004), São Paulo is the second best city in the world for the outsourcing of jobs in the offshoring outsourcing model, due to the quality of its business environment, human capital and supply chain<sup>ii</sup>. In this criterion São Paulo only loses to Manila, the capital of the Philippines, mainly because it is an English speaking country.

### The Development of Offshoring



*The Offshoring Development.*

*Source: Jones Lang LaSalle. Deciding Where to Offshore (2004).*

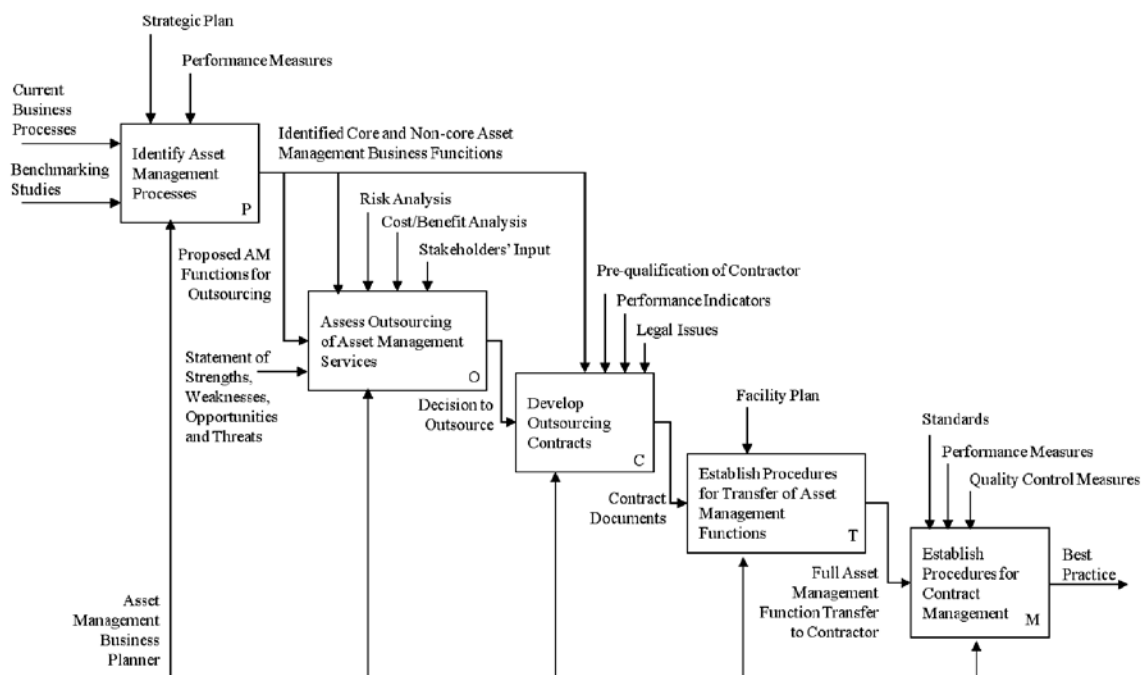
There is also the outsourcing market focused on the shared service's centers of the large company groups, which was identified by the work as another important opportunity of business and maturing of the business process of outsourcing (BPO) in the facilities management. Finally, is presented the macro economic megatrends for the coming years, in ways that it could interfere in the direction of outsourcing deals involving FM in Brazil, i.e. the Brazil's ascension to the group of the largest economies in the world.

## 2. The Analysis of the FM Outsourcing Models

With respect to the investigation itself on the outsourcing processes standards in FM were presented three models:

1. One of U.S. origin, which is based on the research conducted jointly by A.T. Kearney and CAPS Research (2005), a broad range study of great importance held on the subject, which estimates that companies still manage internally over 90% of its routine operational services, what represents a great opportunity for providing services companies of infrastructure and facilities management<sup>iii</sup>;
2. Another from Europe, proposed by Franceschini, F. *et al.* (2004) which presents a generic model for outsourcing, with strategic focus and four main steps: internal benchmarking analysis, external benchmarking analysis, contract negotiation and management of outsourcing<sup>iv</sup>;
3. And the last one from Saudi Arabia, which has achieved remarkable growth in developing urban infrastructure in the past three decades, performed by Hassanain and Al-Saadi (2005), focused on BPO in the FM for municipalities (see diagram below)<sup>v</sup>.

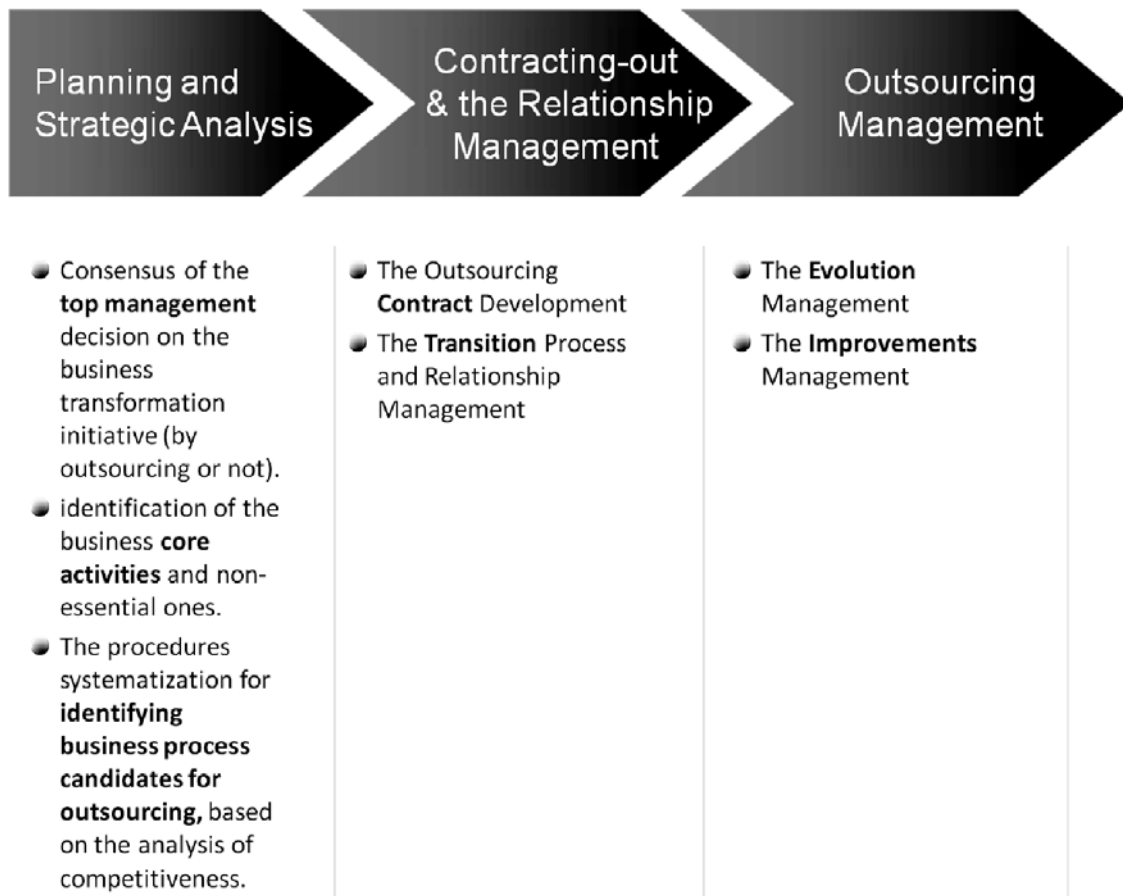
### General process involved in outsourcing asset management services



*The General Outsourcing Process in Facilities Management.*

*Source: Hassanain and Al-Saadi (2005).*

From the study of the models surveyed, it was proposed a synthesis of the models, resulting from the symbiosis of the other three, and consistent with the peculiarities of Brazilian culture of business in this sector. This synthesis is given below, in its phases and main aspects:



*The Synthetic Model for BPO FM decision and implementation.*

*Source: made by the author.*

Some specific points are especially important to be observed during this process. At the “identification of the business **core activities** and non-essential ones” phase, the decision on Outsourcing versus Improvement on the Business Process takes place. It is the turning point of the whole process.

As the outsourcing strategy is decided, “the procedures systematization for **identifying business process candidates for outsourcing**, based on the analysis of competitiveness” happens in five steps: (1) the evaluation of internal references (**benchmarks**); (2) the standard **costs** nature; (3) the identification of the Customer X Vendor relationship nature; (4) the identification of outsourcing **targets**; (5) the outsourcing **risk management** in FM.

Next, during the outsourcing **agreement** development there are some key points to be carefully watched: the evaluation of **strategies for supply / assistance**; the agreement scope and the Service Level Agreement (SLA) development, with its Key Performance Indicators (KPIs); the

suppliers **pre-qualification** and the **proposal requests (RFI / RFP-RFQ)**; the suppliers **evaluation** and choice; the agreement **negotiation**; the nomination of the **head FM professional**.

During the **Transition** Process planning and the beginning of the relationship management it is essential to manage the **Information Technology** systems integration. To reduce resistance and to improve the change management, one of the key factors is **to achieve the internal staff support**.

One of the precautions taken in the core of the work was to present the stages of the synthetic model in detail, so that, wherever possible, could be added to each stage a dedicated and relevant methodological tool for implementation, analysis and / or planning process in question, in order to enrich the didactic use of the model in practice.

In the presentation of each phase of the model development, some topics were highlighted because of their importance in the process and peculiarities in relation to the Brazilian context of facilities management. This is the case of the item "The Outsourcing Risk Management in FM" which for the depth of the theme itself also offers enough content to an exclusive and comprehensive research. This was also the case of the "Request for Proposals – RFP", whose wide - although contested - adoption deserved a different comment because of its paradoxical nature. The dilemma is: to do a bureaucratic and closed process or a collaborative and open one.

Furthermore, in order to increase the transparency, the outsourcing agreements tends to evolve from fixed price contracts to contracts based in a management fee plus reimbursable expenses. More than make the profits explicit, these agreements complies with the requests of Sarbanes-Oxley Act which prescriptions are influencing the international trades since 2002.

### 3. The risks and benefits of Outsourcing

To provide an overview among the risks and benefits for BPO FM, an interesting table was made after the literature review, including Barrett (1995)<sup>vi</sup> and others, enriched by the author's experience and yet, according to the perception of the answers to the inquiries of Monczka, R. M. PhD et. al (2005)<sup>vii</sup> and Hassanain et Al-Saadi (2005)<sup>viii</sup>.

<b>Reasons for Outsourcing</b>	<b>Priority</b>
<b>COSTS</b>	
Operational cost reduction / generate economy in scale	High
Reduce the capital investment	High
Transform fixed costs in variable	Medium
Downsize the head count / reduce space	Medium
Increase competitive intelligence	Low
<b>FOCUS ON COMPETENCE</b>	

Focus on core competence / strategic approach on services	High
Liberate managers time to focus on major priorities	High
Provide more creativity and innovation to increase processes	High
Increase productivity / operational efficiency	High
Gain access to the last technologies, not yet available in the company	High
Add value (without extra cost) / quality	High
Gain access to specialized capability	Medium
Provide alternatives to build capability	Medium
Create additional production capacity	Medium
Supply capability reserve ( <i>back-up</i> )	Low
Align with philosophy / culture / company policy	Low
<b>REVENUES</b>	
Increase flexibility and response capacity	High
Increase market speed	Medium
Reduce customer response time	Medium
Increase quality	Medium
Raise the revenues	Low
Gain access to markets	Low

*Table: Reasons for Outsourcing and it's perception of priority.*

*Source: made by the author.*

The next table lists the main risks and disadvantages of outsourcing followed by its grade of importance to the organizations. This table has the same sources as the previous.

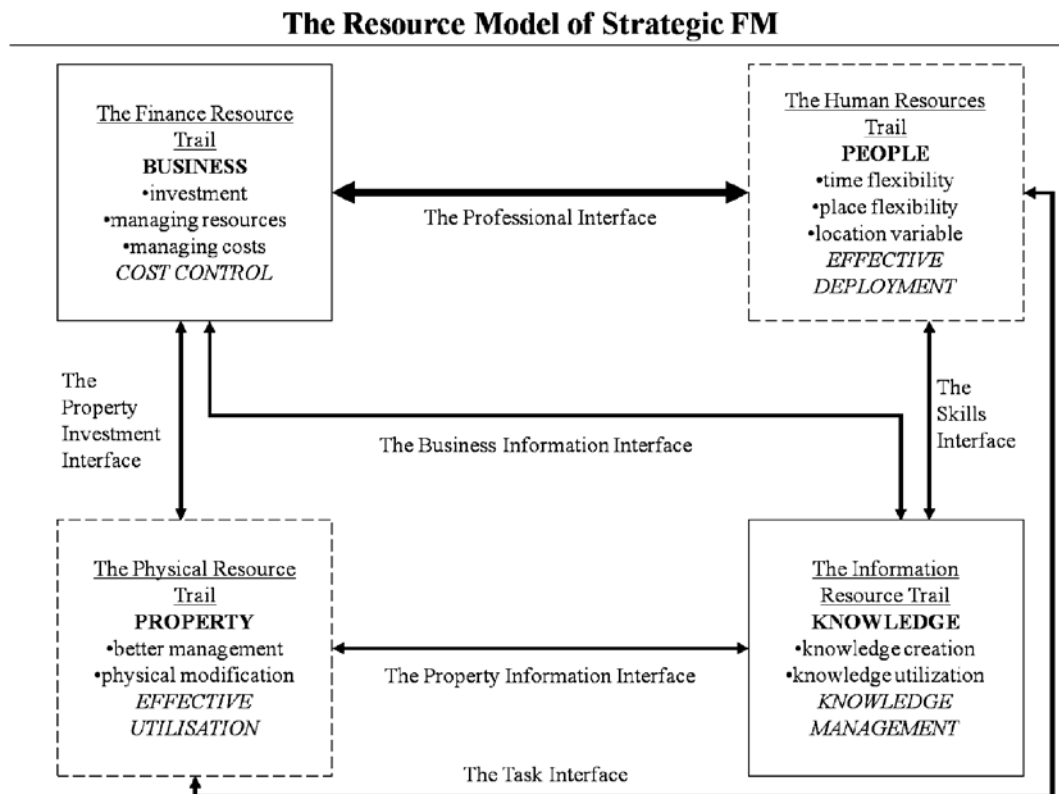
<b>Disadvantages / Risks of Outsourcing</b>	<b>Importance</b>
Perception of lost on suppliers control	High
Protection of intellectual property / confidentiality / information security	High
Conflicts with the policy / philosophy of the organization	High
The existing cases aren't enough to anticipate new management problems	High
Risks in selecting weak / incompetent suppliers	High
Outsourcing agreements expire or get outdated	High
Weak innovation capacity	High
Apprehension with the relationship between employees and community / union	High
Dependence on supplier: commitment, availability and continuity	Medium
Difficulty to revert to insourcing	Medium
Transaction costs (e.g. procurement cost of alternative suppliers)	Medium
Monitoring costs (e.g. if the subcontracted requires more than the insourced)	Medium
Loss of internal capability / expertise for a long period	Medium
<b>Disadvantages / Risks of Outsourcing (cont.)</b>	<b>Importance</b>

Loss of supply base	Medium
New applications owned by subcontracted	Medium
Loss of internal knowledge for a long period (information)	Low
Hidden costs	Low
Subcontracted becomes a competitor	Low
Keep the organizational climate	Low
Failure in previous outsourcing	Low
Legal restrictions on labor force contracts	Low
Department downsizing	Low

Table. Disadvantages / Risks of Outsourcing and its perception of importance  
 Source: made by the author.

### 4. The Interface Professional

Another interesting item extensively explored was "The Nomination of the **Head FM Professional**" which deals with the fundamental role of the interface professional in facilities management. It presented aspects of professional practice and the profile of required skills in this central pivot of the outsourcing process in FM. In the model below, Nutt (2000), quoted by Grimshaw (2003), shows an approach based on "resources", with its four "tracks" for the future in facilities management profession, highlighting the fact that the interfaces among the four infrastructure business focus are changing<sup>ix</sup>.



*The Resource Model of Strategic Facility Management*

Source: Nutt. (2000) apud: Grimshaw (2003).

The model provides a framework for evaluating the issues in the tensions that occur in the six interfaces among the four tracks. Grimshaw concludes that "the management of these interfaces to ensure that tensions are creative rather than destructive defines the challenges facing the management of facilities today and tomorrow."

The facilities manager has a natural inclination to take up the role of professional interface between the companies in an outsourcing relationship. And one of the key factors for success in fulfilling this role is autonomy resulting from an organizational structure focused on service delivery: the higher and more sustainable the facilities manager autonomy associated to a support structure (back-office) able provide technological resources, administrative support, performance indicators, procedures, training and possible reinforcements in mobilizing task forces, the better the synergy resulting from outsourcing, as concluded by Jungman (2000)<sup>x</sup>.

BPO FM is also a strategic solution for the Public-Private Partnerships, helping in funding and operating the facilities management in public infrastructure. Contracting-out specialized services by public companies is a broad range and important market to facilities management and facilities services private companies, and is a well succeeded model in several countries, i.e. Great Britain. Due to its importance as a model and idiosyncrasies, BPO-FM in PPPs is a major theme who deserves itself a specific research, reinforced by the business potential in this emerging market in Brazil.

## 5. Conclusion

The outsourcing opportunities in Latin America region have been growing very fast in the last five years, but there is still a lot to grow both in quantitative and qualitative ways. Likewise, the looking at the outsourcing FM market in Brazil is a new research area. There is not enough available statistics and surveys on this theme, even though the Brazilian market is enormous and emerging.

The adoption of BPO FM in Brazil is still in the beginning. Some big international players are already doing business here, mainly at the City of São Paulo, identified as one of the main global destination for offshoring outsourcing. Besides, facilities management and services are systematically subcontracted by the big Brazilian companies and multinationals. But there is still a huge middle market to be explored.

The major contribution intended with the research about the outsourcing models was to reduce the risks and mistakes during the evaluation of a business process. Many companies fail in outsourcing due to the lack of planning, and consequently missing the opportunity to choose the best model to adopt. This is very common in the Brazilian market, where outsourcing is still in development. An example is the PPP model, actually in a very embryonic stage.

Besides, the legal environment in Brazil still impacts the decisions about BPO when risk management is taken into account. On the other hand, companies tend to use more and more BPO as a transformation strategy, while service providers strengthen their capabilities and business platforms to be a trustful alternative.

The information technology is the vehicle which is boosting the changes. A new organization is arising, extended and with digital links, crossing borders and transforming insourced activities into market transactions.

Similarly, the role of the FM professional is changing into an interface manager, linking basically four tracks – business, people, property and knowledge – and struggling to ensure that tensions are creative rather than destructive.

An interesting perspective to make the research more complete would be a closer examination over the perception of quality in facility services. The integration process between companies, both the contracting and the subcontracted parties, using the concept of the Service Level Agreement is a large field to be explored in a research.

The paper concludes by suggesting a deeper survey among major Brazilian contracting companies in order to map and analyze the stage of actual development of the outsourcing management, its key-decision factors, its development and implementation improvements in a feedback system, the target activities for outsourcing and its organic growth, and the reach of the risks and benefits in a fast growing scenario.



## References

- <sup>i</sup> knowledge@wharton (2004) “Como lidar com os perigos da terceirização”, *HSM Management*, Barueri, year 8, v.1, n.42, p.100-103, jan./feb. 2004.
- <sup>ii</sup> Jones Lang LaSalle (2004) “Deciding Where to Offshore”, *Global Offshoring Index.pdf*, 2004, Chicago, US.
- <sup>iii</sup> Monczka, R. M. Phd et al. (2005) “Outsourcing Strategically for Sustainable Competitive Advantage”, *a research made by A. T. Kearney Inc. and CAPS Research*. Tempe: CAPS Research, 2005. ISBN 0-945968-62-0. Available online [http://www.eds.com/services/innovation/downloads/atk\\_outsourcing.pdf](http://www.eds.com/services/innovation/downloads/atk_outsourcing.pdf) [accessed on 12/10/2005].
- <sup>iv</sup> Franceschini, F. et al. (2004) “Um modelo para a terceirização”, *Benchmarking: An International Journal*, *HSM Management*, Barueri, year 8, v.1, n.42, 74-80, jan./feb. 2004.
- <sup>v</sup> Hassanain, M. A.; Al-Saadi, S. (2005), “A framework model for outsourcing asset management services”, *Architectural Engineering Department, King Fahd University of Petroleum and Minerals*, Dhahran, Saudi Arabia, *Facilities Journal*, London: Emerald, v.23, n.1/2, 73-81.
- <sup>vi</sup> Barrett, P. (1995) “Facilities Management: Towards Best Practice”. Oxford: Blackwell.
- <sup>vii</sup> Monczka, R. M. PhD et. al. (2005)
- <sup>viii</sup> Hassanain, M.A.; Al-Saadi, S. (2005)
- <sup>ix</sup> Nutt, B. L. (2003) “Four trails to the future”, (2000), apud: Grimshaw, R.W. *FM: the professional interface*. *Facilities Journal*, London: Emerald, v.21, n.3/4: 50-57.
- <sup>x</sup> Jungman, M. (2000) “A Influência da estrutura e da organização do trabalho na qualidade do atendimento: um estudo de caso em serviços”, Thesis (Master) – Escola Politécnica, Universidade de São Paulo. São Paulo.



# Innovative Procurement and Partnerships in Facilities Management

**Per Anker Jensen**

Technical University of Denmark

pank@man.dtu.dk

## Abstract

**Aim:** The aim of the paper is to present, analyse and identify learning from two case studies of innovative procurement in Facilities Management (FM) concerning the establishments of partnerships between clients and providers.

**Approach and methodology:** A major study of FM best practice covering 36 cases from the Nordic countries in Europe shows, that the most outstanding examples of innovation in FM are initiated from the demand side and involves new forms of procurement with long term contracts. This paper considers in-depth two differing examples of such innovative procurement approaches from Denmark. The first example is from a private pharmaceutical corporation, which has used so-called function based procurement in relation to office buildings. The second example is from a public organization, which has entered into so-called operational partnership with private providers concerning all municipal buildings and sports facilities in parts of the city of Copenhagen. Each of the case studies has involved both the client and the provider side of the collaboration. The paper presents, compare and analyze the two cases regarding intentions, procurement methods, forms of collaborations, performance measurements, and the results and experiences.

**Conclusions:** The two cases show that an essential element in a successful procurement and partnership is that the client allows the providers freedom to plan their activities. Thereby the providers can optimize the use of their productive capacity and utilize their competences with incentives to profit from such improvements. A major challenge is to balance the risks between the client and provider and to create a common understanding about the quality level between representatives from both parties. For the providers this kind of collaboration set strong requirements on the management style and company culture.

**Limitations of the research:** The research is only based on two case studies, which obviously limits the possibility to generalize the results.

**Practical applications:** The research presents two specific examples of innovative procurement in FM which can give inspiration and learning to other public and private clients.

## 1. Introduction

This paper is based on a research project on Facilities Management (FM) Best Practice in the Nordic countries of Europe, which was carried out at the Technical University in Denmark (DTU) from 2005 to 2008. The project investigated a broad range of cases of the best practice in FM among leading practitioners and with examples of recent innovations. All together 36 cases from Denmark, Norway, Sweden, Finland and Iceland were studied, but most of the cases were from Denmark, including the 2 cases presented in this paper. The cases covered 5 themes: FM concepts, collaboration between demand and supply, space utilisation, technology and infrastructure, and environment. The two cases in this paper both concerned collaboration between demand and supply. The project was divided in 3 phases. The case presented in section 4.1 was part of 21 cases from the first phase in 2005-2006 and the case presented in section 4.2 was part of 15 cases from the second phase in 2007. The third phase in 2008 included the production of a book based on the research, which was published in both Danish and English (Jensen et al., 2008).

The purpose of the research project was general knowledge building about FM as part of developing FM as a new field in research and teaching at DTU. This included production of teaching material for students, support of knowledge sharing among practitioners, development of contacts and network, and a basis to develop a research strategy and programme for further research and development. That this was successful can be seen from the book being used as teaching material both at DTU and other educational institutions and that the externally funded Centre for Facilities Management – Realdania Research (CFM) was established in 2008. The author of this paper was project manager of the research project and is now head of the research centre.

This paper focus on 2 examples of innovative procurement which shows that establishment of partnerships can be a very efficient way to support innovation. The literature on innovation mostly focus on innovation among providers, but these cases show that the demand side can be an important initiator of innovation in the supply chain by creating procurement models with stronger incentives for the involved parties to be innovative.

## 2. Literature review

Innovation is an important area of business development, which has not been researched much in the context of FM. Mudrak et al. (2005) notice that innovation in the FM industry is often recognized, but the innovativeness of FM organisations is seldom studied. They present a case study of four FM organisations covering two in-house organisations and two main-contractor organisations. Based on the study they conclude that FM organisations innovate only mildly. “The innovation in FM industry is incremental due to the day-to-day nature of decision-making in FM projects and fast changing demands and needs of the client organisations” (Mudrak et

al., 2005, p. 103). They also found that the two main-contractors were more innovative than the two in-house organisations, but with such a small sample this result cannot be generalised.

The conclusion that innovation in FM organisations is mostly incremental is supported by the research project FM Best Practice in the Nordic countries. Formalised development units were only found in a few large public FM organisations. However, large providers also have specialist units, who particular are involved in innovative activities in the tendering process of integrated FM contracts and sometimes in developing annual optimisation catalogues to clients, for instance based on gain sharing incentives. It was concluded that major innovations concern new forms of procurement initiated by the demand side, and that innovation in FM mostly concerns the organisation of work and not so much technical innovations (Jensen et al., 2008).

The development in FM is very influenced by the general development in the construction industry. The focus on innovation in the construction industry has traditionally mostly been related to component producers and contractors. However, during the last 15 years there has been an increased focus on the role of the clients in relation to innovation. Among the examples of this are the development of partnering and Public-Private Partnership (PPP). These examples are characterized with clients introducing new forms of procurement and collaboration, which have effects on the supply chain and attempt to introduce incentives for the providers to become more innovative (in the UK for instance Latham, 1994 and DETR, 1998, in Denmark for instance Bygherreforeningen, 2002).

PPP is interesting in relation to FM, because it integrates the responsibility for delivering a building project and the responsibility for operating the facilities for a long period. However, an ongoing study of PPP questions the innovativeness of PPP consortiums, because of the providers being risk adverse and the strong position of the financial partner. Due to the risk factors related to a long contract period, they are unwilling to add further risk from introducing innovative solutions (Kristiansen, 2009).

Implementation of ICT probably represents most technical innovations in FM, which also can have effects on the supply chain. A recent study has thus shown that there is a strong client-supplier interdependency in relation to ICT implementation. Outsourcing can involve that clients requires use of specific ICT systems, but it can also be an incentive for clients to implement their own ICT systems to keep ownership and control over information about their own facilities and to reduce potential high switching costs, when changing FM provider (Scupola and Jensen, 2009).

A literature study from an ongoing study on inter-firm collaboration in FM concludes: “Knowledge sharing seems to be core to the success of collaborative endeavours when it comes to innovation and competitiveness.” (Storgaard et al., 2010, p. 20). They also conclude that difficulties may arise for innovation the more one focus on management information and performance target control. The potential of long-term collaboration is hindered, if there is too strong focus on “exploitation” and too little focus on “exploration” with cooperation based on trust, reciprocity, obligation and communication, where smaller errors are allowed.

### **3. Methodology**

The research project on FM Best Practice in the Nordic countries utilised a common case study framework, which is described in details in Jensen et al. (2008). The main research method was interviews. For the cases on collaboration between demand and supply it was seen important to collect information from representatives from both the demand side and the supply side.

The case from Novo Nordisk Servicepartner (NNS) in section 4.1 is based on information received from a former department manager in NNS, at a meeting January 2006, and from a project coordinator from K&L from a telephone interview February 2006 and subsequent correspondence based on a draft case study report. Some popular articles by the former department manager in NNS (including Hansen, 2007 - published in English) and an example of one of NNS's function based agreements with K&L have been reviewed.

The case from Copenhagen Municipality (CM) presented in section 4.2 is based on participation in start-up workshop for the operational partnership Brønshøj-Husum in March 2007, information received from the founder of the provider company BMT-BYG at a meeting on March 15th, 2007, and succeeding correspondence with him and the project manager from CM. Various material from the prequalification and tendering process of the partnership and some publications about the experiences in CM have been reviewed.

In the development of this paper supplementary literature reviews have been made, including information and inspiration from some of CFM's ongoing research projects, and the two cases have been compared and analysed more in depth.

## **4. Case study presentation**

### **4.1 Function based procurement in Novo Nordisk Servicepartner**

Novo Nordisk Servicepartner (NNS) was a company within the Novo Group owned 100 % by Novo Nordisk and provided facilities services to this pharmaceutical corporation. NNS has recently – and after this case study - stopped as an independent company and has been integrated in the mother company. In order to improve the technical operation and to imply savings NNS has worked innovatively with procurement of the operational tasks. They have realised that it is crucial to organise these tasks in a way so they may have a volume which gives the provider possibilities to make optimal planning in relation to his production resources. One of the methods for this has been implementation of function based procurement of the entire technical operation of some buildings.

### Function based procurement

Function based procurement is a process which aims at making a function based agreement between a client and a provider. Most agreements specify what the provider must deliver, and at service provisions also which resources the provider must put at disposal as input for the service. Instead a function based agreement is characterised by being aimed at the output, which the provider must deliver. In the function based agreement the provider is hence responsible for the maintenance of the technical system in question.

The Danish Maintenance Association in 2001 published a publication about function based agreements for maintenance (The Danish Maintenance Association, 2001). NNS was engaged in the development of this guideline and they were the first to use function based procurement for operation and maintenance of buildings. The differences between a function based agreement and a traditional activity based agreement is shown in table 1.

*Table 1: Comparison of activity based function based agreements*

<i>Activity based agreement</i>	<i>Function based agreement</i>
<i>The client buys activities, for instance</i> <ul style="list-style-type: none"> <li>• 4 inspections a year</li> <li>• Inspection round once a week</li> <li>• Repairs at € X per hour</li> </ul>	<i>The client buys a function</i> <ul style="list-style-type: none"> <li>• Heating: +21 degrees Celciusin offices</li> <li>• Light bulbs in lamps</li> <li>• Tight roof</li> </ul>
<i>Fixed price to preventive maintenance and unit prices to repairs</i>	<i>Fixed price to preventive maintenance and repairs</i>
<i>The client determine size of preventive activities</i>	<i>The provider determine size of preventive activities</i>
<i>The provider will have stability</i>	<i>The client will have stability</i>
<i>The client takes on risk</i>	<i>The provider is applied risk</i>
<i>Continuous optimising will "harm" the provider</i>	<i>Continuous optimising will be to the benefit of the provider</i>
<i>The client will have continuous optimising</i>	<i>The client will have optimising at procurement</i>
<i>The focus is on economy and quality</i>	<i>The focus is only on quality</i>
<i>The competence is with the provider and the client</i>	<i>The competence is with the provider</i>
<i>The client has detailed documentation demands</i>	<i>The customer has superior documentation demands</i>
<i>All repairs must be invoiced by the provider and tested and paid by the client</i>	<i>No repairs will be invoiced by the provider and tested and paid by the client</i>

Differences in the perception of quality level among client and provider is a risk factor for both parties. For the client the main risks of the function based agreement are that the provider may

fail and that the systems after the contract period are delivered in worse condition than assumed. On the other hand, the provider will have more free hands to organise the work and exploit his competences to optimise the use of the resources. The economical matters are in principle settled at the signing of the agreement, so that the further cooperation will be focused on quality, and administrative reliefs are achieved to both parties. To the client the function based agreement gives economical safety.

It is impossible in advance to decide whether the total costs will be higher or lower at a function based agreement compared to an activity based agreement. It depends very much on the provider's risk estimation, and hence the risk premium which the provider adds in his offer, and of course the competitive situation. However, with the function based agreement there are better possibilities for the providers to optimise their services and develop their competences, which in time would make providers with experiences from function based agreement more competitive, hence provide economical advantages both to themselves and their customers.

### **NSS's experiences as client**

NNS has established several function based agreements of building maintenance. The first was agreed in 2003 and included approx. 10.000 m<sup>2</sup> buildings, and in 2005 another function based agreement was completed, of other buildings, and to a similar extent. The agreements includes the function of all building installations, and the mechanical function of external building parts (facades, roof, doors, gates and windows), and internal building parts (surfaces, doors, ceiling coating and floors). However, maintenance of the building envelope was not included in the first procurement. At both procurements the competition was won by the company Kemp & Lauritzen (K&L). Later agreements were not made at the time of this case study.

In the agreement there are requirements of an overall availability of 99 %. Furthermore, specific requirements for out of service time and response time are defined, both in shape of show up time from error message until repair is started, and time of error correction until the equipment is operational. Table 2 provides examples of such time demands within the agreement. The client must report observed errors to the provider within 4 hours after observing the error.

5 providers participated in the tender process in April 2005, and they had rather varied prices. NNS had estimated the total costs in 2004 at approx € 105.000. Two offers were € 13.000-26.000 below, whereas a third tender was approx € 13.000 higher. The remaining two tenders were approx. 3 times and 4 times higher. This means that NNS reached a guaranteed cost reduction of approx 25 % at this procurement. NNS has examined the results of the procurement with each contractor, and the large differences must be seen as a sign that the providers are hesitating to such a new way of procurement, to which they are not used. Hence their experience base is not suitable to calculate this type of bids. There is a lack of maturity within the market, but the fact that some providers dare to enter with a competitive price may be seen as a sign that some providers can see the possibilities in this new form of agreement.



Table 2: Examples of requirements for show up time and time of error correction

	<i>Show up time (hours)</i>	<i>Error correction time (calendar hours)</i>
<i>Ventilation systems</i>	4	48
<i>Heating systems, room heating (Winter: October 1<sup>st</sup> to May 1<sup>st</sup>)</i>	2	4
<i>Heating systems, room heating, system part (Summer: May 1<sup>st</sup> to October 1<sup>st</sup>)</i>	8	48
<i>Cold water systems, system parts</i>	4	48
<i>Hot water systems, system parts</i>	4	48
<i>Lighting, single light source</i>	8	24

NNS has in the beginning of 2006 renewed the first agreement from 2003, and it now includes the building envelope, and NNS and K&L has also made a function based agreement which include further approx. 20.000 m<sup>2</sup> of buildings. Thus approx 40.000 m<sup>2</sup> of the total portfolio of approx 55.000 m<sup>2</sup> are included in function based agreements. The agreements are not time limited but can be denounced by both parties at the arranged notice.

#### **K&L's experiences as provider**

Function based agreement was new to K&L as they had to bid on NNS' first procurement in 2003, but unlike the rivals' they had experiences in establishing a team for bidding at larger traditional service agreements to property companies and a hotel chain. Such a team typical consists of a service manager for ventilation, a service engineer in plumbing and electricity respectively, and possibly also a security specialist. This team jointly make a survey as part of the preparation of a bid. Furthermore K&L have a special function in the sales unit, who are specialised in bidding for total service contracts.

At the beginning of an agreement K&L examines all technical systems in the buildings along with NNS, and each system is given a grade from 0 to 4, where 0 means that the system is functioning satisfactorily, and 4 means that the system is not functioning. In the last case a renovation case is agreed, which is paid for separately. Additionally the examination and the grades contributes to create a shared picture of the condition of the systems, and hence a basis to estimate whether the systems are in a similar state, when the agreement is dissolved.

Most of the everyday tasks in the NNS agreements are carried out by a site electrician, who besides electrical tasks undertakes replacement of lightning sources and other odd jobs. In case of more complicated tasks, for instance adjusting of ventilation systems, specialised technicians are called for. For the tasks as to the roofs, K&L has hired a roofing company as subcontractor, and they see to inspection of the roofing and possible repairs, and also cleaning of gutters and drainpipes etc. The expansion of the size of the agreements in the beginning of 2006 has meant

that K&L now has a full time site electricians dedicated to NNS's buildings, which is a major advantage to K&L, and it entailed a certain reduction of the contract sum.

The site electrician manages a series of odd jobs as a handyman such as removal of furniture and mounting of pictures, and he also contributes to rebuilding work and changes of office layout. Such tasks are not part of the fixed contract but they are extra tasks, which may be requested for by NNS, and which are settled from the use of man hours. NNS has a service desk, from which such tasks are requested for electronically at K&L, through an internet based system. These extra tasks have had a size, which have surprised K&L, and economically they are of the same size as the fixed contract. However, K&L only undertake these tasks in half of the buildings, as NNS's own workshops undertake such tasks in the remaining buildings.

### **Development and evaluation**

In the latest contract between NNS and K&L they have, as suggested by K&L, signed an agreement about risk sharing, so at present a maximum of € 4.000 to K&L's cost is included for each case, for instance repair of a system. There was no maximum to K&L's costs in the previous contracts, hence K&L had to add in a rather high risk premium in their bid, or make reservations to specific systems in bad condition. With the agreed maximum K&L has been able to reduce the contract price and avoid such circumstances, as NNS now pay expenses over € 4.000 for each case.

On the basis of the former experiences it is NNS's evaluation that the function based procurement includes real incentive to the provider, who has possibilities of many small tasks being one total large task. This give possibilities to think in wholes and to use the employees much better with large savings of time of transportation and changeover in relation to each employee who has to work with many small single tasks for various clients. Hence it is estimated that 80 % of all tasks may be solved by a multi-worker. However, the providers' internal division in trade workshops is an impediment to use these potentials. There is a need for education of a new type of multi-worker, who can work with various tasks. Another problem is that planned maintenance at present is subject to calendar tyranny, and a real optimising of the continuous inspection tasks is missing. If the continuous inspection can be changed from once a year to once each 5th quarter it will reduce the resource efforts used by the inspection with 25 %. Accordingly the providers ought to consider the economy in a contract over the entire period, rather than to focus on a profit within each quarter.

To K&L the experiences regarding function based procurement has also been positive, and they will try to make other larger property owners interested in such a form of agreement. Traditionally such companies have a large number of different providers to manage various sorts of operation and maintenance tasks, but using a function based procurement all tasks may be solved by approaching only one provider. This makes life easier to the client, who may even avoid hiring a caretaker.

## 4.2 Operational partnerships in the Municipality of Copenhagen

Operational partnership or service partnership are rather new within the public sector in Denmark. The Danish Enterprise and Building Authority started in 2003 to financially support municipalities and counties who want to develop and establish a public-private partnership about operation and maintenance of buildings. The purpose to the support is to co-finance some of the extra costs which are attached to initiate public-private collaboration. In 2003 the Danish Enterprise and Building Authority furthermore offered a task in developing an electronic partnership instruction to private and public companies, and it was in February 2004 published as a step-by-step instruction of partnership on their web based tendering portal.

Copenhagen Municipality (CM) in 2004 as one of the first public organizations in Denmark established public-private partnership with operation and maintenance of some municipal buildings at Østerbro. In the beginning of 2007 CM established 2 new partnerships including all municipal buildings in two quarters in Copenhagen, Brønshøj-Husum and Vanløse. The private part, both at Østerbro and in Brønshøj-Husum is a consortium with BMT-BYG as the main player. This case focuses on the partnership between CM and BMT-BYG on in particular on how the partnership was established, and how they function.

### The operational partnership Østerbro

The operational partnership at Østerbro included 5 schools and 5 after-school centre of in total 39.343 m<sup>2</sup>. The 5 schools represent 35.137 m<sup>2</sup>. The partnership was established in June 2004 and it was part of a pilot project in collaboration between CM and the Danish Enterprise and Building Authority.

The purpose of the project was

- To develop a new way of collaboration among the municipality, schools/institutions and contractors, which are known by openness, flexibility and fewer conflicts
- That the prioritisation of both internal and external maintenance to a greater extent accommodates the need and wishes of the schools/institutions in short and long term.
- That the maintenance standard is improved

To the municipality the special thing about the partnership was the fact that it was not just a partnership between a private and a public part, but also between the central administration and the decentral units in the municipality – schools and institutions.

The procurement was carried out without prequalification. The procurement materials included a procurement letter, a partnership agreement and the following 4 enclosures: AB92 (common condition for construction and civil engineering work in Denmark) including changes and appendixes, cooperation agreement, operation planning and project description.

In the bids, the tenderers had to specify standard hourly prices divided in 16 types of work and to foreman, building/operation manager and reduction to apprentices. Furthermore, to each of the 16 types of work they had to specify a price index as to standard materials, which stated the tenderer's material price in relation to the distributor's price list. As part of the bid the tenderers had to describe the way they planned to solve the task as to staffing, servicing of users, cooperation with the municipality's technicians and others, competency development and proposition of an incentive model. Finally the tenderers had to include suggestions to further development of the partnership idea, for instance process optimisation and communication.

Choice of provider was made on the basis of the best economic offer based on a total evaluation of the assignment criteria: Price (40%), solution of the task (40%) and development propositions (20%). After choosing provider the cooperation began with a workshop, in which the cooperation agreement was finished jointly and the contract was signed.

As stated objectives to the partnership the following was agreed:

- Streamlining: Better use of staff knowledge, resources and competences with the parties involved
- Competency development, for instance of technical staff, through a close contact among the parties
- 5-20% more maintenance to the price and less urgent calls
- Reduction of the expenses for energy

The partnership began August 2004, and at first it lasted for December 31st, 2005, but a possibility of prolonging the agreement for further 2 years until the end of 2007 was used by CM. The budget for the partnership was in total Euro 2.2 million for 2004-2007. As specific results of the partnership CM has estimated, that they have 19% more maintenance to the price, and the extent of urgent tasks has been reduced from approx. 10 tasks monthly in 2003, approx. 5 tasks monthly in 2004-2005 to approx. 3 tasks monthly in 2005-2006.

The cooperation within the partnership has been successful. A significant cause to this has been that the parties spend much time together at workshops and meetings in the beginning. This led to the fact that the parties became well acquainted with each other, and a relation based on confidence was built up. All involved parties had the will to make the cooperation work out, and there has been a true openness among the parties.

The tasks have included daily maintenance of buildings, technical facilities and paved outdoor surfaces and planned maintenance such as replacing windows and roofs and refurbishment of special class rooms and toilets. The planned maintenance is determined once a year. At the beginning of the year the provider prepare a price catalogue of the future tasks, partly from CM's registrations in the IT-based maintenance system (Caretaker), and partly from the

provider's own review of the buildings. On basis of this the common planning group makes a prioritisation and selection of the tasks which should be finished during the coming year. The exact implementation is coordinated to each institution so they will be of minimal inconvenience to the users.

One of the greatest advantages of the partnership is the possibility to plan larger coherent refurbishment tasks across institutions. For example windows renovation has been done in several institutions in continuation. Likewise the provider has more possibilities to plan the works in relation to his personnel resources, including a certain amount of seasonal level out. In the partnership they are allowed to carry forward money from one financial year to the other, which normally is not possible within the municipal system, and this helps to more flexibility in the planning.

The main part of the budget is based on central funds within the municipality for maintenance, but the partnership has also included the self administered funds, which each institution administer for internal maintenance and various occurring works. This has proved to be less suitable as they had to spend exorbitant time to have the tasks agreed, which were to be performed to the self administered funds. In the new partnership agreements the self administered funds are kept without the agreement itself, but they are included as an option, so that each institution may chose to have these tasks carried out by the provider within the partnership.

In 2006 a midway evaluation of the partnership was finished, which in general was very positive, both as to cooperation among CM and the private consortium, and among the central and decentral parties within CM. Based on the experiences from Østerbro, the newly established Copenhagen Property in CM with assistance from the consulting engineering company COWI prepared the procurement of the new partnership agreements which were established in the beginning of 2007.

### **The private partner BMT-BYG A/S**

BMT-BYG A/S is a building company based in Copenhagen, and they primarily work with rebuilding, refurbishment, operation and maintenance of housing and business facilities in the Copenhagen region. The company was established in 1982 by a master carpenter and in 2004 it was reorganised into a joint-stock company with 3 owners, who also jointly manage the company.

BMT-BYG A/S had prior to the partnership with CM some long-term customer relations. This concerns housing and business facilities, where they for a period of years have managed maintenance tasks. Furthermore they had long-term relations to some architects and consulting engineering companies. Based on bad experiences as a young carpenters company the founder had chosen not to work as subcontractor to the large main contractor companies. BMT-BYG instead acts as main contractor and cooperates permanently with a series of other companies from other building trades, where the same companies again and again are involved based on

trust and without price competition with other subcontractors. These permanent cooperation relations have gradually developed over time, and it has led to the building up of a strong network.

Internally BMT-BYG is also characterised by long-term relations with the employees. Hence they work hard to avoid firing employees. Most employees are now salaried employees, and they started that already in 1985. Piecework is never used within the company. With its 30 employees BMT-BYG is a comprehensive company, and they do not want to grow. There are some special demands on management and staff to work as a provider in a partnership. It is mainly the employees' activities in the field, where they have the direct contact to the customers, which will carry the partnership through. Hence the employees must be minded for this, and have some permanent colleague relations. Some employees are better fit to work with the customers than at building sites, and for the management it is important to be aware of this and use the employees where the fit in the best.

### **The operational partnership Brønshøj-Husum**

In autumn 2006 CM arranged a tender competition of two partnerships which includes operation and maintenance of all the municipal buildings in Brønshøj-Husum and Vanløse, respectively. The partnership with BMT-BYG in Brønshøj-Husum includes in total 53 buildings divided in 6 administration buildings, 10 old people's homes, 8 public schools, 26 day care centre and 3 stadium and sports facilities. The duration is 3 years with the possibility of prolongation for 1 year and the budget is approx. Euro 8.0 million for the 4 years.

The purpose of the operational partnership is:

- To obtain a better utilisation of the central funds, which are used for external maintenance of the buildings
- To catch up with the back-log of maintenance of the buildings
- To coordinate the daily operation and the planned maintenance tasks along with the users and partners
- To create a competence development among the parties and develop more knowledge as to the problems of the building

In connection to the partnership at Østerbro the major change in purpose is an increased focus on competence development and more knowledge. The criteria for success to the partnership are here as well:

- More maintenance for the money
- Less administration within all parts

After implementation of the procurement process, including choice of the consortium with BMT-BYG A/S together with the building services specialists Dalskov EL-VVS A/S, the partnership was initiated through a start-up workshop on March 6th, 2007, with the participation of representatives from the consortium, CP and the municipal institutions, and with consultants from COWI as facilitator. As part of the workshop the parties involved presented themselves to one another and a crosswise teamwork was started, in which the distribution of roles and the communication were discussed. Furthermore a letter of intent concerning the cooperation was worked out together, so they agreed on goals and rules of the game. The letter of intent includes the following main points:

- Shared project goals
- Cooperation and process
- Quality
- Conflict resolution
- Open books
- Incentive structure

In the letter of intent the shared project goals of cooperation and process represent the major part with 15 short "statements". In return the conflict resolution includes the most specific part in the shape of a conflict resolution ladder with fixed hours or days to solve problems and disagreements on each step.

The further procedure was also discussed at the workshop, during which the first meeting in a planning group was arranged. Further COWI presented an effect measurement tool, which would be used to measure the effect of the partnership. The tool was developed by COWI for the Danish Enterprise and Building Authority in cooperation with a work group with representatives from Copenhagen and Frederiksberg Municipalities and BMT-BYG. It is built up with basis in Balanced Scorecard, in which there is measured in relation to the following 4 perspectives: Economy, customer/user, work processes, and competence and learning. Measurements are made through questionnaire surveys each year during the contract period. It starts in year 0 and is supplemented by interviews.

The start-up workshop was finished after signing of the contract and the letter of intent by CP and the private consortium.

## 5. Comparison and discussion

A comparison of characteristics of the two cases is shown in table 3.

*Table 3: Comparison of the two cases*

	<i>NNS</i>	<i>CM</i>
<i>Procurement type</i>	<i>Function based</i>	<i>Operational partnership</i>
<i>Client</i>	<i>Private corporation</i>	<i>Public municipality</i>
<i>Provider</i>	<i>One company: Technical contractor</i>	<i>A consortium: Building contractor and technical contractor</i>
<i>Type of buildings</i>	<i>Offices</i>	<i>Schools, offices, sport facilities etc.</i>
<i>Contract duration</i>	<i>Not fixed</i>	<i>3 years +1 year as option</i>
<i>Remuneration</i>	<i>Fixed total price</i>	<i>Fixed rates</i>
<i>Governance</i>	<i>One point of contact</i>	<i>Steering committee, planning group and operational teams</i>
<i>Work planning</i>	<i>Provider alone</i>	<i>Provider together with client</i>
<i>Relations to end users</i>	<i>Informal</i>	<i>Formalised</i>

The cases are both characterised by implementation of new forms of procurements initiated by the demand side. The providers are given freedom to plan their activities, so they can optimize the use of their productive capacity and utilize their competences. The collaboration is also in both cases long-term. In the private NNS case the contract is with-out time limit and in the public CM case the contract period is 3-4 years based on EU procurement regulations. Both cases are based on competent client representatives and mutual trust between client and provider. Both clients have realised that an extensive contract volume is important to make the collaboration attractive to providers and thereby to achieve economically attractive bids.

The NNS case gives the strongest economical incentives for the provider to be innovative, and is mostly suitable for buildings of limited complexity. The CM case is to a higher degree based on close collaboration with utilisation of complementary competences between client and providers, and with involvement of the users.

The agreements between NNS and K&L were the first example of use of function based procurement for building operation and maintenance in Denmark and so far there are only few other examples. There seem to be a lack of maturity, both with clients and providers to enter into this new way of tendering, but the experiences from the agreements between NNS and K&L indicate that it implies significant advantages to both clients and providers.



Function based procurement and partnerships in FM are inspired from the development in the construction industry, but there are indications that these kinds of long-term collaborations are more suitable to FM than construction. A study comparing the construction department and the maintenance department in a large corporation in the UK found clear differences in the culture. The staff in the construction department is characterised as “hunters”, who are focussed on winning new contracts and finish building projects with strict deadlines and immediately continue to the next project. Contrarily, the staff in the maintenance department is characterised as “farmers”, who are focussed on understanding their customers and building up long-term relationships with them (Johnstone, 2007).

## 6. Conclusion

The two cases presented in this paper show that an essential part of a successful procurement and partnership is that the client allows the providers freedom to plan their activities. Thereby the providers can optimize the use of their productive capacity and utilize their competences with incentives to profit from such improvements. A major challenge is to balance the risks between the client and provider and to create a common understanding about the quality level between representatives from both parties. For the providers this kind of collaboration set strong requirements on the management style and company culture. The case studies support the conclusion from the literature review that the soft side of management based on exploration rather than exploitation is crucial to a successful partnership in FM.

## References

Bygherrefoereningen (2002): *Bygherren som forandringsagent – på vej mod en ny byggekultur. (The building client as a change agent – towards a new building culture)*. The Building Client Association in Denmark. Byggecentrum.

The Danish Maintenance Association (2001): *Funktionsaftale for vedligehold. (Function based agreement for maintenance)*. Dansk Vedligeholdsforening.

DETR (1998): *Rethinking Construction: the report of the construction task force*. (The Egan report). Department of environment, transport and the regions.

Hansen, F. W. (2007): *Facility Management Contract - New contract model can cut property-operating expenses in half*. Article in the periodical EuroFM Insight, Issue 2, 2007, pp. 9-10. EuroFM.

Jensen, P. A., Nielsen, K. and Nielsen, S.B. (2008): *Facilities Management Best Practice in the Nordic Countries – 36 cases*. Book. Centre for Facilities Management – Realdania Research, DTU Management Engineering.

- Johnstone, S., Dainty, A. and Wilkinson, A. (2007): 'Hunters and farmers? The HRM implications of product-service in construction', in *Proceedings from CIB World Building Congress: Construction for development*, pp. 254-265 . Cape Town, May 2007.
- Kristiansen, K. (2009): 'PPP in Denmark – Are Strategic Partnerships between the Public and Private Part a Way Forward?', in Thomas Ng, S. Wong, J.M.W. and Kumaraswamy, M., *Proceeding of the CIB TG 72 PPP Symposium: From 'Revisiting and Rethinking' to 'Revamping and Revitalising' PPPs at The University of Hong Kong 28 February 2009*. Centre for Infrastructure & Construction Industry Development, The University of Hong Kong.
- Latham, M. (1994): *Constructing the team: the final report of the Government/industry review of procurement and contractual arrangements in the UK construction industry*. Her Majesty's Stationary Office, London.
- Storgaard, K., Larsen, J.N. and Olsen, I.S. (2010): *Inter-firm Collaboration in Facilities Management – Theory and Concepts*. Research Report. The Danish Building Research Institute. Aalborg University.
- Mudrak, T., van Wagenberg, A. and Wubben, E. (2005): Innovation process and innovativeness of facility management organizations. *Facilities*, Vol. 23 No. 3/4, pp. 103-118.
- Scupola, A. and Jensen, P.A. (2009): *Information and Communication Technologies and Supply Chain in Facilities Management in Denmark*. Centre for Service Studies, Roskilde University, Research Report 09:3, and Centre for Facilities Management, Technical University of Denmark, December 2009 (available at [www.cfm.dtu.dk](http://www.cfm.dtu.dk)).

# A Conceptualisation for the Future Health Care Sector in Western Economies and its Relationship to Facilities Management

Suzanne Hofer<sup>1</sup>, and Paul Dettwiler<sup>2</sup>

<sup>1</sup>Institute of Facility Management, Zurich University of Applied Sciences

<sup>2</sup>Institute of Facility Management, Zurich University of Applied Sciences

## Abstract

What role will FM play in the future of health care sector of Western economies of the Industrial World? The Health care sector of Western economies encompasses two main categories: (1) Health care aimed at people that wish to maintain their health and (2) Health care for patients that have an illness. To date, these two domains have been regarded as separate domains in the Western societies. Today there is an intense discussion how the society should support the first category because the burden of the society becomes more significant in the second category. This paper highlights the imminent problem of the Western health care sector and its relationship to FM. In addition, upcoming needs of cutting costs and achieving efficiency goals give reason to redesign and conceptualise the core business activities of the two categories. A comprehensive literature review and empirical work were carried out using expert interviews. For the literature review multiple sources were accessed (scientific papers, general literature on definitions, laws and regulations, company-internal sources such as manuals, journals, statistics, and information on organizations and institutions from the Internet). The study is based on comparisons of the two categories Health care aimed for people:(1) that wish to maintain their health, and (2) those who have an illness. In conducting this comparative study, the concept of “Health tourism” came logically as provided a focus. The study reveals that FM has a potential to be coordinated between the two categories of health care provision due to economies of scale; identical services in the core business.. The challenge for FM is to support the transition and imminent changes of the two categories. In addition the dynamics of “insourcing” respectively outsourcing would play a significant role on premises and related FM services. We argue that while the spaces and services of the two categories must be rendered more efficient, a third intermediary concept of “Healthiness” might have its place. A conceptual model is created that renders relevance on the relationship between FM and the two health care sectors and a new intermediary category.

**Keywords:** Health care, Service, Efficiency, Core activity, Space, Knowledge Management

## 1. Introduction

Health has become widely accepted as a service to consumers and is seen as part of general life quality. Medical treatments that contribute to lifestyle are common nowadays. Sometimes even the difference between medical necessity and (medical) wellness is not obvious anymore (Slembeck, 2006). These changes in values not only include medical treatments but also infrastructural and service conditions and standards in hospitals. According to Sigrist (2006), the growth of medical wellness, the so called health or prevention boom, is forecast to become the new “economic power”. This is due to less restriction, higher innovation potentials and the main focus being placed on customers and their wants and needs. Thus, the health care market is a significant value creator in terms of GDP and workplaces in Western economies; in fact 15 % of the GDP of the USA and 11 % of that of Switzerland (OECD, 2008) are related to health care. The new context for attitudes towards health care argues for a new definition that focuses on health rather than disease, and on cost effectiveness, which is dominated by the logic of global consumer markets. Synergies between the markets for "the sick" and "the healthy" will become increasingly relevant in the future and the market for health tourism plays an important role within this broader picture. Furthermore, the concept of health tourism and its underlying economic potential is growing steadily. The future conceptualisation of healthcare has a causal relationship to facilities management that supports the core activities of health care, i.e. the appropriate use of spaces and services and related synergies.

## 2. The Health Industry in the Western World

The concept of “health tourism” includes components from both the health and tourist industries. The definition of health from the World Health Organisation (WHO) helps to clarify the concept of health tourism: “Health is the state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity” (WHO, 1946). This paper focuses on health issues in the Western world, in particular Switzerland, which is here regarded as representative of a country with responsibility for health care shared by the governmental and private sectors. The health care system in Switzerland is a decentralized system, based on the idea of social security. The role of health insurance is particularly crucial to the development of health tourism.

According to Sigrist (2006), there are initial indications that no uniform definition is available for the health care market. Based on the fact that people talk more often about sickness than health, the health care market is divided in this study into two sub-markets (Sigrist, 2006). The traditional health care market is referred to as the "sickness market" and the market for healthy people as a "new health care market." It must be emphasised that there is a large grey area between sickness and health in which health and disease cannot always be clearly distinguished.

- The “sickness market”: This submarket reflects the traditional understanding of health care and contains the features involved in curing the diseases of sick people (Sigrist, 2006). The

market is not only relevant from the perspective of cost, but also from that of the workforce, as already about 10% of jobholders are employed in health care institutions (FSO, 2006).

- The “new health care market”: In contrast to the sickness market, this places a focus on prevention in healthy people. The lifestyle of today's society, where time and rest, and thus the search for wellbeing, are becoming a new luxury, shapes this market. Health is consumable; health offerings are subject to free market forces and buying decisions are the personal responsibility of the consumer. On the other hand, the sickness market is highly regulated (Sigrist, 2006).

Also the concept of “tourism” needs to be defined so that an extrapolation can be made later to the concept of health tourism. WTO provides the following definition: "Tourism comprises the activities of persons travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes" (Gee and Fayos Solá, 1997). Persons travelling to and staying in places away from home usually need accommodation; therefore tourism and hotels are closely linked. "Usual environment" refers to a person's living environment and other regularly frequented places, such as the workplace. A further definition includes, in addition to the maximum stay of 12 months and a destination, the lack of remuneration to be received at the destination. This excludes today's large number of professional commuters from the definition of tourism (Rulle, 2004).

A study conducted by the GDI (Gottlieb Duttweiler Institute), commissioned by the Swiss Hoteliers Association organisation, “hotelleriesuisse”, entitled "The future of the Swiss hotel industry" (GDI, 2007), shows that the hotel industry has not set aside sufficient reserves to maintain and invest in real estate over the years. Another internal weakness was found by the GDI (2007), namely a frequent unwillingness to work in partnerships and thus exploit synergies. External factors are also affecting this industry; due to the increased mobility of the Western population the average length of stays has fallen (GDI, 2007 and FSO, 2006). Another finding is that the market needs of the "older generation" are increasing (FSO, 2006). The demographic change in society and the accompanying increase in life expectancy have promoted this new situation. The older generation is increasingly willing to spend money, and this also benefits the tourism industry (GDI, 2007). Future profit focused entities within health care provision have good reason to pay attention to the segment of older and wealthier health care customers that are particularly interested in retarding ageing, and in the prevention and successful cure of illness. Dettwiler (2010) has presented the concept of “Preventive FM” directed towards the older workforce: this includes an attention to standardisation and regulation that in the imminent future must be adapted to the segment of older workers, due to the fact that a universal retirement age is now being called into question. In the future a larger number of elderly people will be involved in productive work for demographic and financial reasons.

### 3. Health Tourism and Adjacent Concepts

There is no consensus on how the term "health tourism" should be defined (Rulle, 2004, Berg, 2008, and WTO through Gee and Fayos-Solá, (1997). Various definitions can be found, among them that of the WTO: "Tourism associated with travel to health spas or resort destinations where the primary purpose is to improve the traveller's physical well-being through a regimen of physical exercise and therapy, dietary control, and medical services relevant to health maintenance" (Gee and Fayos-Solá, 1997).

Already in the ancient world and in the early middle ages, wealthy people invested their time in maintaining health and prolonging youth. The term "SPA" is an abbreviation from the Latin expression "Sanus Per Aquam" which means "Health through water". Travelling to springs and wells with a particularly beneficial composition of water (for bathing and consumption) has been popular in Europe since Roman times. Stays in resorts have also provided the opportunity for patients to focus on other medical treatments. In the 19<sup>th</sup> century tuberculosis patients had to be treated in sanatoria located at high altitudes in the Alps. Today, alternatives (particularly from Asia) to conventional medical treatments are being sought, and new concepts combining alternative and traditional medicine have appeared. The cure and treatment of the human body is thus traditionally linked to travel and accommodation away from one's regular residence.

Health-oriented holidays as a type of vacation have relevant links to health tourism; the two concepts differ with respect to the lack of clear targets and the holistic approach to maintaining good health. "Recuperation", rather than an improvement in health, is the focus, and should be achieved through spontaneous activities. Superior accommodation, food, and entertainment are regarded as significant factors (Rulle, 2004); it is therefore obvious that supporting services such as operational FM have a crucial role to play.

"Patient tourism" is characterised as the international tourist traffic of patients who desire to obtain medical services abroad for various reasons. In general, the treatments are financed by the patients themselves (Rulle, 2004). An important travel motive in such cases is the lower cost of services abroad. Corresponding destinations including Eastern Europe, but also Thailand and Dubai, are especially highly frequented and growing in significance; these locations offer dental, aesthetic and plastic surgery and have won a reputation for their qualified workforce, most of whom have educational roots in the western economies. The services are less expensive than at home due to lower local wages and in some cases to weak national currencies. Patient tourism is also subject to criticism. Berg (2008) points out that the savings effect of such a journey is often cancelled out if expensive follow-up treatments are needed which are not generally accepted by the statutory health insurance. Nevertheless, it is believed that the health care market and with it patient tourism will continue to grow internationally over the coming years. Political negotiations on a health agreement with the EU may be important in this context (Lüthi, 2008).

Patients for "operation tourism" are sent by hospitals in their home country for surgery abroad in order to avoid long waiting lists for operations in their home country. This is especially

practised in Scandinavian countries (Rulle, 2004). This kind of tourism is solely characterised by "technical" improvements, so that targeted follow-up treatment aimed at a holistic improvement in the patient's health, which is a further feature of health tourism as a whole, is missing.

Services in the core business of health care are highly variable due to rapid developments in the medical sector. The needs for space and services are thus also variable; cost reductions can be achieved as long as the gap between supply and demand can be reduced.

Patient hotels accommodate so-called "low-care patients". These are patients needing a low level of care, who no longer need to be cared for in hospital around the clock (Loeffler, 2008). In the United States and Scandinavia, new forms of care for patients have been in existence for several years. The length of stays in acute hospitals can be reduced and parallel capacity for acute patients eliminated. The introduction of DRG (Diagnosis Related Groups) has resulted in structural changes. This was confirmed by Dr. Luca Stäger at the SwissDRG Forum in Basel (2006): "Looking at the experience from Canada, Australia and the USA, there has been (...) a reduction in the length of stays and care duties have shifted to the pre- and post-stationary areas." The infrastructure is also relevant to health care: due to the proximity of patient hotels to the hospital, the patient remains in easy reach and can be immediately transferred to the acute ward in case of any emergency. Within this context, provision of flexible spaces requires skills that relate to the competence field of FM. One night in a patient hotel costs considerably less than an overnight stay in hospital; according to Fillipini (2007) a reduction of one day of hospitalisation lowers the total cost by 4%, as savings on staff and infrastructure in the sickroom are possible (Loeffler, 2008). Appropriate coordination of available resources and services might well contribute to affordability for lower income end-user segments.

For a few years now, German hospitals have also been adopting this system and the differences have been calculated: in a three- to four-star patient hotel the cost of the stay was in the proportion of around 2:3 to a hospital stay (gv-praxis, 2007, Kohl & Partners, 2008) – significantly cheaper than a hospital bed (Berg, 2008). The target group for patient hotels is patients who are still on sick leave after surgery, but no longer need intensive medical care, and are on the road to recovery. Hotel operators can increase their room utilisation and the patient is in an environment where the grade of service is more significant than it is for a health care provider (Tränker, 2008). A Swedish Patient Hotel (in Karlstad) pointed out that the average duration of stay per guest is two days after a hospital stay of 2.3 days on average. Due to the radical changes taking place in Switzerland through the area-wide implementation of SwissDRG, patient hotels are seen as having huge potential (Hofer and Bögli, 2008). Because the hotel is located near a hospital and is therefore often close to the normal living environment, patient hotels do not correspond to the definition of health tourism, where the journey is an essential component (Hofer and Bögli, 2008, Rulle, 2004, Gee and Fayos-Sola, 1997).

## 4. Methodology

To answer the questions on the state of research into scientific definitions of health tourism in Europe, a comprehensive literature review and empirical work were carried out using expert interviews and questionnaires from primary and secondary sources. For the literature review a variety of media were used (scientific papers, general literature on definitions, laws and regulations, company-internal sources such as manuals, journals, statistics, and information on organizations and institutions from the Internet). For the questions on health tourism four experts were interviewed. These are involved in the Verband Schweizer Kurhäuser (Wohlbefinden Schweiz / Association of Swiss Spa Centres), in a rehabilitation centre and in a health insurance company. The interviews were conducted on the basis of qualitative, semi-standardised model interview questions. The focus was on the function of the interviewee and not on the person him- or herself.

## 5. Core Activities of Health Tourism Connecting to FM

The concept of Health Tourism implies use of spaces and various services. The core activities consist of “cure” and “rehabilitation”. The concept of “wellness” is also significant, as it represents a basic requirement of modern society. The core business within the health care sector has a complex character, so that FM must exhibit features of adaptation and rapid flexibility. This is *per se* enabled by ICT technology, Decision Support Systems (DSS) and Knowledge Management.

The role of health insurance is particularly crucial to the development of health tourism. The health insurance law regulates what services must be paid for out of the basic health insurance cover that is compulsory for Swiss residents. In addition to offering compulsory basic insurance, insurers may also, according to the Health Insurance Act, offer supplementary insurance. Supplementary insurance is voluntary for policyholders. The risks of this cover are spread only among people with such supplementary insurance (Ackermann-Liebrich et al., 2007). This area of supplementary insurance is significantly involved in the development of health tourism.

In recent years, rehabilitation clinics in Switzerland and other countries have had to close, which can be explained by medical advances – as some diseases can be treated with medication, so that rehabilitation has become redundant (Hofer and Stampfli, 2008). Nevertheless in 2006 total rehabilitation clinic (turnover) costs rose 9.7%, which represents 1.6% of the total health care costs (FSO, 2008). A similar pattern can as well be found globally. Hofer and Stampfli (2008) deal with the future of Swiss rehabilitation clinics, which in view of the changes in the health care system and the shortage of financial resources are undergoing substantial change.

*Wellness* is a universal concept. The study "Health Horizons" by Sigrist (2006) describes the term “wellness” as a major buzzword for the health care market and uses the heading "Wellness



is dead, long live wellness". The reason given is that the term has lost much of its charisma through inflationary use in recent years. Economic considerations may also play a role. But the study also points out that the demand for wellness products is growing continuously. Consequently, the consumer goods market and the hotel industry will continue to count on "wellness" as a market concept. Clarification of the concept shows that wellness is strongly driven by the motive of voluntary health promotion and can therefore be classified under health care. Lanz (2002) describes wellness as a health condition characterised by harmony of body, mind and soul. "Wellness hotels are for people who want to do something for their health" (Heimgartner and Zundel, 2008b). Typical elements are self-responsibility, fitness and body care, healthy eating, relaxation, mental activity, social relations and environmental sensitivity (Lanz, 2002). These characteristic elements can be aligned with tourist attractions and thus are of special significance for wellness tourism. From this perspective, Lanz (2002) developed the following definition of wellness tourism:

"Wellness tourism includes travel and a stay by individuals who are primarily motivated to maintain or promote their health. The stay takes place in a hotel with corresponding professional expertise and individual attention, [...]" (Lanz, 2002).

We argue that activities in core business of health care are complex and dependent on facility services, space and infrastructure. According to Sigrist (2006), hospitals are e.g. transferring their patients at an increasingly early stage into rehabilitation clinics; this fact is connected with the introduction of the DRG system. This is why rooms with 24 hour monitoring are needed and rehabilitation clinics with such rooms have a unique market advantage (Hofer and Stampfli, 2008). The clear demographic changes in the population will cause the demand for geriatric rehabilitation to increase significantly in the coming years. Ongoing adjustment of services and methods of treatment to medical and technological progress is therefore inevitable; in addition, health care expenditures for each individual will be necessary for an extended period, due to higher life expectancy.

It is clear that the above described concepts are complex, with interrelated dependencies. Thus, an evident allocation of services is not always easy to pursue. Frequently, it is not clear whether public or private sources should cover the costs of treatment. To minimise costs, attention must be paid to the dynamics and financial optimisation of insourcing, and to the outsourcing of spaces and services that support treatment.

## **6. Creating Facilities Management for the Concept of Healthiness**

As argued, the health care market can be divided into two sub-markets, "the market for the sick" and "the market for the healthy". The latter has also been transformed into "the new market for healthy people", from which health tourism is especially likely to benefit. This promising connection of the new health market to the health tourism sector is offset by the critical statements from the surveys carried out for this paper. It turned out that a medically

indicated service is seen as an overriding criterion for health tourism. Thus it is aimed at the target group "the sick". Medically indicated services are therefore generally to be provided in a spa, therapeutic bath or rehabilitation clinic. Mostly this takes place after a hospital stay or an examination by a physician where the prescription of a doctor is absolutely necessary. Rehabilitation clinics support people who "have to" do something to restore their health; health resorts and spas those that "should" do something for their health (Heimgartner and Zundel, 2008a and b). Wellness and health protection tourism, however, aim at the target group of people who "want to" do something for their health. In this sector there is a lack of medically indicated services. Experts speak of wellness tourism as providing pampering products and classify it under traditional tourism. The research carried out for this work led to the conclusion that a service from the field of health care must have been provided prior to health tourism. This allows health tourism to be classified under the health care system. Providers operating in the field of health tourism will need to align their infrastructure towards the care of sick people. It is thus clear that health tourism cannot be seen under the umbrella of tourism, as was the case in previous definitions. Thus, health tourism cannot be classified under the "new market for the healthy", but under the market for the sick. Therefore a definition for "the new market for the healthy", for example "health(i)ness", is essential and could help to clarify the terminology. Despite these findings, the concept of health tourism will probably continue to be used and interpreted in misleading ways. Nevertheless, synergies between the two markets are not excluded, as the comments above show. In summary, medically oriented wellness tourism can be seen as a combination of traditional health and rehabilitative care and wellness tourism, in the markets for both sick and healthy people.

Awareness of the concept of health(i)ness and health tourism and in particular its underlying economic potential is growing steadily. How far the market for the healthy will develop towards medical indications in terms of prevention, and thus be classifiable as a medically aligned preventive service, remains to be seen. Medical wellness is seen as "product of synergies" from both markets and health(i)ness is seen as "philosophy of life" (Table 1).

Table 1: Medical wellness vs health(i)ness

<b>Classification</b>	<b>Medical wellness</b>	<b>Health(i)ness</b>
Field	Health tourism and "Health(i)ness"	"Health(i)ness"
Market	Both markets (sick and healthy)	"The new market for healthy"
Type of guest	Sick and healthy people	Healthy people
Motive	Health promotion, primary prevention	Prevention
Paradigm	"Limitation of damage"	"The non appearance of illness"
Infrastructure	Spas, hotels and resorts, rehabilitation clinics, "converted" hospitals	Care centres, surgeries, health(i)ness-centres
Duration of stay	Often only a weekend or 1-2 weeks with special treatments	"Philosophy of life" with corresponding activities
Services used	Movement, nutrition, relaxation, health education	Various activities under medical supervision

Decision	Own initiative, voluntariness or medical advise	Voluntariness, programme defined by a physician and partially paid for by health insurance
Goals	General wellbeing and health - conscious lifestyle	“Prevention programme”
Financing	Mainly self-payers	Mainly self-payers, the insurance companies are going to reward the healthy (paradigm shift)

A conceptualisation of “Health(i)ness” requires the mastery of complex process changes in both core business and support services. Today’s health care sector is in a historical sense profoundly related to the concept of outsourcing and Facilities Management (Dettwiler, 2006). It is commonly known that the experience of outsourcing has frequently resulted in negative outcomes (Duce 2008). The challenge of the future is to connect the knowledge of the complex processes in the core business to the supporting processes. The challenge of today is to connect the means of ICT technology, where a large amount of data must be connected in a relevant way. The rapid changes within the core activities in the fields of wellness and healthcare must to a considerable extent be supported by services and spaces. Acceptance for gaps between detected needs and available resources has been continuously reduced considering the urge for reducing costs. Therefore Knowledge management with its means of data mining, DSS, and ICT argues for a central role in the management of future health care and transitions to new concepts. In other words, the core process can provide services with higher efficiency if the supporting processes are organised in an economical and professional way of a facilities manager. The established role of Facilities Management is to coordinate various support factors which is in fact the *raison d’être* of the discipline and is argued to create added value for the organisation. Figure 1 proposes a conceptual model that combines traditional health care with a wellness concept. Certainly the fields of the two domains will always be separate; however, combinable parts of services (both in the core and support business) must be detected in order to achieve synergy effects. A new attitude to the existing solutions would give birth to new conceptualisation, proposed here as *Health(i)ness*. A pro-active approach of FM would also contribute as an input for creating future concepts with the new roles within health care and wellness as well.

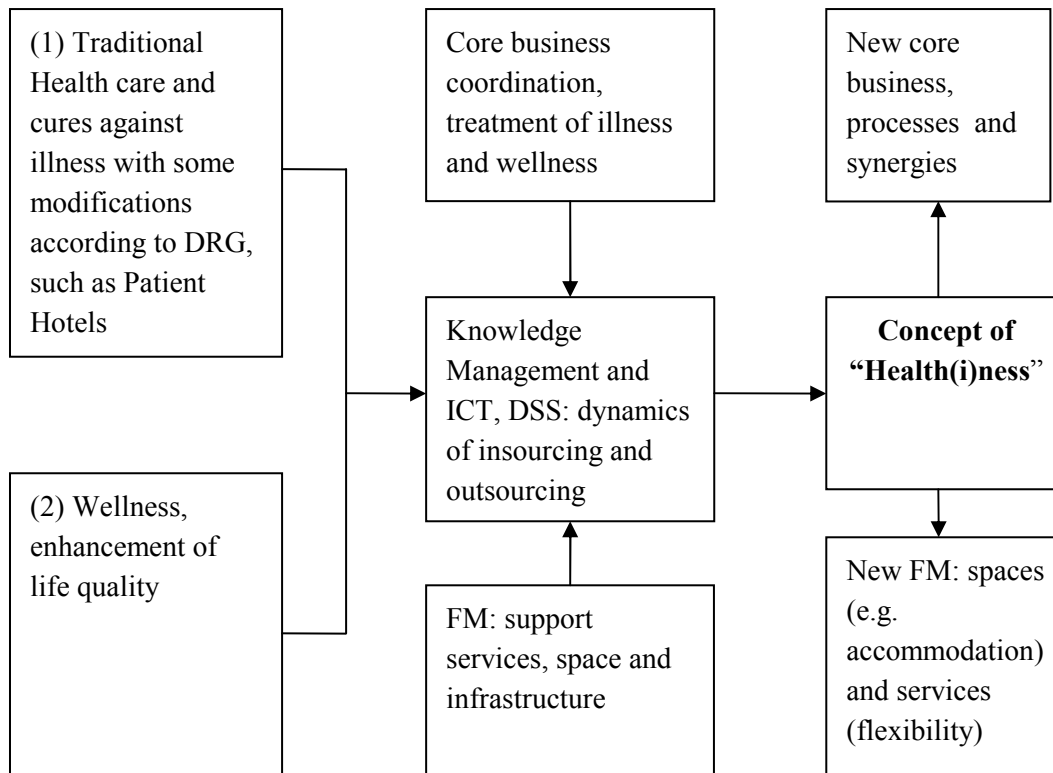


Figure 1: Health(i)ness in relation to FM and existing health care solutions

## References

Ackermann-Liebrich, U., Ludwig, C., Darioli, R., Thommen, A., Meier, C. and Zemp Stutz, E., (2007), „Versicherungsmedizin“, in Gutzwiller, F. and Paccaud, F. (ed.), *Sozial- und Präventivmedizin*, Public Health (3<sup>rd</sup> complete revised edition), Hans Huber Verlag, Bern, pp. 153-193.

Berg, W. (2008), *Gesundheitstourismus und Wellnesstourismus*, Oldenburg Verlag, München.

Dettwiler, P. (2006), *Facilities Management of the Offices of Growth Firms: Phases and Location*, Doctoral dissertation, Chalmers University of Technology, Gothenburg.

Dettwiler, P. (2010), Supporting the Elderly Workers and Entrepreneurs; Conceptualisation of Preventive FM, (Eds.) Barrett, P., Amaratunga, D., Haigh, R., Keraminiyage, K., Pathirage, C. IN *Building a better world..Programme and Book of Abstracts*, 10-13 May 2010, Salford.

Duce, Ch. (2008) Scottish Government bans private contractors from servicing NHS hospitals. <http://www.caterersearch.com/Articles/2008/10/21/324126/Scottish-Government-bans-private-contractors-from-servicing-NHS.htm>

Fillipini, M. (2007), *Für mehr Effizienz: Spitalnetze bilden!*, Competence, No. 10/2007.

FSO / Bundesamt für Statistik (2006), *Demografisches Porträt der Schweiz*, Eidgenössisches Departement des Innern.

FSO / Bundesamt für Statistik (2008), *Statistisches Jahrbuch*.

GDI / Gottlieb Duttweiler Institut (2007), *Trendstudie - Die Zukunft der Schweizer Hotellerie*, IN *hotelleriesuisse* (ed.), Studie zum 125-Jahre-Jubiläum von hotelleriesuisse, hotelleriesuisse, Bern.

Gee, Y. and Fayos-Solá, E. (1997), *World Tourism Organization*, WTO, Madrid.

gv-praxis (2007), *In den Startlöchern*, available at: <http://www.ahrservice.com/files/ahr-42-indenstartlochern.pdf> (accessed 31 October 2008).

Heimgartner, S. and Zundel, G. (2008a), *Wer bezahlt stationäre Kuren oder eine Rehabilitation*, Health Unit - Sprechstunde Extra, special edition from the journal *Gesundheit Sprechstunde*, special edition Vol. 15, pp. 13-16.

Heimgartner, S. and Zundel G. (2008b), *Zum Wohl von Körper und Geist: Reha, Kur und Wellness. Die Unterschiede sind klar - und doch fließend*, Health Unit - Sprechstunde Extra, special edition from the journal *Gesundheit Sprechstunde*, special edition Vol. 15, pp. 5-7.

Hofer, S. and Bögli, C. (2008), *Patientenhospitals – Der neue Trend im Gesundheitswesen*, internal working paper, Zurich University of Applied Sciences, Zürich.

Hofer, S. and Stampfli, K. (2008), *Rehabilitationskliniken – Wohin führt die Zukunft*, internal working paper, Zurich University of Applied Sciences, Zürich.

Kohl & Partner, (2008), available at: [www.tvlog.at/wpcontent/uploads/2008/03/fachartikel2008.pdf](http://www.tvlog.at/wpcontent/uploads/2008/03/fachartikel2008.pdf) (accessed 10 October 2008)

Lanz Kaufmann, E. (2002), *Wellness-Tourismus. Entscheidungsgrundlagen für Investitionen und Qualitätsverbesserungen*, IN Müller, H. (ed.), *Berner Studien zu Freizeit und Tourismus*, No. 38, Forschungsinstitut für Fremdenverkehr der Universität Bern, Bern.

Löffler, C. (2007), "Kranksein deluxe. Geht der deutsche Patient künftig nicht mehr nicht mehr in die Klinik, sondern ins Hotel? Für die Krankenhäuser wäre das eine massive Kostenersparnis.", *Zeit online*, 25 February, available at: <http://www.zeit.de/online/2007/09/patientenhoteles> (accessed 31 October 2008).

Lüthi, U. (2008), Offene Grenzen, *Zeitschrift für Krankenpflege der SBK-ASI*, No. 7, pp. 20-21.

OECD (2008) Organization for Economic Cooperation and Development, Health Data, Paris.

Rulle, M. (2004), Der Gesundheitstourismus in Europa. Entwicklungstendenzen und Diversifikationsstrategien, IN Hopfinger, H. (ed.), *Eichstätter Tourismuswissenschaftliche Beiträge* (Vol. 4), Profil Verlag GmbH, München / Wien.

Slembeck, T. (2006), *Kostentreiber im Schweizer Gesundheitswesen*. SantéSuisse.

Sigrist, S. (2006) *Health Horizons - Guide zu den neuen Gesundheitsmärkten / Guide to the new Healthmarkets*, No. 20, Gottlieb Duttweiler Institut / GDI, Zürich.

Tränker, K. (2008). *Patientenhotel in Deutschland – keine Zukunftsvision. Bedeutung von Hotelleistungen bis hin zum Patientenhotel unter Berücksichtigung der Diagnostics related Group*. VDM Verlag Dr. Müller

World Health Organisation / WHO (1946), *Verfassung der Weltgesundheitsorganisation*, Translation to German, available at: <http://www.admin.ch/ch/d/sr/i8/0.810.1.de.pdf> (accessed 3 July 2008).

# The interfaces and impacts of designs, design management and scope at the facilities management.

**Karen Maneschi**

Escola Politécnica - USP – Construction Engineering Department  
kmaneschi@terra.email.br

**Silvio Burratino Melhado**

Escola Politécnica – USP – Construction Engineering Department  
silvio.melhado@poli.usp.br

## Abstract

In Brazil, the latent demand and competition in the construction market generate an impact on the product conception phase that is developed by only a few disciplines or just one – architectural design. The short deadlines imposed by the contractors due to commercial interests and financial returns, leads to a distortion in the potential product quality it could achieve.

There are many requirements, interfaces and criteria that have to be adopted by the architectural and engineering designers. It is difficult to ensure that the designed product not only complies with standards and regulations, but that it satisfies human needs. It is paramount to consider the expectations and the performance over the building service life since in the conception phase designers consider the real planning needs, services, cost control as regards facilities management at the use and operation phases in the building.

Since multidisciplinary is not considered in the preliminary development phases, the conception design product phase is focused on the investor financial return, in very general formalist and technological concepts - and they are not completely known in detail, or standardized, given the scarcity of Brazilian technical standards.

Moreover, late hiring and disconnected from project management besides all subsystems necessary to develop the project hinder rationalization, productivity, performance and sustainability. Thus, the service life of the building and its performance is compromised during the use and occupation phase, which ultimately reduces their quality from the users' point of view.

The lack of design process management, as a briefing that really meets the real needs of the final users; scopes defined for each design specialties, a database that contains technical solutions that are already being used by production teams or those assessed or even suggest by the design feedbacks by facilities management teams; as well as a complete and updated set of technical standards affect the quality of the product as a whole.

In this context, the aim is to show the real importance of human needs, the correct moment of hiring design management, designers and consultants, the importance of design scopes and also the paramount interfaces among designers, production and facilities management teams.

**Keywords:** Design Management, Facilities Management, Design Scope.

## **1. The Design, Design Management, Production and Operation**

### **1.1 The multi-disciplinary team, the integrated working and the interaction of the team.**

According to Fabricio & Melhado (2008), conventionally, the development of a building project is clearly divided into stages. In this divided and sequential process, the possibility for collaboration between the various participants is rarely ideal and often fragmented. Changes to the design could easily result in significant rework and errors due to the complexity of coordinating and checking multi-authored information. Furthermore, participation of contractors, subcontractors, material suppliers and users in the design phase is sometimes very limited, which can lead to a gap between the product design definitions, the production design definitions and also the operation of the building.

Mesquita & Melhado (2006) emphasized the contemporary paradigm of design, production and operation of buildings, stressing its new package, in which business is associated with an 'investment' in service to their users. Therefore, as any other capital, the building must provide adequate performance to their use, contributing to the productivity of organizations based on it, through structural safety, functionality and suitability of spaces, environmental comfort, efficiency and effectiveness in building systems. In parallel is the attention to values such as durability, safety and economy of use over time and sustainability.

In case of improper planning or operation, there are burdens that slow or paralyze the activities performed in the building and even exceed the available resources of the organizations involved, resulting in reduction of benefits sought with it. Thus, it appears that it is not enough to design and to execute the project properly: it is necessary to ensure their proper use, which involves planning the use and building maintenance in its 'Operation' phase.

There is a latent need to consolidate data, even at beginning of the design stage, the production stage and also the inclusion of values related to the operation phase, such as providing documentation of supporting data on this activity.



## 1.2 Concurrent Building Design and DPD Design

Concurrent Design, as named by Fabricio & Melhado (2008), is a powerful way to manage the Design and Production, mainly if PDP is used as well.

According Fabricio & Melhado (2008), integrated product development is supported by different approaches that emerged and were practised in the late 1980s and the 1990s, the most well-known being concurrent engineering. Concurrent engineering (CE) emphasises parallelism and multidisciplinary collaboration in the product development process and particularly emphasises the need to integrate new product development (product design) with the development of production design technologies (Paashuis, 1998). Initially, concurrent engineering focused on technical and engineering processes, then the development process view expanded to incorporate pre-design activities, linked to marketing and market prospects, aligning the product development process to the corporation's strategic planning. Over time, concurrent engineering was developed to include product follow-up, which helps to obtain knowledge and learning that can be configured into a management approach for the entire product life cycle.

Maneschi & Melhado (2010), quoting Wong et al. (2004), state that design for production (DFP) is a product design methodology that determines if a manufacturing system has sufficient capacity to achieve the desired throughput and estimates the manufacturing cycle time, and performance. The authors define DFP as a 'systematic method that leads to a product design with minimum production cost while satisfying all the functional requirements'.

Maneschi & Melhado (2008), quoting Herrmann (2004), also say it is clear that product design, which requires a specific set of manufacturing operations, has a huge impact on the manufacturing system performance. Hence, understanding the relationship between the two is important to improve the manufacturing system performance for the product.

Product development process (PDP) is an approach from the manufacturing sector that comprises the product design and its production process. This is more comprehensive than the traditional methods adopted by construction companies that mostly focus on the product production process. PDP involves the formulation of needs, design and development of the product formal, functional and technical characteristics, along with design and planning of the necessary production means, including follow-up on the product performance in use. Progressively, the design process involves the participation of more design disciplines in specialized functions, motivated by the growing complexity of products and the need for design solutions of greater technological complexity. In this context, the management of new product development processes tends to be structured in a specialized, hierarchical, sequentially organized way (e.g. Womack et. al., 1990). With the dissemination of the lean production paradigm, the flow of activities and the concept of added value gained prominence in industrial production strategies. Design is increasingly seen as a priority phase for adding value to products (e.g. Koskela, 1992).

### 1.3 Contracts, Scope Designs and Design Manager

The relationships between Design Phases up to enterprises operation phase due the satisfaction of its users linked with the proper performance of their buildings is something that the Brazilian construction market can no longer ignore taking into account the sectoral competition, operating costs and the actual requirement of the end-user regarding quality, durability and maintainability.

Considering all the interfaces between Design - and their subsystems, Production, and Facilities Management - feedback and input data are relevant in the conception design phase. It is essential not only to satisfy the user, but also for life cycle in building and for its maintenance.

Mesquita & Melhado (2006) state, based on authors such as John & Cremonini (1989), Gomes (1992) and Hendriks et al.(2000), that the concern of those involved remains focused on solving challenges inherent to the planning stages, design and production as well as integration, "design-implementation". Lack also concerns the systematic analysis of the impact of decisions taken at the design level or production needs ahead of the operation.

Fabricio & Melhado (2008), in an attempt to overcome these shortcomings inherent to a sequential process, have developed and implemented concurrent and integrated working methods, , aided by rapid developments in information and communication technologies. In concurrent engineering, models of work coordination packages can help to foster integration, multi-disciplinary interaction and decision-making. Concurrent design takes the concurrent engineering philosophy and applies it specifically to buildings design.

According to Barrett (2007), the design criteria needs to focus on sustainability, flexibility and adaptability, community needs, safety and security.

Unfortunately, designers are still guided by technology, money and the fashion side of architecture, while they should consider human needs and preview those needs in the design in the first place, considering the environment, the human senses and the functionalities, but always prioritizing the clients' needs and what they judge essential and very important into the space they will live.

In order to have harmonic integration between all those variables, it is relevant to manage the contracts of each professional involved, linked with their functions, the design scope of each designer and also to hire a professional who can establish the design management of the design process – the Design Manager - that is incumbent with organizing all those variables with a process systemic view.

## 2 Facilities Management (FM)

### 2.1 Definition and Primary Functions

According to Egbu (2009), Facilities Management (FM) is a profession that encompasses multiple disciplines to ensure the functionality of the built environment by integrating people, place, processes and technology. It is also the integration of processes within an organisation to maintain and develop the agreed services which support and improve the effectiveness of its primary activities as the integration of multidisciplinary activities within the built environment and the management of their impact upon people and the workplace.

Barrett (2009) defined FM: *“A strategic integrated approach to maintaining, improving and adapting the buildings and supporting services of an organisation in order to create an environment that strongly supports the primary objectives of that organisation”*

The primary functions of the FM professional are to:

- Manage and maintain the efficient operation of the "built environment". Ensuring that services are delivered in a way that contributes to the productivity and profitability of those people who utilize a facility;
- Reduce the impact of the use of facilities on the environment;
- Minimise operational life cycle costs of facilities;
- Conduct repairs and maintenance, security and cleaning as well as more highly technical services required for the efficient operation of a facility.

The Facilities Manager operates at a strategic level, with high level decision, contributing to planning and operational management level, dealing with technical issues, such as repairs, maintenance, security and cleaning.

## 3 Knowledge Management

### 3.1 Definition and the importance on the facilities management

According to Egbu (2009), the definition of knowledge consist of: *“Truths, beliefs, perspectives, concepts, judgements, expectations, methodologies and know-how.”* All these concepts originate in the minds of ‘knowers’.

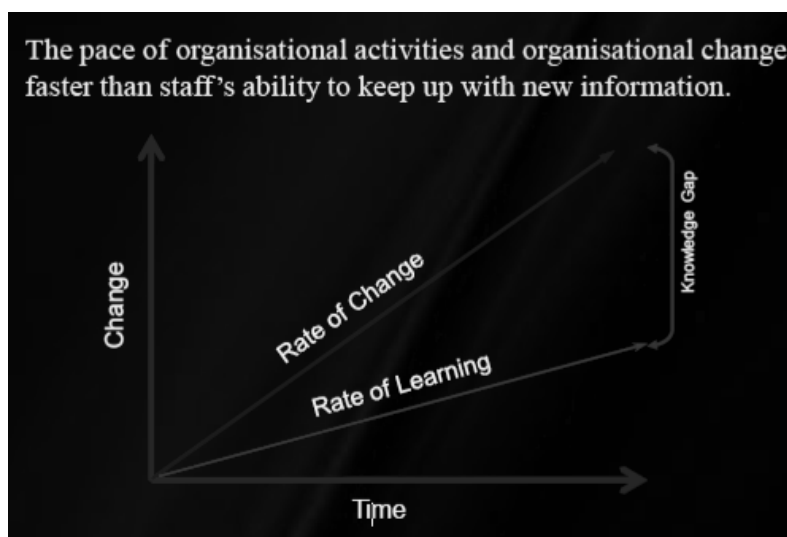
Knowledge is now seen as a resource that is important to an organization as labour and capital were in the old economy. About 20% of the knowledge available to an organization is actually used.

The innovation capacity depends substantially on the knowledge and the staff expertise. It also depends on the staff proportion of the value to the organization as it can be embedded in organisational routines, such as processes, practices, norms and in repositories.

When the knowledge is intrinsic to the professionals, they are able to understand the briefing and also to apply an innovative solution to a problem.

Knowledge sharing leverages expertise and organizational know-how to improve responsiveness, innovation, competency and efficiency, helping the Facilities Manager (FM) to better solve customers' problems.

According the same author, Knowledge Management (KM) is: *“The management of any process or practice of creating, acquiring, capturing, sharing and using knowledge wherever it resides in order to meet existing and emerging needs, to identify and exploit existing and acquired assets and to develop new opportunities”*.



*Figure 1: Facilities Managers x knowledge Management (Egbu, 2009)*

## 4 Life-cycle, Design and the Construction Process

Figure 1 shows the Life-Cycle stages linked with the Design Phase, the Production and also the operations Phase.

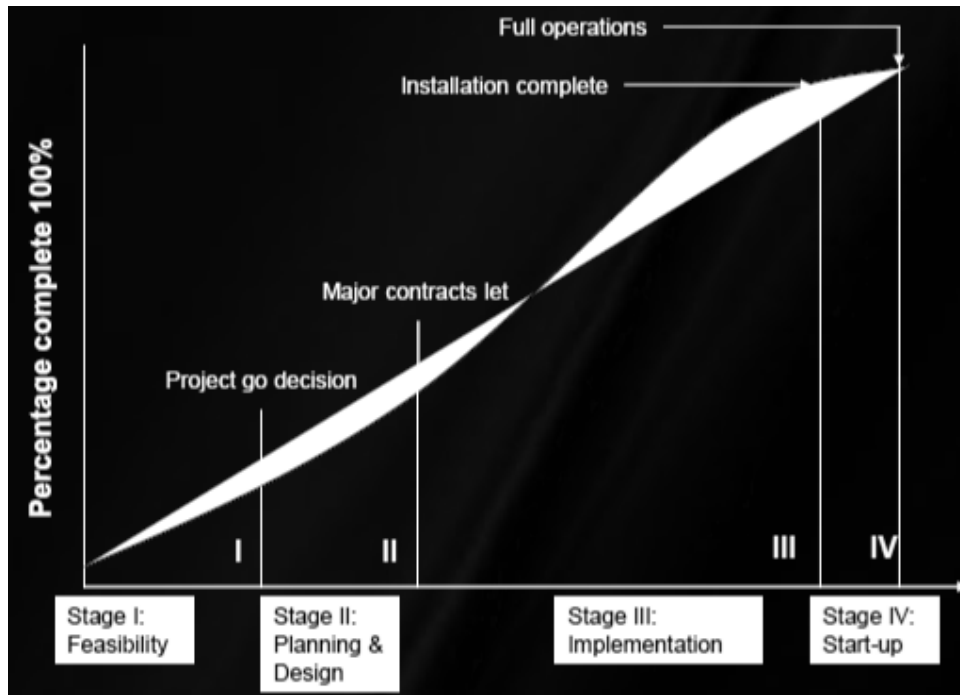


Figure 2: Project life-cycle (Egbu, 2009)

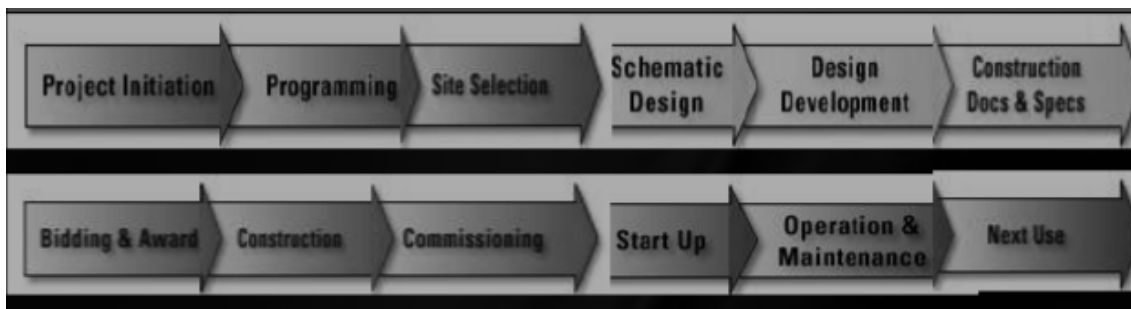


Figure 3: Building Design and Construction Process (Egbu, 2009)

In Figure 2, each Stage, I, II, III, IV, is linked with building design and also to the construction process:

- Stage I- Project Initiation, Programming, Site Selections
- Stage II – Schematic Design, Design Development, Constructions, Docs & Specs
- Stage III- Bidding & Awards, Construction, Commissioning
- Stage IV- Start up, Operation & Maintenance, Next Use

Following these 2 figures, one can realise the whole process of the life-cycle, the development Stages and also figure out the professionals involved at each Stage.

To succeed in the enterprise, it is paramount to be aware of both macro and systemic view so as to manage all the possible problems and solutions at each Development Stage in order to anticipate possible corrective actions at the operational stage.

## 5 Findings

Quoting Mesquita & Melhado (2006): Those accounting for the performance of the building at the operational stage are the management and building maintenance teams, implementing actions conditioned by a methodology for land management (Gomes, 1992). Also active, consumer and user agents are, respectively, the ones who actually buy and use the product, and ultimately bear its operation and maintenance costs.

In the operation phase, the performance level that meets users' needs is clear, while the phases prior to use affect the performance of subsequent stages. Thus, performance in use derives from decisions taken at design and implementation. Preventing the occurrence of disorders, pathologies such as constructive or excessive consumption of resources, even during the design costs little. Fixing the problem in the implementation phase is more expensive. If the problem is transferred to the user, the cost will be much greater generating problems for the FM professional to resolve them while they could have been resolved at the conception design phase.

The FM professional operates at a strategic level and should stay at that level and not to solve low-level problems, but should contribute to a strategic and major planning.

In this sense, the facilities managers, while they need to solve urgent operational problems and decisions, they have to plan their operations differently, seeing to the most common, low-level issues, which should have already been considered since the conception-design phase.

The integration of Design-Production-Operation, with feedbacks and also a data bank with those solutions and inputs, such as a careful contract management - considering the scope of each professional at each development phase, a DFP develops design that can consider all the processes and procedures and the hiring of a design management that will have the systemic view to optimize the FM workers and also involve them in the resolution of high-level complexity problems.

## References

Barrett, P (2007) *'Revaluing Construction: a holistic model'*, Building Research & Information, 35:3,268 — 286

Barrett, P (2009) *'Revaluing Construction'*, Workshop of Built & Human Environment - Salford University, Salford, UK, 2009

Egbu, C (2009) *'Knowledge Management And Life Cycle- An FM Perspective'*, Workshop of Built & Human Environment - Salford University, Salford, UK, 2009

Fabricio, M. M., Melhado, S.B. (2008). *Concurrent Design: a model for integrated product development* In: EMMITT, S.; PRINS, M.; OTTER, A. *Architectural Management: international research & practice*. 1 ed. Oxford: Wiley-Blackwell, 2008. p. 119-134.

Maneschi, K., Melhado, S.B (2008). *Scope of Design for production of Partition Walls and Coverings' interface*. In: CIB W96 Design Management in the Architectural Engineering and Construction Sector International Symposium, 2008, Brazil. Proceedings of The CIB W96 Design Management in the Architectural Engineering and Construction Sector International Symposium, 2008, São Paulo: USP- Brazil, 2008.

Maneschi, K., Melhado, S.B (2010). *Scope of Design for production of Partition Walls and Coverings' In: Architectural Engineering and Design Management*, 2010, volume 6. p. 3-17.

Melhado, S.B., Mesquita, M.J.M. (2006). *Project management: towards an emphasis in 'conception-operation' interface*. In: CIB W107 Construction in Developing Economies International Symposium, 2006, Santiago. Proceedings of The CIB W107 Construction in Developing Economies International Symposium "Construction in Developing Economies: New Issues and Challenges". Santiago: PUC - Chile, 2006.





## Session 3 - WWW - Work, Worker and Workplace

Prof. Dr. Kunibert Hubert Lennerts<sup>1</sup> & Dr. Claudia Miranda de Andrade<sup>2</sup>

<sup>1</sup>Karlsruher Institut für Technologie - Facility Management - Karlsruhe/German

<sup>2</sup>MBA/USP Facilities Management

<b>Experience of concentration or distraction: the cost to knowledge organizations</b>	<b>163</b>
JUNJA, Parminder; ROPER, Kathy O. Georgia Institute of Technology, Atlanta, Georgia, USA	
<b>Workplace preferences – does age make a difference?</b>	<b>175</b>
ROTHER, Peggie; LINDHOLM, Anna-Liisa; HYVÖNEN, Ari; NENONEN, Suvi Aalto University School of Science and Technology	
<b>Environmental preferences of office occupiers</b>	<b>191</b>
KARHU, Jessica; ROTHER, Peggie; FALKENBACH, Heidi; LINDHOLM, Anna-Liisa; HYVÖNEN, Ari; LAITALA, Ari Aalto University of Science and Technology	
<b>Offices - the need to design both the spatial and social configuration in new ways</b>	<b>203</b>
STEEN, Jesper Royal Institute of Technology, Sweden	



## Experience of concentration or distraction: the cost to knowledge organizations

**Parminder Juneja**, Ph.D., Georgia Institute of Technology, Atlanta, Georgia, USA

**Kathy O. Roper**, Georgia Institute of Technology, Atlanta, Georgia, USA  
kathy.roper@gatech.edu

### Abstract

The social, psychological, and cognitive sciences have shown that auditory distractions in open work environments are a hindrance to cognitive task performance; negatively impact the psychology and health of individuals; and alter the behaviour of individuals towards each other. The frequency and severity of these affects is heightened with complexity of the tasks. The architectural sciences have repeatedly shown that open work environments are high in auditory distractions coming from the surroundings, such as people talking, laughing, and machines beeping, to name a few noise sources. However, most workspaces in the U.S. and Canada are open plan; usually seen as a rational and economical trade-off to meet the requirements of communication and flexibility. In view of these inconsistencies and the fact that knowledge workers, who are the key assets of knowledge-based organizations, are mostly involved in complex cognitive tasks; the question arises as to whether open plan workspace that is high in auditory distractions is valuable for knowledge-based organizations.

Further, exploratory studies on workplace requirements for knowledge workers strongly argue that the key requirements of knowledge workers from their workspace are the following: support for concentration, when they need to concentrate; and support for collaboration, whenever their work requires them to collaborate. This is not feasible with traditional open plan workspace designs.

Consequently, this research addresses estimation of the value of a distraction controllable adaptable workspace (DCAW) for knowledge-based organizations. Because the costs of distractions and the benefits of workspace's key requirements include key soft factors such as psychological costs, physiological costs, and social costs, to name a few cost factors; therefore, a multi-attribute utility model is used to provide a quantifiable value to score alternatives on all key attributes. The goal is to facilitate corporate decision makers in choosing the most appropriate workspace type in accordance with their organization's work, policies, and budgetary bottom-line. With enterprise transformation and an increase in knowledge-based work, DCAW represents major improvements in distraction conditions for knowledge workers and the workspace's must-have requirements. Thus DCAW better promotes knowledge-based organizations financial and business bottom-line.

**Keywords:** Auditory distractions, Knowledge workers, Multi-attribute utility model, Distraction controllable adaptable workspace.

workspace's must-have requirements; and hence better promotes knowledge-based organizations' financial and business bottom-line. The goal is to facilitate corporate decision makers in making an informed choice about workspace type in accordance with their organization's work, policies and budgetary bottom-line. In the next Section 2, multi-attribute utility technique as applied to the problem of workspace selection is presented.

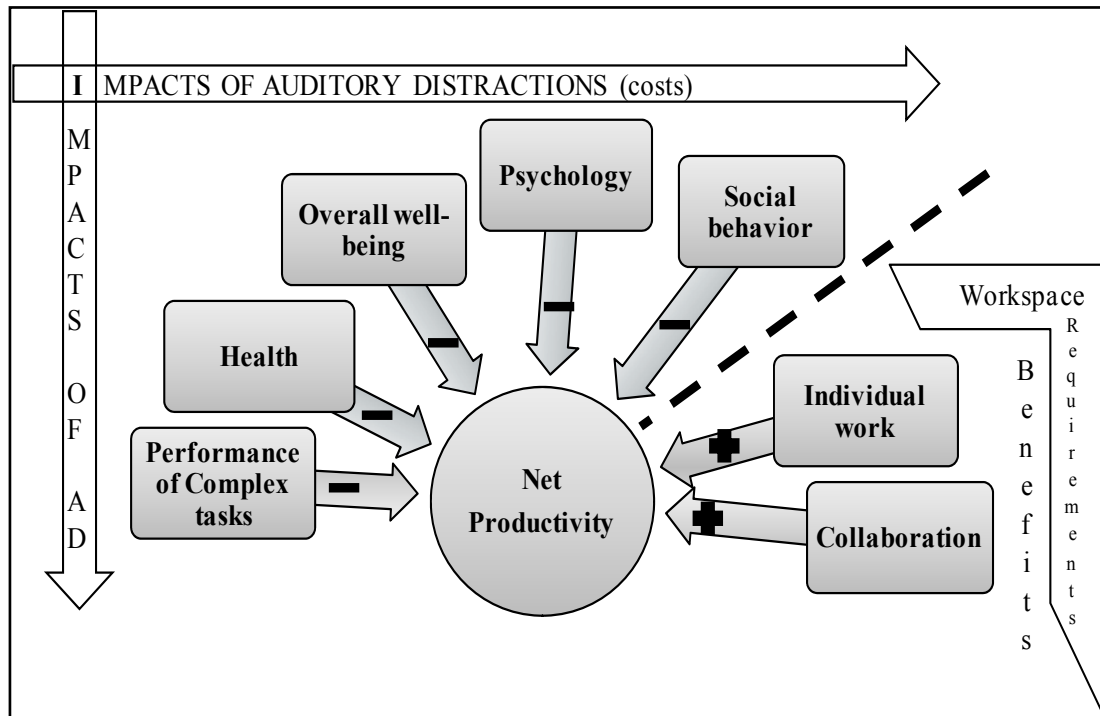
## 2. Methodology

To evaluate the value of DCAW for knowledge-based organizations, first it is important to recognize the costs of auditory distractions, both speech and sound, to knowledge workers and to their knowledge-based organizations. In turn, these costs can be fed into the equation for value analysis. Literature from a number of disciplines shows that the costs of distractions to knowledge workers, and thus their organizations, are subjective in nature. Primarily due to this subjectivity, a precise dollar figure is difficult to attach to the costs of distractions. Analytical investigation of approximately 150 studies resulted in identification of the major components of these costs. These include performance costs due to difficulty concentrating, reduced task motivation, increased absenteeism, and plummeted quality to name a few factors that cause performance costs to rise. Additionally, psychological costs resulting from increased anxiety, reduced emotional well-being, and physiological costs due to increased musculoskeletal problems, fatigue, and social costs due to development of hostility and bitterness should all be included in the final evaluation. In view of the multiple costs of auditory distractions, it is obvious that evaluating the value of DCAW using traditional cost-benefit technique is not appropriate. Consequently, multi-attribute utility assessment (MAUA) is applied to address the issue of value analysis of workspace options.

Utility assessment methodology is a robust and pragmatic approach for this problem for many reasons. The costs of distractions are mostly subjective in nature rather than being objective, necessitating development of subjective indices of measurement. The technology of utility assessment is such that it allows aggregation of both objective and subjective measurements in one equation, solving which provides the expected utility of various alternatives (Winterfedt and Edwards, 1986). The alternative with the highest utility (satisfaction) yields the highest or the best rank and vice-versa. Johnson and Huber (1977) call utility assessment a "process for quantifying human judgment" (p. 312). Furthermore, utility assessment methodology implicitly captures the risks and uncertainty associated with processing of the subjective variables (Keeney and Nair, 1975). This is very important as most of the costs of distractions are subjective and their likelihood varies depending on a number of personal factors, along with the type of task.

Another set of studies provided evidence that for knowledge work, support for need-based concentration and collaboration at the same workspace are must-have requirements to enhance performance, attract valuable intellectual capital, and reduce attrition (Brill et al., 2001, Heerwagen et al., 2004, Olson, 2002). These in turn, help increase the net productivity of an organization. However, achieving these must-have requirements in current open work

environments is not feasible. A summary of the above discussed costs and benefits is shown in the Figure 1.



*Figure 1: Summary of costs of auditory distractions and benefits of workspace’s must-have requirements for knowledge work*

### 3. Multi Attribute Utility Theory – Workspace Evaluation

Multi attribute utility assessment methodology follows a well-defined procedure to eventually result in ranking of various alternatives under evaluation. Generally, the alternative with the highest utility is ranked the best alternative and the alternative with the lowest expected utility is ranked the worst alternative. In this research five workspace alternatives were hypothesized, W1 through W5. These workspaces differ in their control over auditory distractions from none to very significant; provide varying support for individual work and collaboration at the same workspace ranging from none or very little support to very significant support; and differ in their initial costs from very little to very significant. A summary of these workspaces is provided in Table 1. The objective of this research study is to find out which alternative seeks highest expected utility and, thus, is most preferred for knowledge-based organizations.

Two groups were formed for this decision, knowledge workers and corporate decision makers. Knowledge workers were involved because they are the main users of workspace; thus they are

suggested as the key stakeholders in the workspace choice problem. The aim was to compare and analyze differences in the two groups for attributes preferences, risk attitudes, and workspace preferences. This will help understand the differences in satisfaction with workspace between the users and the decision makers. Consequently, it becomes simple to align the workspace decisions with the business bottom-line of organizations.

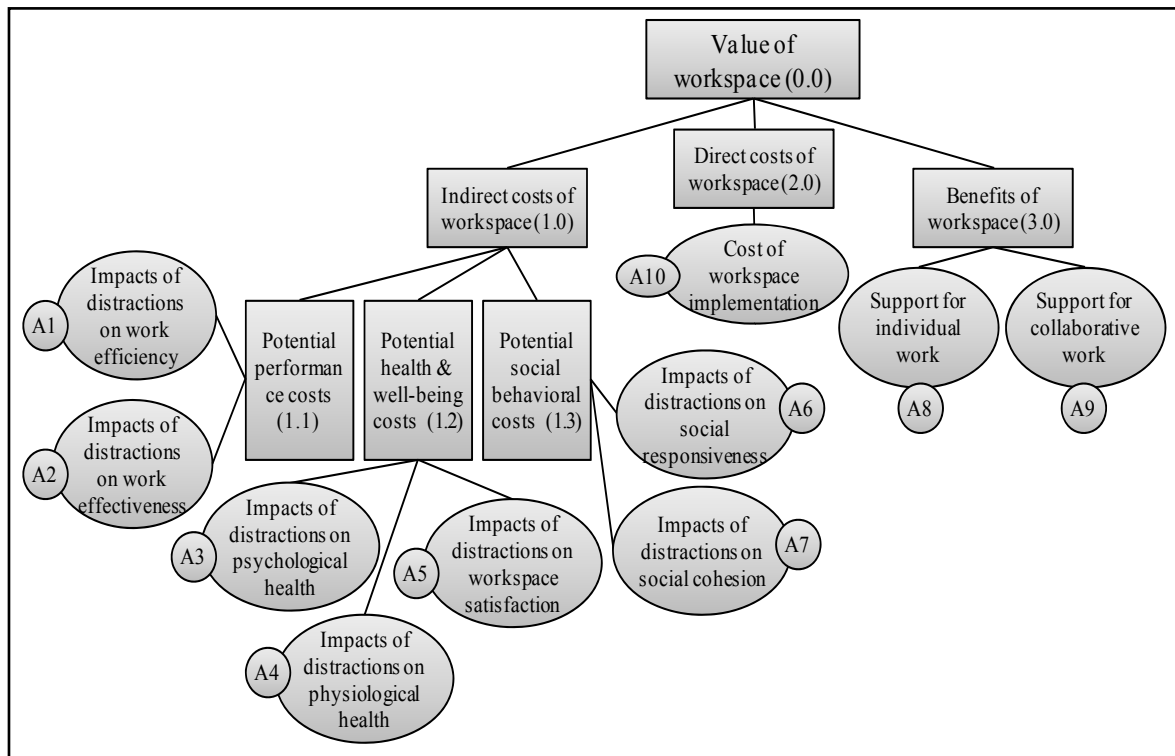
*Table 1. Workspace Alternatives (Juneja, 2010, p.137)*

<b>Workspace Alternative</b>	<b>Type of control over auditory distractions; support for individual, collaborative work; costs</b>	<b>Example</b>
W1	None or very little	Open plan workspace
W2	A little	Noise cancellation headphones
W3	Moderate	Personal sound masking system
W4	Significant	Flexible acoustic screens
W5	Very Significant	BlueSpace; Attentive Office Cubicle

The first step in applying multi attribute utility (MAU) analysis requires the development of a value structure that can form a basis for evaluation and comparison. This structure is called the fundamental objective hierarchy (Keeney, 1996). The fundamental objective hierarchy is developed in such a way that the top level objective represents a broad, holistic concept, and the lowest level objectives represent specific accomplishments or actions. How an alternative performs with respect to the lowest level objectives suggests its overall performance. The degree of achievement of an objective is measured through its attribute. Ideally, all the lowest-level objectives are measurable, either objectively or subjectively. Other terms used for an attribute are: measure of effectiveness; performance measure; metric; and evaluation measure.

Considering the costs and benefits of auditory distractions and workspace's must-have requirements, as stated in Section 2 and shown in Figure 1, this study argues that a distraction controllable adaptable workspace (DCAW) that allows control over distractions and provides support for both, concentration and collaboration, is valuable over traditional open plan workspace. A fundamental objective hierarchy for workspace choice was developed using the top-down and bottoms-up approach of structuring objectives. A summary sketch of workspace choice objective hierarchy is shown in Figure 2. This value structure forms a basis for evaluation of workspace options, where the overall objective is to maximize the value of a workspace for an organization. A Web-based two-round Delphi study was conducted to validate the structure of the workspace choice objective hierarchy. In all, 11 national and international experts from industry as well as academia participated in the Delphi study. These experts had

broad and specific experience and interests in workplace environments, human behaviour, and office noise and acoustics.



**Figure 2: Summary sketch for workspace choice objective hierarchy**

The finalization of the objective hierarchy for workspace choice and the identification of alternative options and stakeholders are prerequisites to the next step in multi-attribute utility assessment (MAUA) process. This involves face-to-face interviews with each subject to obtain the following data: indifference points for each lottery designed to seek subject’s marginal utilities; weight for each attribute; probabilities of different possible consequences in the decision space; and answers to utility independence verification. A MAU research instrument was designed to conduct this interview. Each goal was achieved using an appropriate methodology; for instance, Keeney and Raiffa’s (1976) probability equivalence method was used to assess subject's marginal utilities, which were then plotted to obtain single attribute utility functions (SAUF) for each subject. In all, 200 such functions were plotted for the set of 10 attributes and 20 subjects. The probability equivalence method was appropriate because it can be applied to both discrete and continuous set of objects; and also because it does not require the attributes to possess a natural scale, as was the case in this decision problem. A non-hierarchical swing weighing methodology was used to elicit weights. Literature documents that swing weighing is an appropriate methodology when the problem involves use of individual judgments which can be superfluous and sometimes even distorted. The splitting-bias in the unbalanced value structure is accounted for by using the non-hierarchical weighing rather than the hierarchical weighing (Poyhonen, 1998). Subjects verified the assumption of utility

for workspace W1 is shown in Figure 3. According to Mongin (1997), “expected utility (EU) theory states that the decision-maker chooses between risky or uncertain prospects by comparing their expected utility values, i.e., the weighted sums obtained by adding the utility values of outcomes multiplied by their respective probabilities” (p. 342). The expected utility of a lottery yielding consequences  $x_1, x_2, x_3, \dots, x_n$  with probabilities  $p_1, p_2, p_3, \dots, p_n$  is shown in Equation 1 (Winterfeldt and Edwards, 1986):

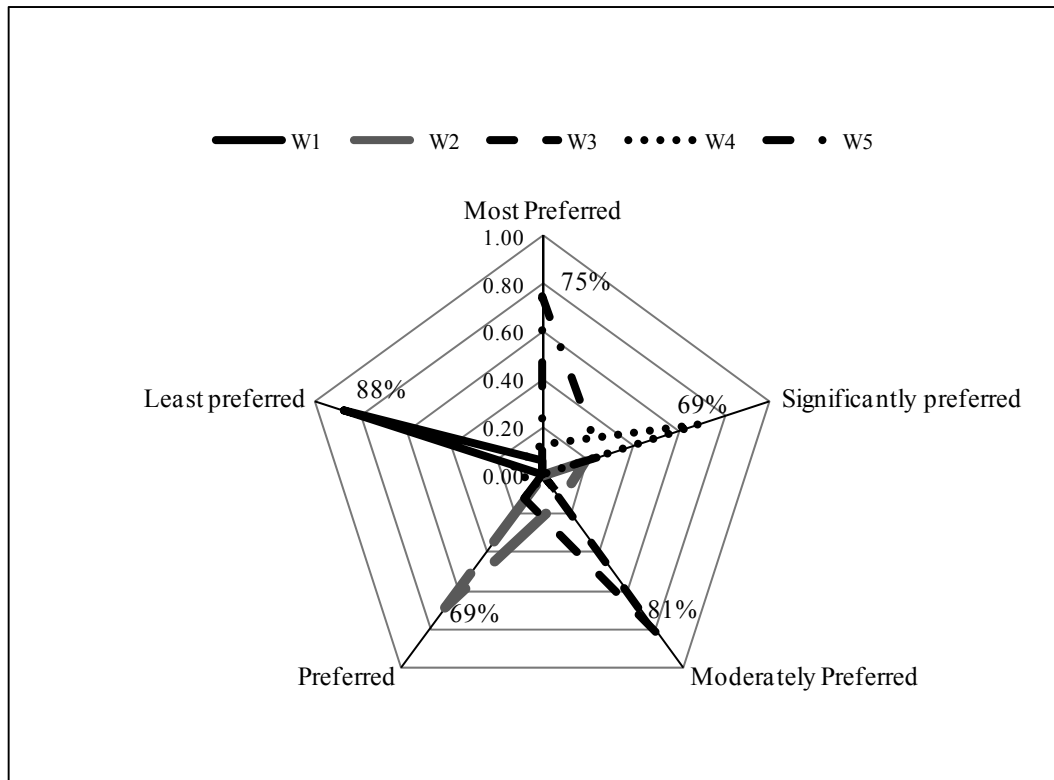
$$E[u(\bar{x})] = \sum_{i=1}^n p_i u(x_i) \quad (1)$$

Equation 1 was used to calculate the expected utilities of the workspaces: W1 (open workspace), W2 (open workspace with noise cancellation headphones), W3 (open workspace with personal sound masking system), W4 (open workspace with flexible acoustic screens), and W5 (adaptable workspace). The results of expected utilities are presented in Table 2 (Juneja, 2010, p.205). Figure 4 shows the summary of overall workspace rankings obtained by using the multi-attribute workspace choice decision model (Juneja 2010, p.220).

Table 2. Expected utilities of Workspace Alternatives (Juneja, 2010, p.205)

Subject	Expected Utility					Subject	Expected Utility				
	W1	W2	W3	W4	W5		W1	W2	W3	W4	W5
kw1	0.448	0.576	0.631	0.681	0.762	dm1	0.543	0.482	0.338	0.283	0.306
kw3	0.278	0.716	0.715	0.865	0.954	dm2	0.282	0.307	0.392	0.617	0.622
kw4	0.456	0.490	0.576	0.787	0.862	dm3	0.147	0.232	0.320	0.380	0.793
kw6	0.334	0.583	0.865	0.890	0.985	dm6	0.219	0.658	0.656	0.780	0.760
kw7	0.516	0.588	0.616	0.876	0.904	dm7	0.770	0.804	0.810	0.729	0.730
kw8	0.413	0.424	0.422	0.553	0.513	dm8	0.448	0.576	0.631	0.681	0.762
kw9	0.617	0.638	0.689	0.734	0.826	dm9	0.509	0.658	0.582	0.581	0.689
kw10	0.094	0.129	0.659	0.974	0.980	dm10	0.334	0.356	0.510	0.511	0.570





**Figure 4: Summary of overall workspace ranking (Juneja, 2010, p. 220)**

Figure 4 shows the following results (Juneja, 2010):

- 75% of the subjects rank workspace W5, adaptable workspace, as the most preferred workspace.
- 69% subjects rank workspace W4, open workspace with flexible acoustics screens, significantly preferred.
- 81% subjects rank workspace W3, open workspace with personal sound masking system, as moderately preferred.
- 69% subjects rank workspace W2, open workspace with noise cancellation headphones, preferred.
- Workspace W1, open workspace, is ranked as the least preferred by 88% of the subjects.

These results are in alignment with what could have been otherwise expected because a number of studies on controllability and predictability discuss that providing control, environmental controls in this problem, into user's hand is directly proportional to their satisfaction (Graeven, 1975). The better the control the more is the satisfaction. Despite this realization, most organizations end up adopting open plan workspace. The explanation is that in the absence of a structured approach for workspace selection, the decision makers tend to ignore and even cannot process the subjective factors associated with such decisions. Therefore, they chose the open plan workspace that seems to have the most appropriate alignment with organization's financial bottom-line, as it costs less, it seems to promote collaboration and flexibility.

This research provides evidence that with enterprise transformation and an increase in knowledge-based work, distraction controllable adaptable workspace (DCAW), such as IBM's BlueSpace (IBM, 2001), represents the most valuable workspace choice for knowledge-based organizations, as it is shown to better promote knowledge-based organization's financial and business bottom-line. Open plan workspace that is generally suggested as the most cost-effective solution is actually the least preferred workspace solution, implying the least valuable workspace solution for knowledge-based organizations. The research findings are interesting for corporate facility decision makers and for all those organizations who believe that their knowledge workers are their key assets. Also, these findings are the result of huge effort that goes into properly determining a utility function. However, these are not absolutely free of limitations that are faced for two reasons: because of the limitations of the multi-attribute utility assessment process; and because the subjects involved in multi-attribute utility assessment were confined to small region of Southeastern North America. These limitations are further discussed in detail in the next section, Section 4.

## 5. Limitations of the Research and Future Research

This research provided a comprehensive multi-disciplinary effort. The goal was to collate knowledge and theories from a number of fields and sub-fields that provide sound basis to understand the problem piecemeal, but do not connect in the existing literature. The key limitation of such research is the likelihood that certain theories, approaches, and models could have been overlooked. Nonetheless, the goal of this research was not to develop an integrative one-for-all workspace choice decision theory. Rather, a comprehensive knowledge base was intended that provides structured information on the costs of auditory distractions and the costs of not meeting workspace's must-have requirements for knowledge workers and thus their organizations.

Furthermore, the fact that this research was conducted with local subjects from Southeastern North America raises questions about the validity of the workspace rankings in other areas of North America and the World. Due to the personal nature of this problem, conducting the multi-attribute analysis with international subjects will be valuable. The nature of the problem is suggested as personal because the issues of auditory distractions are quite subjective in nature, and the attributes A1 through A10 (see Figure 2) vary in their importance in different countries and cultures.

The other limitation of multi-attribute evaluation is that the results of MAUA for one organization may or may not fit another organization. Consequently, MAU evaluation process has to be repeated for each unique organization, which makes it a cumbersome task as MAU evaluation process in itself is a challenging task. However, with multiple evaluations the results can act as a quick guide or best practice.

Another, interesting phenomenon is the current downturn in the global economy. The data collected for this study was in the last quarter of 2008 and early 2009, when the economy was

not as bad as it is today. This research sees downturn in economy as a major factor that may alter the results of workspace rankings. Therefore, the results of this research are valid and applicable only under the assumption of normal global economic conditions. A follow up study in today's economic environment may be expected to bring other important insights.

Despite the several limitations discussed in this section, the goals identified for this research were theoretical as well as practical. From the practical standpoint, the aim was to facilitate corporate decision makers in selecting the most appropriate workspace that aligns strategically with their organization's business and financial bottom-line. This is the topic of the next section, Section 5, where practical applications of this research are discussed in greater detail.

## 6. Practical applications

Knowledge workers are the key assets of knowledge-based organizations; these organizations are the fundamental building blocks of today's knowledge economy. The productivity, which is defined as revenue minus the costs, of these organizations is a direct outcome of the productive outcome of knowledge workers (Davenport and Prusak, 1998, Toffler, 1980). Therefore, the workplace design and environmental factors that negatively affect the productive outcome of these workers, either directly or indirectly, are of significant concern to knowledge-based organizations. This research discussed how auditory distractions, speech and sound, coming from the surrounding work environment, are detrimental to the performance, psychology, physiology, and behavior of the individuals who are involved in knowledge work, because knowledge work is complex and highly cognitively demanding. In doing so, a comprehensive knowledge base is created that provides a quick overview as well as detailed discussions about the costs of auditory distractions and workspace's must-have requirements for knowledge workers and thus for knowledge-based organizations.

The research suggests that the improved understanding of the negative impacts of auditory distractions on office workers, particularly knowledge workers, combined with innovations in built environment technology, can help significantly improve and transform the effectiveness of knowledge-based organizations. However, the decision to adopt and implement new technologies and solutions is often difficult and complex. The reason could be lack of analysis of the potential value; uncertainty and risks involved in integration with existing systems, organizational values, cost overruns, and alignment with overall business and financial strategies. This study was conducted with an objective to develop a robust methodology that takes into account the costs of auditory distractions and workspace's requirements for knowledge work, thereby providing rankings of workspace options for a specific organization. Multi-attribute utility analysis of five workspace options, W1 – W5, showed that despite the high initial costs, adaptable workspace is the most preferred workspace for knowledge-based organizations, and open plan workspace that exists in dominance in North America is actually the least preferred workspace option. Further extension of this model to include the costs of other distractions in work environments, such as technological, environmental, and physical distractions, would be a valuable effort in the field of Facility Management.

## References

- BENCIVENGA, D. (1998) A humanistic approach to space - office designs *HR Magazine*.
- BRENNAN, A., CHUGH, J. S. & KLINE, T. (2002) Traditional versus Open Office Design: A Longitudinal Field Study. *Environment and Behaviour*, 34, 279-299.
- BRILL, M., WEIDEMANN, S. & OLSON, J. (2001) *Disproving widespread myths about workplace design*, Kimball International, Jasper, IN.
- COHEN, S. (1978) Environmental load and allocation of attention. IN BAUM, A., SINGER, J. E. & VALINS, S. (Eds.) *Advances in Environmental Psychology - The Urban Environment*. Hillsdale, New Jersey, Lawrence Erlbaum Associates.
- DAVENPORT, T. H. & PRUSAK, L. (1998) *Working Knowledge: How organizations manage what they know*, Boston, MA Harvard Business School Press.
- DAVIES, H. (2005) Productivity and the knowledge worker. IN SIDWELL, A. C. (Ed.) *COBRA*. Brisbane, Australia, Queensland University Of Technology, Australia.
- GENERAL SERVICES ADMINISTRATION (1999) *The integrated workplace: a comprehensive approach to developing workspace*.
- GRAEVEN, D. B. (1975) Necessity, control and predictability of noise as determinants of noise annoyance. *Journal of Social Psychology*, 95, 85-90.
- HEERWAGEN, J., KAMPSCHROER, K., POWELL, K. & LOFTNESS, V. (2004) Collaborative knowledge work environments. *Building Research & Information*, 32, 510-528.
- IBM (2001) [www.research.ibm.com/bluespace](http://www.research.ibm.com/bluespace).
- JOHNSON, E. M. & HUBER, G. P. (1977) The technology of Utility Assessment. *IEEE transactions on Systems, Man, and Cybernetics*, SMC-7.
- JUNEJA, P. K. (2010) Auditory Distractions in Open Office Settings: A multi attribute utility approach to workspace decision making. *School of Building Construction*. Atlanta, Georgia Institute of Technology.
- KEENEY, R. L. (1996) *Value-Focused Thinking: A Path to Creative Decisionmaking*, Harvard University Press
- KEENEY, R. L. & RAIFFA, H. (1976) *Decisions with Multiple Objectives: Preferences and Value Trade-Offs* New York, Wiley.
- MONGIN, P. (1997) Expected Utility theory. IN DAVIS, J., HANDS, W. & MAKI, U. (Eds.) *Handbook of Economic Methodology*. London, Edward Elgar.
- OLSON, J. (2002) Research about office workplace activities important to US businesses - And how to support them *Journal of Facilities Management* 1, 31-47.

POYHONEN, M. (1998) On attribute Weighting in value trees. *Systems Analysis Laboratory*. Finland, Helsinki University of Technology.

SMITH, A. (1991) A review of the non-auditory effects of noise on health. *Work and Stress*, 5, 49-62.

TOFFLER, A. (1980) *The third wave*, New York, William Morrow and Company, Inc.

WINTERFEDT, D. V. & EDWARDS, W. (1986) *Decision analysis and behavioural research*, Cambridge University Press.

WITTERSEH, T., WYON, D. P. & CLAUSEN, G. (2004) The effects of moderate heat stress and open-plan office noise distraction on SBS symptoms and on the performance of office work. *Indoor Air*, 14, 30-40.



## Workplace preferences – does age make a difference?

### **Peggie Rothe**

Aalto University School of Science and Technology, Built Environment Services Research Group  
peggie.rothe@tkk.fi

### **Anna-Liisa Lindholm**

Aalto University School of Science and Technology, Real Estate Research Group  
anna-liisa.lindholm@tkk.fi

### **Ari Hyvönen**

Aalto University School of Science and Technology, Real Estate Research Group  
ari.hyvonen@tkk.fi

### **Suvi Nenonen**

Aalto University School of Science and Technology, Built Environment Services Research Group  
suvi.nenonen@tkk.fi

### **Abstract**

**Aim** - User orientated workplace design has to take a variety of user groups into account. The existence of four different generations in work life is a unique phenomenon of the 21<sup>st</sup> century. The aim of this paper is to identify the differences in the work environment preferences of office users of different age.

**Methodology** - The data was collected through an internet survey. A total of 1106 responses from office workers in the Helsinki Metropolitan Area, Finland were analyzed. The survey included questions concerning user preferences in terms of location, buildings, workplaces and services.

A principal component analysis (PCA) was done for the questionnaire results. The respondents were divided in to five clusters based on their year of birth and subsequently, in order to find possible preference differences between the clusters, the results of the PCA were compared based on the clusters.

**Conclusions** - The results indicate that there are differences in some workplace preferences of different age groups. Sustainability features are valued more by the older respondents than the younger ones. The younger respondents do however see features that support bicycle commuting more important than the older groups.

Work environments that support team work, social interaction and innovation within the organization are preferred more by the younger groups while networking possibilities with

other interest groups within the building are valued more by the older ones. The virtual environment and mobility is in general valued more among the younger respondents while personal services and being able to adjust the indoor climate are more important to the older groups. The smallest differences were found concerning privacy.

**Limitations of the research** - The main limitation of the study is the use of cross-sectional data which makes it difficult to determine if the identified differences in preferences are linked to age and experience or generational differences. It does however give indications whether there are differences in the workforce as it currently exists. In order to gain more knowledge on this matter, a longitudinal study should be conducted. Additionally the cultural context has to be taken into account when generalising the results as this research is limited to the Helsinki Metropolitan Area.

**Practical applications** - The results give new insights on what office users of different age prefer in their work environments. The information of user preferences is valuable both for user organizations and facilities management. Based on the results it is evident that the workplace is no longer a standardized product: one has to pay more attention to options provided.

**Keywords:** Work environment, End-user, Age, Preference



## 1. Introduction

As knowledge work increases the notion that the employees are organisations' most important assets is becoming generally accepted. Employee satisfaction, productivity and well being are becoming even more crucial for organisations that want to achieve a competitive advantage in today's knowledge intense business environment (Brill et al. 2001; Chan et al. 2007).

The influence of the workplace on employees has been the object of research in several recent studies within workplace research. There is a growing body of evidence linking the physical workplace with both satisfaction and productivity of employees. De Croon et al. (2005) systematically reviewed the scientific literature on effects of office concepts and found in total 49 publications that were original studies, examined office location, office layout or office use as independent variables, were conducted among individuals who perform office work and that examined the effects on work conditions, short- or long-term reactions. De Croon et al. (2005) found that office concepts do affect the office worker's job demands, job resources and short-term reactions. More recently also Haynes found that office workers do perceive that the environment has an impact on their productivity (Haynes 2008a) and also concludes that there is enough evidence to support the claim that office comfort can affect productivity (Haynes 2008b).

The individual employee experience has been approached in the research which is connected with user satisfaction by several researchers (e.g. Lee 2006; Windlinger 2008; Langston et al. 2008). Leaman (1995) and Batenburg and Voordt (2008) found satisfaction with facilities to have an influence on the perceived productivity of employees while Lee and Brand (2005) found that more personal control over the physical workspace and easy access to meeting places led to higher perceived group cohesiveness and job satisfaction. Windlinger (2008) states that the design of office environments has effects on performance that are not direct but mediated and that the key variables for the mediation of these effects are job satisfaction and perceived control over the physical work environment. He further concludes that the perceived physical work environment and the experiences in work environments play an important role for job satisfaction and individual work performance.

Work environment design should therefore not only focus on meeting the functional needs of the organization but also the individual needs and preferences of the users. One solution does not fit all. Different people require different environments in order to perform well, depending on personal factors and the task they are performing. One general belief is that age plays an important role: the older generations are used to working in their private rooms and do not blissfully welcome change while the young new workforce prefers working in teams and take highly developed IT-solutions for granted. But how accurate is this general notion?

To summarise, there is a clear connection between the workplace and office users' satisfaction and productivity. The creation of workplaces that result in satisfied and productive end users requires information about user preferences towards their work environments, and as the nature of work is changing, there is a need for updated research within this subject.

In order to better understand how to design for satisfaction of users - regardless their age - it is important to know what kind of differences there are in the workplace preferences of office users of different age. The purpose of this paper is to increase the understanding on different office users' work environment preferences. The aim of this paper is to identify the differences in the work environment preferences of office users of different age.

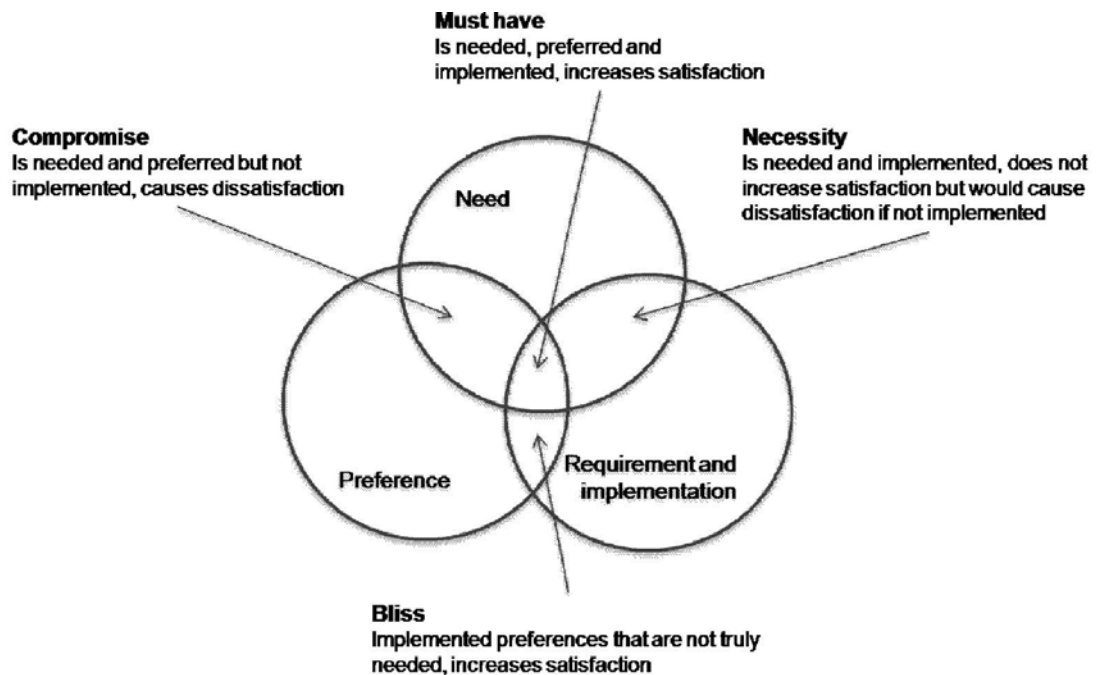
This paper is divided in six parts. After the introduction, an overview is presented on what user needs, preferences and satisfaction are and how these have been studied. In the third part generational research is briefly presented. The methodology of the research is presented in the fourth part following the results and conclusions in parts five and six.

## 2. Studying needs, preferences and satisfaction

There is quite a fragmented research focusing on office users' needs, preferences and user satisfaction. A distinction between the concepts is required: in this research *needs* are issues that are necessary for employees to perform well. End-user needs are often seen as needs related to work processes, activities and workplace setting (Brunia & Hartjes-Gosselink 2009). Recent research has however brought the attention also to human and psychological needs of the end-users (Oseland 2009; Brunia & Hartjes-Gosselink 2009). People cannot perform to their maximum potential if basic psychological needs such as comfort, safety, security and sense of belonging are not met (Oseland 2009). *Preferences* are issues that cause happiness and satisfaction but which are not necessarily needed to perform a task. Preferences are the things end-users would like to have if they had the choice. For example, office users often state that they *need* an own private room when in fact they could perform as well in a landscape office. What they mean is that they *prefer* their own room. In order to reach end-user *satisfaction*, both needs and preferences have to be taken in to consideration: "Employee satisfaction refers to the degree to which the working environment meets the wishes and the needs of the employees" (Voordt 2004). Even so, the needs of the individuals have to be balanced with the needs of the organisation (Oseland 2009).

In reality when organisations are planning and developing their work environments, only a part of the needs and preferences of the users are established as requirements and finally implemented, which can then lead to dissatisfaction. A distinction between needs and preferences and their contribution to user satisfaction and dissatisfaction can be made similar to Herzberg's two-factor theory of employee satisfaction. According to the theory elements within the job and job environment are either dissatisfiers (hygiene factors) or satisfiers (motivators). Hygiene factors contribute to employee dissatisfaction if they are not met while the motivators increase satisfaction when they are fulfilled (Herzberg et al. 1959). Herzberg (1987) also proposed that the opposite of job satisfaction is not job dissatisfaction, it is *no* job satisfaction. The proposed distinction between work environment needs and preferences is that needs have the properties of hygiene factors: dissatisfaction increases if the needs are not met, while the preferences are motivators: in order to increase satisfaction also preferences have to be fulfilled. However, it is proposed that concerning the work environment the same element can be both a need and a preference simultaneously (i.e. the user prefers something that he or she also needs),

which means that it contributes to dissatisfaction when not fulfilled but increases satisfaction when implemented. Similarly, the opposite of being satisfied with the work environment is not being dissatisfied, but rather not being satisfied. The relationship between the concepts *need*, *preference* and *requirement and implementation* is presented in Figure 1.



**Figure 1: Relationship between needs, preferences and requirements and implementation**

In general it can be said that a large portion of the preference and satisfaction based research is connected with existing facilities. For example P. L. Martin and Black (2006) looked in their research on the quality of the current workplace and on how important different elements in the current workplace areas factors keeping the employees with their current employer. Schwede et al. (2008) analysed satisfaction ratings of 12 workplace environment features from more than 5 000 endusers in new, refurbished and unmodified office environments in order to understand how the features affect enduser satisfaction and to investigate differences in satisfaction of users in the different office settings. Also Langston et al. (2008) studied enduser satisfaction with the existing physical work environment with the aim to analyze possible differences between users in government, educational and commercial settings.

The Dutch Center for People and Buildings has developed a diagnostic tool which allows evaluating and benchmarking work environments based on user experience. The tool also addresses the importance of some work environment aspects to overall satisfaction and productivity (Maarleveld et al. 2009). Surprisingly enough this kind of research with a focus on what users see as important and their preferences seems to be fairly limited.

Two exceptions are Fleming (2005) and Lee (2006) who examine not only user satisfaction with their current workspaces but also measure users' rating of importance and expectations towards their work environment or. Lee (2006) brings up the importance of not only measuring satisfaction and concludes with the statement that "Without such research, specifying employees' needs and understanding their expectation toward workplace might lead to incomplete workplace practice".

User satisfaction with their current workplaces is a key research area in order to achieve better workplaces. However, in order to develop the user-orientation it is important to widen the research agenda and identify more precisely what the actual user preferences are instead of focusing solely on how they are adapting and experiencing the existing situation and environment.

As office users are not alike, there is also a need to better understand the variety of users and their needs and preferences. One contribution was made by Erlich and Bichard (2008) who in their research focused on matching the needs of older knowledge workers with the open plan office space. They found that the workplace is good for collaboration and teamwork activities, but that it fails to provide environments for tasks that require concentration, ways of working that are alternative to the computer, and rest and recuperation. As pointed out by the researchers themselves, the study was intentionally limited to the experiences of older workers, and therefore it can only be assumed that younger workers will share many of the needs pointed out by the older colleagues. (Erlich & Bichard 2008.)

Finally, there is a need for a more holistic approach of workplaces. The workplace does not only consist of the physical building and the different spaces and solutions it provides: when aiming to meet workplace needs and preferences of office employees also the location, services and the virtual environment needs to be investigated.

### **3. Generational difference or age difference?**

Kupperschmidt (2000) defines generations as "an identifiable group that shares birth years, age location, and significant life events at critical developmental stages". A lot of published material such as books, articles and conference presentations can be found on generational differences and the serious consequences that can follow if organizations do not consider these in their management. For example, members of Generation Y are found to be independent, they enjoy challenging work, want immediate feedback and love freedom and flexibility. If they cannot find opportunities for ongoing education, socializing and creativity in an organization, they will go somewhere else. (C. A. Martin 2005.)

There is however those who are sceptical towards the significance of the generation gap, if it exists at all. Giancola (2006) reviewed a wide body of research on the theory of generational differences, found a lack of published research in academic journals on the issue and ends up suggesting that "the generational approach may be more popular culture than social science".

He points out several other major issues with the generational approach, such as the findings which indicate that the factors that motivate the generations are surprisingly similar.

Another challenge pointed out by Giancola (2006) is that researchers do not agree on the birth periods for the different generations. For example the Baby Boomers have in recent research been classified as the people born 1946-1961 (Cennamo & Gardner 2008), 1945-1964 (Wong et al. 2008) and 1946-1964 (Chen & Choi 2008). The classification of generations should also consider the geographical aspect, as the generations, by the definition provided by Kupperschmidt (2000), share also location and significant life events. Therefore adapting generation classifications from other cultures can be misleading.

Another challenge in generational research is that some of the characteristics of generations are in fact more dependent on experience and life stage than on generational issues. Most of the older workforce has experienced changes in their work environment; they have for example seen their office change from a cellular office to an open office. Having experienced a private room is not self evident for their younger colleagues. Another aspect possibly influencing the workplace needs and preferences of older workers is ageing, which can be associated with decline in various abilities such as physical strength and agility, perception, memory, learning, hearing and sight (Erlich & Bichard 2008).

Whether influenced by generational differences or other issues, it is still important to understand if and how needs and preferences of office users of different age vary. In order to understand how to meet the workplace needs and preferences of the entire workforce, more information is required about the possible differences in workplace needs and preferences of employees of different ages. In this research we decided to examine workplace preferences of different age groups rather than defined generations, in order to avoid the risk of defining generations incorrectly or to make misleading conclusions about generational differences - which could in fact be consequences of e.g. experience and life stage.

## 4. Methodology

Understanding office users' preferences concerning their workplace requires data from a scale of various real estate and workplace elements. For this research an internet based survey with email invitations was selected as the appropriate data collection method.

The questionnaire was developed by a group of researchers in cooperation with industrial specialists during spring 2009. The complete survey included a wide range of logical questions with multiple choice answers consisting of options that suit each respondent. Some open questions were added to the survey to get additional new insights. The survey consisted of questions in which the respondents evaluated given work environment attributes with a five step scale: *not important*, *less important*, *neutral*, *important to some extent*, and *very important*. This part of the questionnaire was further divided in to 4 sections based on the object of the questions: locational attributes, service attributes, office building attributes and workspace attributes. The questionnaire included 81 attributes which were divided in categories as shown

in Table 1. At the end of the questionnaire the respondents were asked to give background information of themselves such as age, gender, education and position.

*Table 1: Attributes included in the questionnaire*

<i>Category</i>	<i>Amount of attributes</i>
<i>Location</i>	<i>12</i>
<i>Services</i>	<i>30 (of which 14 within walking distance and 16 in the office building)</i>
<i>Office building</i>	<i>21</i>
<i>Workspace</i>	<i>18</i>
<b><i>Total</i></b>	<b><i>81</i></b>

The survey was carried out during spring 2009. It was sent via e-mail to office employees in the Helsinki Metropolitan Area (HMA), which is the most significant investment region for domestic and international investors in Finland. The questionnaire was sent to 4 275 employees in 21 organisations. A total of 1116 answers were received of which 1006 were taken in to further analysis. The return rate was 26,0 per cent.

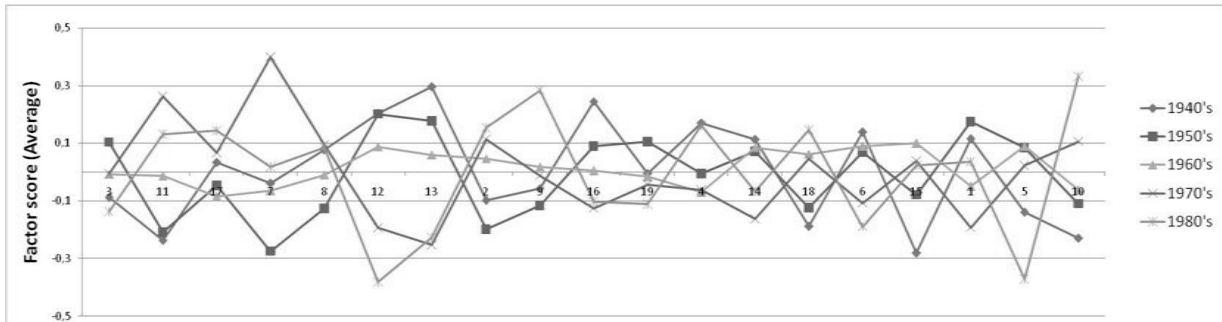
The analysis started with a principal component analysis (PCA) to develop an understanding of the underlying features that office users prefer in a similar way. Through the PCA a total of 19 factors were extracted. In the extraction 8 attributes failed to load and were removed. The rotation method was Varimax with Kaiser Normalization.

After the PCA the respondents were divided in to five groups based on their year of birth. The five groups were respondents born 1940-1949 (7,3 per cent of the respondents), 1950-1959 (27,5 per cent), 1960-1969 (28,8 per cent), 1970-1979 (23,9 per cent and 1980-1989 (12,5 per cent). Factor scores were extracted by regression analysis and used to identify where factor differences between the preferences of the age groups could be found. In order to confirm the analysis, DA was used to determine the relevant factors for the grouping of respondents to their respective age group. The potency index was then calculated for the resulting relevant factors to reveal the order of influence these factors had on the discriminant model. Stepwise estimation was used for construction of the discriminant model. The calculations were done with Statistical Package for the Social Science (SPSS).

## 5. Results

The Principal Component Analysis resulted in 19 factors that consist of 73 attributes. The factors and the attributes they comprise are presented in the attachment of this paper. Factor 1 comprises the majority of the sustainability attributes related to the building. Factor 2 includes elements from the virtual environment. Factor 3 consists of work related services while factors 7, 8, 11, 12, 13 and 17 include services that serve the individual. Factors 4, 14 and 18 describe the image of the building and area. Factor 5 supports commuting by car, while factor 10 refers

to arriving to work by bicycle. Factors 6 and 15 include elements concerning the possibility to influence on the work environment and factors 9, 16 and 19 describe collaboration and privacy attributes. The total variance explained was 67,1 %.



**Figure 2: Factor scores**

Analysis of the factor scores of the different age groups (Figure 2) and the potency indexes Table 2) indicate that there are some differences in the workplace preferences of different age groups. In order to give the reader a better overview of the preference differences, the results are presented in seven themes as follows: service preferences (factors 3,7,8,11,12,13 and 17), virtual and mobility preferences (factor 2), collaboration and privacy preferences (factors 9, 16 and 19), image preferences (factors 14,4,18), impact preferences (factors 6 and 15) sustainability preferences (factor 1) and commuting preferences (factors 5 and 10).

*Table 2: Potency Indexes of the resulting relevant factors*

<i>Factor</i>	<i>Potency Index</i>	<i>Factor</i>	<i>Potency Index</i>
<i>Factor 7</i>	<i>0,149</i>	<i>Factor 9</i>	<i>0,110</i>
<i>Factor 12</i>	<i>0,133</i>	<i>Factor 13</i>	<i>0,104</i>
<i>Factor 10</i>	<i>0,119</i>	<i>Factor 11</i>	<i>0,104</i>
<i>Factor 5</i>	<i>0,115</i>	<i>Factor 6</i>	<i>0,063</i>

### 5.1 Service preferences

The services preference theme consists of factors 3, 7, 8, 11, 12, 13 and 17. The services included in the survey were both work related services, such as lobby, posting and meeting room services, and services that serve the individual. Based on the result, the variation in preferences concerning work related services was fairly low.

Bigger preference differences were however found concerning services that serve the individual. Practical services such as daycare services in the area and building, laundry and car rental, were valued much higher by the group born in the 1970's than the others. This can probably be explained by the fact that this age group is the one most likely to have children that attend day care. The older age groups value personal services, such as beauty, culture, bank and post services near the workplace, higher than the younger generations. The younger ones do on the other hand appreciate restaurants, cafés and bars in the area more than the older generations.

The restaurant and café offering in the building also seems to be more important for the younger employees than the older ones, but the difference is not significant.

The preferences concerning workout services (e.g. fitness center in the building) did not differ remarkably between the generations although, surprisingly enough, these services were more appreciated by the respondents belonging to the oldest and the two youngest age groups (40's, 70's and 80's).

## 5.2 Virtual and mobility preferences

The virtual and mobility preference theme consists of factor 2, which comprises attributes of the virtual environment and the possibility to choose type of workplace according to the current task. Based on the results, there are small differences between the age groups, but these are not significant and the factor was not relevant in grouping the respondents in to their respective age groups.

The small differences that were found indicate that the younger age groups see the virtual environment and mobility a little bit more important than the older age groups. The group born in the 1980's is the one that has indicated the virtual environment most important, followed by the respondents born in the 1970's. However, the group that rated these issues least important compared to the others is the group of respondents born in the 1950's and not the 1940's, which could perhaps have been expected.

## 5.3 Collaboration and privacy preferences

The collaboration and privacy preference theme includes factors 9, 19 and 16. The issues covered by these factors are work environments that support team work and openness, that the workplace supports tasks that require privacy and the possibility to network with others in the building.

Based on the results the privacy preferences are very similar for all age groups. All respondents valued their privacy to the same extent, although it can be noted that the respondents born in the 1950's valued privacy a bit more than the others. The difference is however not considerable. Privacy preferences can perhaps be better explained based on the tasks the users are completing rather than age.

The collaboration and networking preferences did however count for a more considerable difference: the youngest group of respondents stand out as valuing work environments that support team working and socializing within the team much higher than all the other groups. The two oldest age groups on the other hand value the possibility to network with others in the building much more than the younger ones, but based on the DA this factor was not relevant in grouping the respondents.



## 5.4 Image preferences

The image preferences consists of factors 4, 14 and 18 of which the two first factors portray the image of the area and building and the last one the importance of how the workspace supports the image and values of the organization.

The differences in image preferences between the groups are not considerable; none of the factors were relevant in grouping the respondents in to their respective age groups. Small differences can however be noted. An interesting finding is that the image of the area and building is seen most important by the youngest and the oldest age groups while the three other groups value this aspect less. The safety and cleanliness of the area is valued most by the three oldest groups while the respondents born in the 1970's and 1980's do not see this aspect as important as the others. A workspace that supports the image and values of the organization is perceived less important by the respondents born in the 1940's and the 1950's than by the others.

## 5.5 Impact preferences

The impact preferences refer to the possibility of the individual to be able to have an impact on his or her work environment. The theme includes factors 6 and 15 of which the first represents the possibility to adjust the indoor climate and the second includes the possibility to adjust furniture and have an influence on workplace development.

Neither of the two factors was relevant in grouping the respondents in to their respective age groups. The results indicate that being able to adjust the indoor climate is more important for the older age groups than the younger ones. The possibility to have an influence on workplace development and to adjust the office furniture is on the other hand valued most by the respondents born in the 1960's, followed by the respondents born in the 1970's and 1980's, but the differences are not as significant as concerning the indoor climate.

## 5.6 Sustainability preferences

The sustainability preferences theme consists of factor 1 which covers the sustainability characteristics of the building and its management, such as energy efficiency, recycling, green cleaning and possible green building certificates.

Some differences were found in the preferences of the groups. The two oldest age groups see the sustainability characteristics of the building most important compared to the others while the respondents born in the 1970's are ones valuing these features the least. The differences were however not significant and the sustainability factor was not relevant in grouping the respondents in to their respective age groups.

## 5.7 Commuting preferences

The commuting preferences theme consists of factor 5 which describes the preferences concerning issues that support commuting by car and factor 10 which contrary consists of attributes that support bicycling to work. Both factors were relevant in the grouping of the respondents. What really stands out is the youngest age group not caring much about issues that support commuting by car but highly valuing characteristics of the workplace that support riding a bicycle to work. Based on the results, the commuting issue is in general not important to the oldest respondents compared to the others.

## 6. Conclusions and further research

The aim of this paper was to identify the differences in the work environment preferences of different age groups. The research was done by analyzing the results of an internet questionnaire concerning office users' preferences conducted in the Helsinki Metropolitan area.

The results indicate that there are some differences in the workplace preferences of different age groups. The biggest preference differences were found concerning personal services, commuting by car or bicycle, workspace that supports team work and innovation, the restaurant offering in the neighborhood and adjustability of the indoor climate while the smallest differences were found concerning privacy, workout services, the café and restaurant offering in the building and the image of the area and building.

The cluster with respondents born in the 1980's stands out as valuing features that support bicycle commuting and work environments that support team work, social interaction and innovation more than the other clusters. The preference trend line of the 70's cluster is similar to the one of the 80's cluster but with smaller peaks.

Characteristic for the 40's and 50's clusters are seeing personal services more important than the other clusters. These two clusters also value sustainability features and networking possibilities in the building more than the other clusters. The virtual environment and the possibility to choose work desk based on ones tasks were preferred less compared to the other clusters but it should be noted that the differences were not significant. The preferences of the 60's cluster seem to represent the average preferences of all respondents.

The results give new insights on what office users of different age prefer in their work environments. The information of user preferences is valuable both for user organizations and facilities management. Based on the results it is evident that the workplace is no longer a standardized product: one has to pay more attention to options provided.

There is still a need for more research with the focus on needs and preferences of office users of different generations as the matter is too often discussed based on anecdotal verification and no or diminutive academic research evidence. The main limitation of the study is the use of cross-sectional data which makes it difficult to determine if the identified differences in preferences

are due to generational differences or if these are a result of age and experience. It does however give indications whether there are differences in the workforce as it currently exists. In order to gain more knowledge on this matter, a longitudinal study should be conducted. Additionally the cultural context has to be taken into account when generalising the results as this research is limited to the Helsinki Metropolitan Area.

## References

- Batenburg, R.S. & Voordt, T.J.V.D., 2008. Do facilities matter? In *EFMC 2008 Conference Proceedings*. Manchester.
- Brill, M., Weidemann, S. & The BOSTI Associates, 2001. *Disproving widespread myths about workplace design*, Kimball International.
- Brunia, S. & Hartjes-Gosselink, A., 2009. Personalization in non-territorial offices: a study of a human need. *Journal of Corporate Real Estate*, 11(3), 169-182.
- Cennamo, L. & Gardner, D., 2008. Generational differences in work values, outcomes and person-organisation values fit. *Journal of Managerial Psychology*, 23(8), 891-906.
- Chan, J.K., Beckman, S.L. & Lawrence, P.G., 2007. Workplace Design: A New Managerial Imperative. *California Management Review*, 49(2), 6-22.
- Chen, P. & Choi, Y., 2008. Generational differences in work values: a study of hospitality management. *International Journal of Contemporary Hospitality Management*, 20(6), 595-615.
- De Croon, E.M. et al., 2005. The effect of office concepts on worker health and performance: a systematic review of literature. *Ergonomics*, 48(2), 119-134.
- Erlich, A. & Bichard, J., 2008. The Welcoming Workplace: designing for ageing knowledge workers. *Journal of Corporate Real Estate*, 10(4), 273-285.
- Fleming, D., 2005. The application of a behavioural approach to building evaluation. *Facilities*, 23(9/10), 393-415.
- Giancola, F., 2006. The Generation Gap: More Myth than Reality. *Human Resource Planning*, 29(4), 32-37.
- Haynes, B.P., 2008a. Impact of workplace connectivity on office productivity. *Journal of Corporate Real Estate*, 10(4), 286-302.
- Haynes, B.P., 2008b. The impact of office comfort on productivity. *Journal of Facilities Management*, 6(1), 37-51.
- Herzberg, F., 1987. One more time: how do you motivate employees? *Harvard Business Review*, 65(5), 109-120, including a retrospective commentary (originally published in 1968).
- Herzberg, F., Mausner, B. & Snyderman, B., 1959. *The Motivation to Work*, John Wiley, New York.
- Kupperschmidt, B., 2000. Multigeneration employees: strategies for effective

- management. *The Health Care Manager*, 19(1), 65-76.
- Langston, C., Song, Y. & Purdey, B., 2008. Perceived conditions of workers in different organizational settings. *Facilities*, 26(1/2), 54-67.
- Leaman, A., 1995. Dissatisfaction and office productivity. *Facilities*, 13(2), 13-19.
- Lee, S.Y., 2006. Expectations of employees toward the workplace and environmental satisfaction. *Facilities*, 24(9/10), 343-353.
- Lee, S.Y. & Brand, J.L., 2005. Effects of control over office workspace on perceptions of the work environment and work outcomes. *Journal of Environmental Psychology*, 25(3), 323-33.
- Maarleveld, M., Volker, L. & Voordt, T.J.V.D., 2009. Measuring employee satisfaction in new offices – the WODI toolkit. *Journal of Facilities Management*, 7(3), 181-197.
- Martin, C.A., 2005. From high maintenance to high productivity: What managers need to know about Generation Y. *Industrial and Commercial Training*, 37(1), 39-44.
- Martin, P.L. & Black, R.T., 2006. Corporate real estate as a human resource management tool. *Journal of Corporate Real Estate*, 8(2), 52-61.
- Oseland, N., 2009. The impact of psychological needs on office design. *Journal of Corporate Real Estate*, 11(4), 244-254.
- Schwede, D.A., Davies, H. & Purdey, B., 2008. Occupant satisfaction with workplace design in new and old environments. *Facilities*, 26(7/8), 273-288.
- Windlinger, L., 2008. Direct and mediated effects of office design on performance. In *EFMC 2008 Conference Proceedings*. Manchester.
- Wong, M. et al., 2008. Generational differences in personality and motivation: Do they exist and what are the implications for the workplace? *Journal of Managerial Psychology*, 23(8), 878-890.
- Voordt, T.J.V.D., 2004. Productivity and employee satisfaction in flexible workplaces. *Journal of Corporate Real Estate*, 6(2), 133-148.

## Attachment

The extracted factors and the total variance explained

	<i>Attributes</i>	<i>Factor loading</i>	<i>Communality</i>	<i>Percent of variance explained</i>
<b>Factor 1</b>	<i>Environmental friendly cleaning</i>	,849	,788	
	<i>Environmental friendly interior and surface materials</i>	,835	,755	
	<i>Energy efficiency of the building</i>	,797	,709	
	<i>Spaces support environmental responsibility</i>	,796	,763	
	<i>Environmental certifications</i>	,775	,679	
	<i>Diverse recycling possibilities</i>	,763	,693	
	<i>Communication concerning energy efficiency</i>	,762	,669	
	<i>Environmental friendliness of catering services</i>	,750	,638	8,6 %
	<b>Factor 2</b>	<i>Possibility to use virtual communication channels</i>	,787	,709
<i>Wireless connection in the office</i>		,743	,705	
<i>Possibility to work mobile by using mobile equipment</i>		,739	,632	
<i>Wireless connection in the building</i>		,635	,681	
<i>Possibility to use virtual meeting places</i>		,633	,547	
<i>Possibility to choose work station depending on task</i>		,457	,396	5,1 %
<b>Factor 3</b>		<i>Bookable meeting rooms in the building</i>	,769	,654
	<i>Tele and videoconference services in the building</i>	,746	,713	
	<i>Lobby service in the building</i>	,667	,626	
	<i>Postal services in the building</i>	,643	,566	
	<i>Video conference possibilities that reduce need to travel</i>	,619	,634	4,4 %
<b>Factor 4</b>	<i>Image of the building</i>	,733	,743	
	<i>First impression when entering the building</i>	,679	,740	
	<i>Image of the area</i>	,676	,671	
	<i>The area is modern</i>	,637	,601	
	<i>Cultural history of the area</i>	,556	,643	
	<i>High quality representation spaces</i>	,418	,585	4,4 %
<b>Factor 5</b>	<i>A sufficient amount of parking areas in the area</i>	,813	,782	
	<i>Accessibility by car</i>	,811	,799	
	<i>Accessibility by public transportation</i>	-,666	,682	
	<i>Accessibility by walking/bike</i>	-,616	,638	
	<i>Car cleaning service in the building</i>	,476	,600	
	<i>Location near city/town centre</i>	-,445	,576	4,2 %
<b>Factor 6</b>	<i>Adjustment possibility of Air conditioning</i>	,925	,921	
	<i>Adjustment possibility of Temperature</i>	,922	,910	
	<i>Adjustment possibility of Lightning</i>	,822	,768	3,8 %
<b>Factor 7</b>	<i>Day care facility within walking distance</i>	,843	,764	
	<i>Day care facility in the building</i>	,796	,732	
	<i>Car rental within walking distance</i>	,644	,625	
	<i>Laundry service within walking distance</i>	,457	,585	
	<i>Hotel within walking distance</i>	,440	,557	3,5 %
<b>Factor 8</b>	<i>Fitness centre in the building</i>	,830	,789	
	<i>Guided training in the building</i>	,795	,746	
	<i>Possibilities for sports within walking distance</i>	,557	,651	

	<i>Attributes</i>	<i>Factor loading</i>	<i>Communality</i>	<i>Percent of variance explained</i>
	<i>Physiotherapist in the building</i>	,475	,599	3,4 %
<b>Factor 9</b>	<i>Spaces support team work</i>	,773	,704	
	<i>Spaces support social interaction and tacit knowledge transfer</i>	,766	,681	
	<i>Spaces support innovation</i>	,580	,565	
	<i>Spaces support openness and transparency</i>	,555	,538	3,3 %
<b>Factor 10</b>	<i>Bicycle storage in the building</i>	,849	,789	
	<i>Shower and changing facilities</i>	,797	,747	
	<i>Accessibility by bike</i>	,698	,619	3,3 %
<b>Factor 11</b>	<i>Cafeteria within walking distance</i>	,800	,747	
	<i>Restaurant within walking distance</i>	,784	,690	
	<i>Bar within walking distance</i>	,585	,524	3,3 %
<b>Factor 12</b>	<i>Beauty services within walking distance</i>	,785	,741	
	<i>Beauty services in the building</i>	,700	,735	
	<i>Cultural services within walking distance</i>	,517	,613	3,1 %
<b>Factor 13</b>	<i>Bank within walking distance</i>	,821	,762	
	<i>Post office within walking distance</i>	,794	,760	
	<i>Occupational Healthcare within walking distance</i>	,398	,502	2,8 %
<b>Factor 14</b>	<i>Cleanliness of the area</i>	,789	,740	
	<i>Safety of the area</i>	,774	,728	
	<i>Proximity of nature</i>	,554	,598	2,8 %
<b>Factor 15</b>	<i>Adjustability of Office furniture</i>	,662	,535	
	<i>Workplace supports wellbeing at work</i>	,575	,511	
	<i>Possibility to influence workplace development</i>	,533	,531	2,4 %
<b>Factor 16</b>	<i>Players from the same industry in the building</i>	,816	,739	
	<i>Clients and other interest groups in the building</i>	,789	,692	2,3 %
<b>Factor 17</b>	<i>Restaurant in the building</i>	,792	,695	
	<i>Cafeteria in the building</i>	,697	,697	2,3 %
<b>Factor 18</b>	<i>Office reflecting the values of the organisation</i>	,682	,721	
	<i>Office supporting the image of the organisation</i>	,665	,747	2,2 %
<b>Factor 19</b>	<i>Spaces support tasks that require concentration and privacy</i>	,656	,596	
	<i>Possibility to store and archive documents in physical format</i>	,458	,497	2,0 %
<b>Total</b>				67,1 %

## Environmental preferences of office occupiers

**Jessica Karhu**

Aalto University *School of Science and Technology*

[jessica.karhu@tkk.fi](mailto:jessica.karhu@tkk.fi)

**Peggie Rothe**

Aalto University *School of Science and Technology*

[peggie.rothe@tkk.fi](mailto:peggie.rothe@tkk.fi)

**Heidi Falkenbach**

Aalto University *School of Science and Technology*

[heidi.falkenbach@tkk.fi](mailto:heidi.falkenbach@tkk.fi)

**Anna-Liisa Lindholm**

Aalto University *School of Science and Technology*

[anna-liisa.lindholm@tkk.fi](mailto:anna-liisa.lindholm@tkk.fi)

**Ari Hyvönen**

Aalto University *School of Science and Technology*

[ari.hyvonen@tkk.fi](mailto:ari.hyvonen@tkk.fi)

**Ari Laitala**

Aalto University *School of Science and Technology*

[ari.laitala@tkk.fi](mailto:ari.laitala@tkk.fi)

### Abstract

The aim of this paper is to describe the occupiers' preferences concerning sustainability in the office environment. The objective is to identify which real estate attributes related to sustainability office employees prefer the most and the least.

A literature review was carried out in order to identify the green characteristics of the office environment. Based on this literature review several attributes like location, energy efficiency, working space and services were chosen to include in a questionnaire. The literature review gave us the understanding of the general attitude towards environmental questions and also of the effectiveness of environmental preferences as part of the behaviour of employees.

In this study, the real estate preferences have been studied through an internet based questionnaire, which was sent to people working in different companies in the Helsinki Metropolitan Area. A total of 1110 responses were taken into further analysis from a total of 1116 responses. The questionnaire was developed by a team of researchers based on previous

literature, a workshop with industrial specialists and performance tests. The questions related to environmental values and preferences were one theme of this questionnaire.

The analysis of the results show that office employees highly value attributes like transport connections, both public and private. Also the possibility to use bike or pedestrian paths on daily journeys was important. The energy efficiency of the working environment and possibilities to recycle also emerged from the data as important attributes. Nevertheless office employees did not value highly the official certificates of environmental friendly buildings or 'office location in a city centre'. The results of the analysis indicate that in the Helsinki Metropolitan Area there are four different clusters or groups of employees that value environmental attributes differently.

For user organizations it is important to recognise the employees' preferences but for example for an investor it is essential to understand user organizations' preferences in order to be aware if the organizations are willing to pay more for sustainable attributes. This research does not yet give answers concerning the correlation of office employees' and user organizations' sustainability preferences. That is a task for further research. Also the possible impact of sustainability preferences on how employees choose employer needs to be investigated. The results provide an insight to the management community concerning the sustainability preferences that office employees value the most. This knowledge is a valid tool to management when evaluating what attributes give added value to the employees, which in turn leads to more efficient and sustainable work environments. This study gives knowledge also on how office users' understand sustainable values and whether they need more information and education on sustainable development.

**Keywords:** Office occupier, sustainability, real estate preference, energy efficiency, workplace



## 1. Introduction

According to the Finnish Ministry of Employment and the Economy (2008) in the European Union and in Finland the buildings cause 40 percent of total energy consumption and carbon dioxide emissions. The building sector is growing rapidly and for that reason it is crucial to reduce its emissions substantially and without delay. European Commission has legislated on May 2010 a revised directive on the energy efficiency of buildings. (EU / Energy Performance of Buildings Directive, 2010.) A massive work has been done to study and create energy efficiency buildings but only few researchers have concentrated on the users of the buildings and to the contribution of their habits to the buildings' environmental impact. However the user's role is definitive in the long term. The best energy efficient design can be demolished by incorrect or disregarded use.

To the environment the environmental sustainability of the office buildings signifies less CO<sub>2</sub> emissions, lesser water consumption and micro particles. Based on the demands of the Kyoto – agreement the Finnish Ministry of Employment and the Economy wrote a National Climate and Energy Strategy. This strategy was presented to the Finnish Parliament as Government Report the 6 November 2008. In this strategy the requirements to the decreasing of the energy consumption are ambitious. For example according to the objective, in 2020, electricity consumption will equal 98 TWh, instead of the baseline, which is 03 TWh. Stopping the growth of the energy consumption requires rapid and efficient actions on all the energy consumption fields. The most urgent actions affect those fields and structures that recur slowly like building environment and infrastructure. On all the energy fields the development of the existing technology and innovations has an essential role. In the increase of the energy efficiency the new technology and the innovative way of actions are emphasized. With information guidance the authorities try to have an effect to the owners and to users of the build environment and also to single consumers' behavioural habits. (Ministry of Employment and the Economy, 2008)

To the owners of buildings the environmental sustainability of the office buildings signifies clear challenges and possibilities. The owner of an office building is normally at all times focussed on maximising the capital value of the building, which is achieved by increasing income, decreasing costs or decreasing the capitalisation rate. Nevertheless many office building owners would like to become more energy efficient and recognise the importance of sustainable practices this is usually at a substantial financial cost. (Reed&Wilkinson, 2005) For that reason improvement on the energy efficiency or other more sustainable habits among the office building owners are adopted after the demands of changing regulation but there are some signs on the markets that the value of the green certificates like LEED and Breeam are more and more recognized.

To the occupiers the environmental sustainability of the office buildings can signify changes that affect their daily habits to use an office building and their work environment. Usually these changes are approved afterwards by most of the occupiers as improvements but opposition against the changes is often strong beforehand. Also an individual's motivation to acquire new

sustainable habits requires relevant information about the possibilities and ways to use environmental technical solutions. The delivery of information on crucial moment when the resident is acting in environmental friendly way – constant feedback of actions is also important, social model example – and the sense of sustainable community strengthens the individual actions and mandatory norms (Karhu&Nenonen, 2009). Thus it is important to understand occupier's preferences when changes are made in order to have a more sustainable office building.

The aim of his paper is to describe the occupiers' preferences concerning sustainability in the office environment. The objective is to identify which real estate attributes related to sustainability office employees prefer the most and the least.

This paper is divided in five parts. After the introduction in the second chapter we argue that we lack research on habits of the occupier of the office building although we have some studies on housing sector on inhabitants' sustainable habits. In chapter three we explain the methodology of the research, our data collection and analysis. On chapter four we indicate our results and in chapter five we present some conclusion.

## **2. Research on occupiers contribution to office buildings life-long environmental impact**

Some studies on office buildings life-long environmental impact has published past years. Junnila (2004) demonstrates in his research that operating electricity is clearly the life-cycle phase that impacts on the environment the most. In his research four of the five studied impact categories it alone produces around fifty percent or more of the impact. He argues that the three following life-cycle phases are the building materials, the operating heat and the maintenance. They each produce on average around 15 % of the environmental impact. In his research the two last life-cycle phases, the construction work and the demolition of the building clearly have a lesser impact, less than 5 % impact in all the studied categories. It is clearly that operating electricity depends besides energy efficient electric apparatus on the users and their habits to use electronic apparatus.

In housing sector several studies have discussed on inhabitants' environmental impact and on attempts to contribute on it. For example Derijke's and Uitzinger's (2006) case study indicates that environmental issues were more important for residents that participated in the building process. They argue that sustainable systems in residences should be designed in such a way that environmentally-preferred behaviour is also the most logical and easiest accomplish. In everyday life it is very important that and effective that residents have agreed with goal-setting for example in energy consumption (McCalley and Midden 2006). Lorek and Spangenberg (2001) have identified areas of consumption in which private households can make significant contributions to environmental sustainability, and presented a transparent and comprehensive set of indicators for them. Based on their analysis, three consumption clusters were identified as priority fields for action by households: construction and housing, food/nutrition and transport

(in this rank order). After them all other consumption clusters can be considered environmentally marginal, providing combined saving potentials of less than 10% of the total resource consumption.

But only few studies can be found that discuss on office occupiers' habits and motivations to use workplaces in a sustainable way.

The real estate attributes can be divided into four groups, which are location, services, building and workspace attributes (Luoma et al., 2009). Some of these attributes are out-of occupiers' authority but on some attributes occupiers can contribute on accordingly their own values. An occupier cannot choose the location of the office building but he or she can make an individual decision to use bicycle instead of the personal car. He or she cannot choose the cleaning company but an individual decision can be made on recycling and further on. Rothe et al. (2009) found in their study that it seems that sustainability has an effect on office occupiers' preferences, when the sustainable impact of the behaviour is noted.

Kimmet (2007) have studied sustainability in the workplace. According to him there are limits to the sustainability processes that are enabled by the built form, and these can be only exceeded, and indeed, redefined, through social reform within the workplace. Communication for socially sustainable buildings must deal with the wider challenges sustainability presents, such as:

- workers are generally content with their unsustainable behaviour
- rewards and savings from sustainability are often delayed and indirect
- behaviour change can be slow, so messages need to be sustained
- target audiences range from young adults to company directors, all with different motivators and understandings of sustainability and its implications
- sustainability is a complex issue incorporating environmental, social and economic factors
- experts are more familiar communicating with management than with users
- there are disparate and unformed views of what a socially sustainable building looks like and how it can be acquired.

Communication that brings about the social changes required for sustainability tends to be more effective if it comes from trusted, credible sources such as work colleagues in informal social settings. It aims for an exchange of ideas with the goal of a shared understanding, affording ownership of what has been communicated rather than imparting one-sided rational arguments. (Kimmet, 2007).

### 3. Data collection and analysis

In this study, the real estate preferences have been studied through an internet based questionnaire, an internet based survey with email invitations was selected as the appropriate data collection form to study office occupiers' real estate attributes, since the focus was to bring descriptive and precise analysis of the occupiers' evaluation of the real estate attributes. The survey consists of a wide range of logical questions with optional answers consisting of options that suit each respondent. The questions related to environmental values and preferences studied in this research were one theme of this questionnaire.

The questionnaire was generated in cooperation with a group of researchers and industrial specialists. In the first phase in spring 2009, the researchers and other specialists had brainstorming sessions in order to define the aim and to construct the questionnaire based on previous studies. In March 2009, in the second phase, a workshop focusing on the survey was arranged for the industrial specialists. A draft of the questionnaire was sent out beforehand to give the possibility to study the survey in advance. At the workshop, the structure and the questions were widely discussed in working groups of five to seven participants. Researchers facilitated the discussions and made full notes, which were afterwards joined together. A researcher evaluation session for examining and analysing the researchers' notes was arranged shortly after the workshop.

In order to establish fresh and spontaneous views on the survey and to test its relevance, in the last phase after the modifications the questionnaire was tested by the researchers and office employees who had not been acquainted with the survey beforehand. Based on the feedback from the performance tests, the questionnaire was modified to its final form.

The complete survey included a wide range of logical questions with multiple choice answers consisting of options that suit each respondent. Some open questions were added to the survey to get additional new insights. The survey consisted of questions in which the respondents evaluated given work environment attributes with a five step scale: *not important*, *less important*, *neutral*, *important to some extent*, and *very important*. This part of the questionnaire was further divided in to 4 sections based on the object of the questions: locational attributes, service attributes, office building attributes and workspace attributes. The questionnaire included 81 attributes. At the end of the questionnaire the respondents were asked to give background information of themselves such as gender, age, education and position.

The survey was carried out during spring 2009. It was sent via e-mail to office employees in the Helsinki Metropolitan Area (HMA), which is the most significant investment region for domestic and international investors in Finland. The questionnaire was sent to 4 275 employees in 21 organisations. A total of 1116 answers were received of which 1110 were taken in to further analysis. The return rate was 26,0 per cent.

### 3.1.1 The questions related to environmental values and preferences

The survey included nine out of 21 office building attributes dealing directly with environmental issues. Some other attributes like this question “How important it is to you that there is a proper place to store your bicycle in the office building” gave indirectly information of the respondents’ environmental attitudes even it was meant to deal with physical attributes. The respondents were asked firstly:

How important the following attributes related to the office building are to you?

- The energy efficiency of the office building
- The office building was granted a certificate of environmental friendly or energy efficiency building, for example LEED –certificate
- Environmental friendly materials and furnishing
- Location of the office building nearness of the public transport and bicycle paths
- Functional teleconference facilities that reduce the need of travelling
- Versatile recycling facilities
- Environmental friendly food services like close produced and organic food supplies
- Environmental friendly cleaning services like using environmental friendly cleaning materials
- Active information on the environmental impact of office building

### 3.1.2 Data analysis

In this research the special interest focused to the answers concerning the environmental attributes and that part of the entire data was analysed separately. This data was analysed by explorative grouping analysis. In order to find the possible clusters we used Ward’s hierarchical cluster method. To eliminate the correlation between the attributes were used the Mahalanobis – distance. This method highlighted us four groups that value differently environmental attributes.

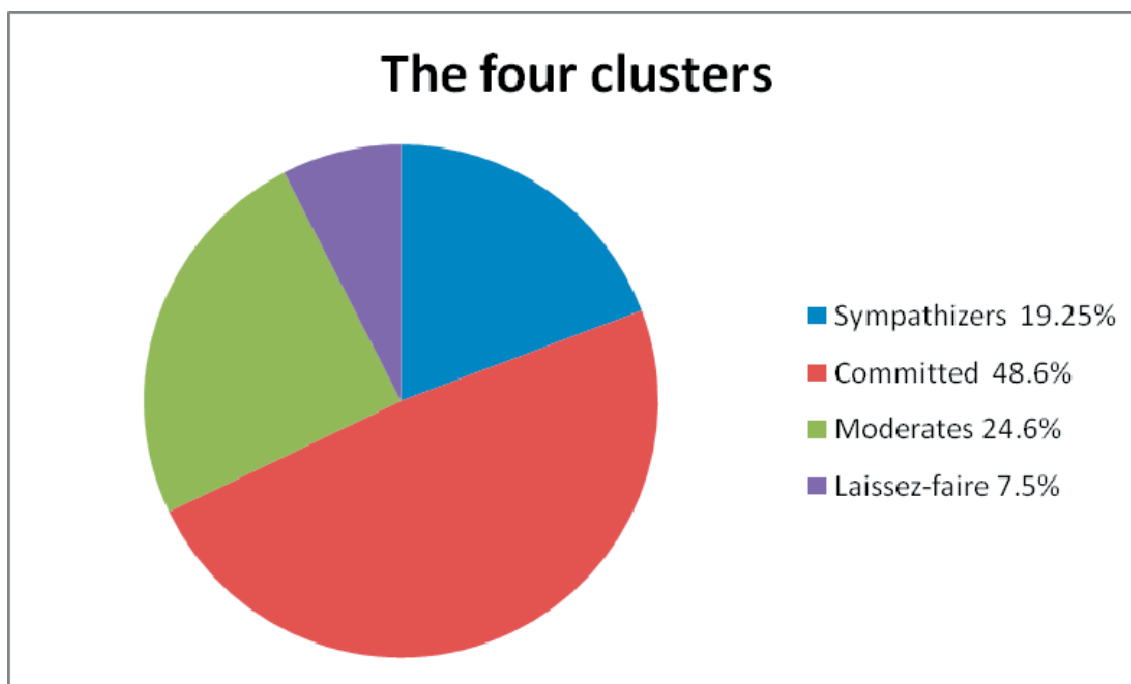
In the next part of the analysis we calculated the mean values of every attribute by group by group and compared these to the means calculated out of all responses given to that specific attribute.

The third part consisted of calculating balance figures (%) for each attribute, which enables ranking the attributes in order. The balance figure can have values from +100 per cent to -100

per cent. A positive balance figure ( $0 \leq \text{balance figure} \leq 100$ ) implies importance of the attribute and a negative balance figure ( $0 > \text{balance figure} \geq -100$ ) is a sign of the unimportance of the attribute.

## 4. Results

The four clusters that rose from the data are described in this chapter. We named them as the Sympathizers (cluster 1), the Committed. (cluster 2), Moderates (cluster 3) and the Laissez-faire (cluster 4). The percentage values of these clusters are represented in figure 1. The difference of the means of the attributes in different groups and means of all the respondents' answers are presented in figure 2. In figure 3 is presented the balance figures of the attributes group by group. With the differences of the means and with the balance figures we can discover which attributes the different clusters find important or not important and the how the four clusters differs from each others.



*Figure 1: The percentages of the four clusters*

Cluster number 1 with percentage of 19.25 was named the Sympathizers. The respondents in that group valued clearly the environmental attributes but in a sensible manner. They avoided the extreme evaluations. They valued especially the location nearness of the public transport and bicycle paths, environmental friendly cleaning services and recycling possibilities. On the contrary they did not find important the environment certificates or the information on the environmental impact of the office building.

Cluster number 2 with percentage of 48.6 was named the Committed. They valued the most almost all the environmental attributes. They value highly especially the location nearness of the

public transport and bicycle paths, teleconference possibilities, recycling possibilities, environmental friendly cleaning services and energy efficiency of the office building.

Cluster number 3 with percentage 24.6, were named the Moderates. They might value the environment attributes but these are not in their top priorities. The most typical answer was rather. Nevertheless they do appreciate the possibility to commute by bicycle, teleconference possibilities and recycling possibilities. They did pay lesser attention to the environmental certificates, to the information on the environmental impact of the office building, to environmental friendly cleaning service and to environmental friendly food.

Cluster number 4 with percentage 7.5, were named the Laissez-faire. They appreciated the least all the environmental attributes. Their favourite was the teleconference possibilities and the energy efficiency of the office building. They valued poorly the certificate of environment, the information on the environmental impact of the office building and the location nearness of the public transport and bicycle paths.

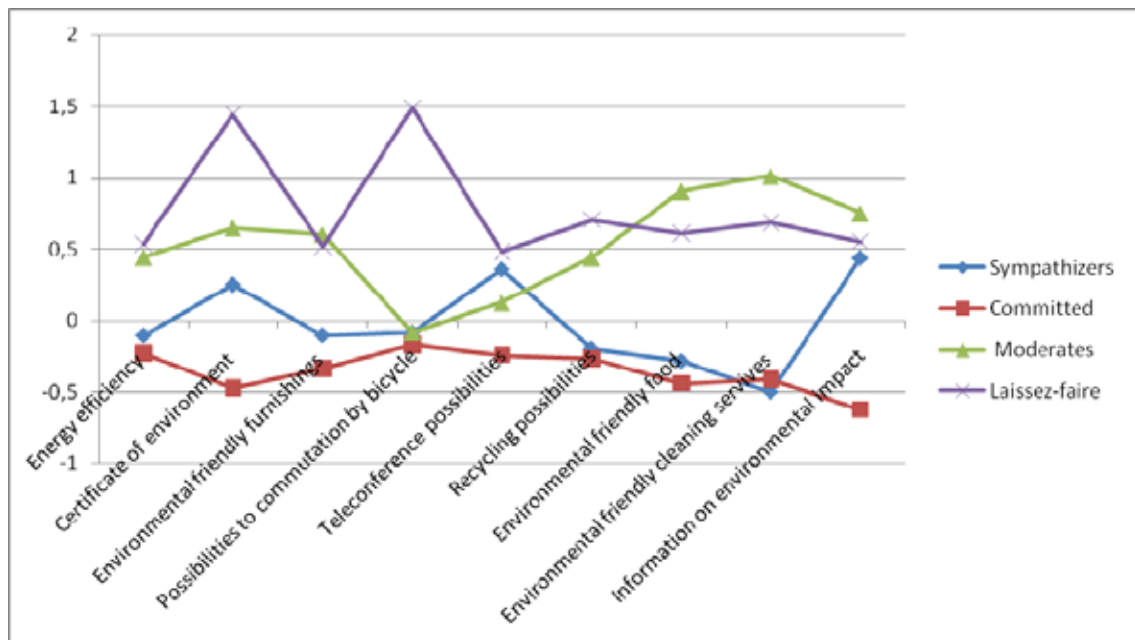


Figure 2: The differences between the mean values of all respondents and the respondents in one group

The differences of the means represented in figure 2 describe how far and towards what direction group’s opinion on average is from the average opinion of all the respondents. The value zero indicates that that attribute was valued on average same way in that specific group than among the all the respondents. A positive value indicates that that attribute is valued less in this group than among all the respondents and a negative value indicates that that attribute is valued more in this group than among all the respondents. We can notice that the Laissez-faire group differs on all of the attributes towards to the direction “not important” measured with the means. Or all the means of this group was lesser than the average means of all respondents. The Committed group appreciate all the attributes more than the other groups on average except in

one case. The attribute “environmental friendly cleaning services” was valued by the Sympathizers more than the others. The Committed group was the only group that valued a certificate of environment, the teleconference possibilities and the information on office building’s environmental impact more than the respondents on average. The attribute information on office building’s environmental impact was valued by the other groups in a similar way that was lesser than the average respondent but the group Committed appreciated it more than the average respondent. The location nearness of the public transport and bicycle paths clearly distinguish the Laissez-faire group from the other groups. Under this attribute the differences between the Laissez-faire group’s mean from average mean was almost 1.5 to the direction “not important”. The other three groups’ means differs from the average mean approximately from 0.8 to 1.6 to the direction “very important”.

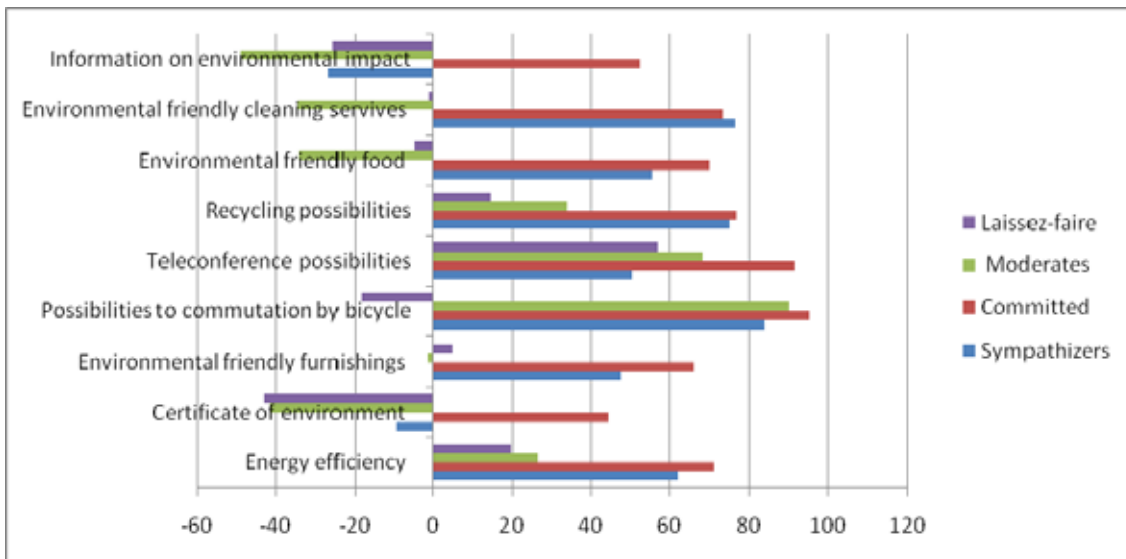


Figure 3: The balance figures

The balance figures in figure 3 describes the order of importance and the differences of the attributes cluster by cluster. The attributes that all the clusters appreciated more or less are the energy efficiency, the teleconference possibilities and the recycling possibilities. The groups Committed and Sympathizers in generally prioritized in the same way the attributes. Only about the certificate of environment and information they had a different opinion. The Committed group was the only group that valued the information on environmental impact and environmental certificates of the office building. Environmental cleaning service as well the environmental friendly food was appreciated by Committed and the Sympathizers but not by the Moderates and the Laissez-faires. The environmental friendly furnishing was appreciated more or less by all the other groups but not by the Moderates.



## 5. Conclusions

The aim of this paper was to describe the occupiers' preferences concerning sustainability in the office environment. The objective was to identify which real estate attributes related to sustainability office employees prefer the most and the least. In order to achieve this aim we analyzed respondents' answers concerning environmental preferences of an internet questionnaire concerning preferences of office buildings users conducted in the Helsinki metropolitan area.

The results verify that there are different groups with different profiles that value differently environmental preferences among the office occupiers. It is relevant that after the results of this questionnaire almost the half of the respondent valued highly the environmental preferences and major part of the respondents appreciated the environmental attributes. But still a significant amount of respondent nevertheless did not concern with the environmental preferences.

This result gives us new information on the profile of office occupiers who needs special motivation to act and behave more sustainable ways. But for further research it is important to study in-depth the motives of respondents. Some of the answers may tell more about general interest towards healthy-life than about sustainable preferences.

## References

European Commission (2010) ‘*Energy Performance of Buildings Directive*’, (available online <http://register.consilium.europa.eu/pdf/fi/10/st05/st05386.fi10.pdf> [accessed on 31/05/2010])

Derijke, E. and Uitzinger, J. (2006). Residential behavior in sustainable houses in *User behavior and technology development*, Verbeek et al., Springer: 119 – 126.

Junnila, S.(2004) ‘Life cycle assessment of environmentally significant aspects of an office building’, *Nordic Journal of Surveying and Real Estate Research, Special Series, Vol. 2 (2004)*

Karhu, J., Nenonen, S.(2009) Sustainable housing – how facility services of the low-energy building concept can support sustainable housing and resident’s sustainable behavior. *International Ecce Conference, Euroinfra 2009*, Helsinki, Finland, October 14-15., 2009

Kimmet, P. (2007) ‘Partnering for sustainability in the workplace’, *Int. J. Environment, Workplace and Employment*, Vol. 3, No. 1, pp.37–49.

Lorek, S. and Spangenberg, H. (2001). Indicators for environmentally sustainable household consumption. *International Journal of Sustainable Development*. Vol. 4. Iss. 1. pp. 101-120.

Luoma, T., Niemi, J., Rothe, P., and Lindholm, A., (2010), Office occupiers’ real estate attributes – identifying occupiers’ preferences. In *FIG Congress 2010 Proceedings “Facing the Challenges – Building the Capacity”* Sydney, Australia, 11-16 April 2010

McCalley, L. T. and Midden, C. J. H. (2006). Making energy feedback work in *User behavior and technology development*, Verbeek et al., Springer: pp. 127 – 137.

Ministry of Employment and the Economy of Finland, (2008) *National Climate and Energy Strategy* (available online <http://www.tem.fi/?l=en&s=2542> [accessed on 31/05/2010])

Reed, Richard G., and Wilkinson, Sara J. (2005) ‘The increasing importance of sustainability for building ownership’ *Journal of Corporate Real Estate* Volume 7 Number 4 2005, pp. 339–350.

Rothe, P., Lindholm, A., Hyvönen, A., Nenonen, S., (2010) Profiling office end-users based on work environment preferences. In *EFMC 2010 Conference Proceedings*. Madrid.

## Offices – the need to design both the spatial and social configuration in new ways

**Jesper Steen**

Royal Institute of Technology, Sweden

jesper.steen@arch.kth.se

### Abstract

Over the last decades there have been significant changes in general in offices. One change has been a move towards flatter organisations with more comprehensive tasks for office workers; another has come in the form of technological developments which increase independence in terms of time and space. Changes of this kind have rendered the issues of knowledge development and creativity more strategically relevant for office design. The overall aim of our research is to understand the interplay between social and spatial systems in offices. Our method involves comparing cases that have similar spatial concepts but different types of activities, and vice versa. We use observation techniques supplemented by questionnaires and interviews. Over a ten year period, we have studied several office organisations comprising more than 2,000 individuals. We have found that, on average, the amount of interaction is similar in spite of differences in work tasks, work organisation and spatial configuration. We have further found that it is important to take different types of accessibility, into account. Passing other people's workstations when moving to common areas obviously increases the chances of interaction. Individuals who are more visible than others tend to interact more with co-workers. We also interpret our findings in the area of visual exposure: the individuals you see most often will be the ones you trust and will therefore also be the people you consult for judgement-related questions. We argue that this kind of interaction is the very reason for working in an office. The second kind of interaction deals with fact-related issues, which are easier to handle at a distance and are not so easily disturbed by office noise. Another important finding is that organisational borders act strongly as walls. This indicates that so-called spontaneous interaction is of a more programmed nature than is usually conceived to be the case. This is probably very efficient. If, however, we look for interaction across borders to be the trigger for new questions and creativity, this disciplined behaviour may be problematic in the long run. In conclusion, it is necessary to combine design efforts for spatial configuration with new design solutions for social configuration. It is imperative to maintain established relationships and roles, while supplementing them with new arenas for interaction across the borders of an organisation. The FM sector faces the challenge of supporting experiments in this direction and developing sustainable knowledge.

**Keywords:** work space design, office work, interaction, spatial configuration, social configuration

## 1. Introduction

Our research has long focused on interaction between office workers in the same lines of business, the kind of interaction that motivates a co-ordinated workplace. As researchers within the field of architecture, it is natural that our interest lies in the influence of an office's spatial configuration on its interactions, and especially the kind of interaction defined as spontaneous, as opposed to planned interactions in meeting rooms and break areas. However, there is always interplay between the physical and social side of life, and in this paper we highlight the importance of social configuration in enhancing the kind of interaction that benefits the overall development of a business.

## 2. Research strategies

Our investigative strategy has been prefaced on a twofold approach: studying similar office activities in different office concepts; and studying different activities in similar office concepts. In the first case, we studied a technical consultancy firm located in five different buildings (Steen 2001). Next we examined the headquarters of an insurance company that had individual rooms and landscapes, as well as three tax offices with cellular offices, combi-offices and cubicles (Steen et al 2005, Blombergsson and Wiklander 2006). We then studied a newspaper office with open plans: one for the editorial section and another for administration (Markhede and Steen 2006). Finally, we looked at the head office of the Swedish mail company where we studied three similar floor plans with some differences in work activities (Markhede and Koch 2007, Markhede and Miranda 2007, Steen and Markhede 2008). The idea has been to study what might be considered normal office work: the relatively independent management of a certain amount of tasks/commissions. The newspaper case was selected on the basis of being somewhat different.

Social data was collected through observations, logbooks, questionnaires and interviews. In the final case, data was also gathered by asking office workers to map out their own face-to-face interactions. Spatial data was gathered using Space syntax methods (Grajewski 1993, Hillier 1996, Penn et al 1999). Initially, we used Axman-analysis, followed by Depthmap in the later cases, supplemented by other spatial values.

## 3. Results from earlier studies

### 3.1 The interaction pattern

In our observations of spontaneous interaction we found that, on average, nine out of ten interactions occur at workstations, with one out of ten interactions occurring in common areas

such as corridors or in the proximity of printers. We found the highest value of interaction, 17%, in the common areas of cellular offices, compared to an upper value of 14% for open plan solutions.

In our analysis using space syntax methods we did not find any correlation between integration values and movements. Consequently, there was no correlation with the outcome of interaction. On the global level there is more correlation with movement, but not with interaction. This is most likely an effect of the necessity for a building as a whole to form a tree-like structure, and act accordingly.

One explanation for the lack of correlation at the local level is the existence of common functions, which either act as attractors or assume the position of counteracting or supporting spatial properties. Obviously this is not limited to the position of hard artefacts: managerial staff and experts are also attractors in the spatial system.

Shallow systems at the local level may provide a second explanation for the spatial values in our analysis of the major differences encountered at each office included in the study. As almost every workstation is positioned one or two steps from the main passages, the spatial configuration will not create the major differences in terms of use and usability that had been anticipated.

In order to understand more about the mechanism behind so-called spontaneous interaction and the associated role of spatial properties, we used a new method for our final case, the head office of the Swedish mail company Posten. Our problem had been a lack of knowledge of who was interacting with whom. Now we asked every office worker on the three floor plans (250 people) to map all their interactions over a two-day period. Each person's data is represented on a single layer in the computer and is tagged with the information of the applicable organisation (for departments consisting of 30 to 50 people).

This new method made it possible for us to see that 95% or more of all reported interaction occurs within the same department. And this is the case even in situations where two departments are closely integrated spatially. This means that spontaneous interaction is very much programmed: people talk to others who are appointed as their fellow-workers – people with whom they are supposed to cooperate and produce joint results. Perhaps we can say that people are not social in the sense of talking to just anybody: they economize their sociality. However, not every interaction must be of immediate importance and use. Some interactions seem to have as their primary role the maintenance of the social system at the individual level. Organisational belonging is the cause of interaction, while also lending it legitimacy. With this in mind, we should perhaps avoid using the concept of spontaneous interaction. But if the interaction is programmed in the sense that it is related to work tasks and roles, we do not consider every interaction to be a necessity. As such, there will be a scale ranging from interactions that are probably useful to those that are necessary. Almost all forms of interaction do seem however to be related to the formal organisation in ways that can seem surprising.

In order to evaluate the interaction pattern, we conducted a social network analysis. In the questionnaire sent out to all office workers at the three floor plans at Posten, we asked for the names of five people within the whole organisation with whom the person in question most frequently interacted in the following ways: a) face to face, b) by mail, c) by phone. As we knew the names and positions both of the respondents and the people they named, it was possible for us to study the influence of physical distance as well as the configurational relations in space.

We divided the floor plan into squares of four or, in some cases, two workstations. If the respondent named a person sitting in the same square, the distance was 0. If the person was sitting in an adjacent square, either at a right angle or a diagonal, the distance was 1, and so on. Had space not played a part, face-to-face interaction would have resulted in a value of 5.9. Our questionnaire provided a result of 1.2. By this we can conclude that 41% of interactions of this kind occur within the same unit of workstations. 76% of the respective respondents' five most regular face-to-face contacts sit within a distance of 1, and 88% within a distance of 2.

We also found the distance effect to be strong in our early study of the technical consultancy firm, where almost everybody works in cellular offices. There we asked for the distance to the five most useful people. On average, we received responses to the effect that three of the five most useful people had workstations in the immediate proximity (Steen 2001).

### **3.2 Proximity and knowledge sharing**

The impact of distance on interaction frequency is significant. This should not come as a surprise when one considers that it is normal management strategy to position people close to each other on the basis of their likelihood to cooperate. Members of a team obviously understand that their task is to cooperate for the common good. There are however reasons for questioning the way in which this positioning tallies with the organisation of work tasks into different roles, i.e. social configuration. In interviews aimed at understanding existing work processes in terms of similarities and differences, we found that the level of cooperation between office workers in the same group/team is not at all as homogeneous as the results shown by the questionnaires. To some extent, these differences are hidden behind the "five people most contacted". They are relational values and reveal nothing about the number of contacts per day.

One reasonable initial explanation for the importance of proximity relates to the level of confidence built up as a result of seeing a person regularly. It should perhaps also be noted that much weight seems to be given to relationships occurring at an equal level, i.e. a mutual relationship of giving and taking. The effect of proximity – talking more to people in one's immediate vicinity – is reinforced by the tendency to regard people encountered regularly as more useful.

It is my contention, however, that the phenomenon can be further explained by the content of the interaction. We know that it is extremely difficult to acquire information on an interacting pair's verbal exchange without disturbing the situation. If however we could obtain concrete information about the interaction content, we would be forced to develop new theories to categorize the data in relevant ways.

Rather than drowning in a surplus of knowledge categories, we have identified a main level where differentiation occurs only between two categories of knowledge, or knowledge-related interaction types: *fact-related knowledge* and *judgement-related knowledge* (Steen 2009).

For fact-related questions, people will carefully consider who to ask on the basis of their expertise. If that person cannot provide an answer he/she will say so, enabling the asker to either put the question to another expert or attempt to find the answer in written material.

When it comes to judgement-related questions, anybody can ask a question and expect to receive an answer. As it is not a matter of right or wrong, everyone can understand the question to some extent and have an opinion. But as these kinds of questions depend so much on an understanding of the context, one must have confidence in the other's experiences and value systems. When it comes to matters of judgement, it is my view that people rely on those in their proximity, the people one sees often and knows as individuals to some extent. Furthermore, this interaction process will strengthen the ties to people in the immediate vicinity. In addition, face-to-face contact is often crucial in areas of judgement, as often a counterpart's facial expression offers sufficient evidence of their opinion. Fact-related questions are easier to define and transmit via email or telephone.

### 3.3 The downside of interaction

So far we have looked at interaction as a positive force in office lives. But even if interaction is necessary for businesses there is also a negative side, which must be understood if we are to draw any conclusions about the design of office concepts.

In most office work you are forced to work individually to achieve results, and there are limitations on the amount of time you can interact with others. Since we know that a normal work pattern for office workers involves interaction integrated into work tasks on an hourly basis – which is one of the reasons teleworking is not more widespread – handling the surplus of interaction is essential to minimise disturbances to work concentration.

Exposure to movement is not a cause of disturbance; instead, problems arise through exposure to eyes and ears. In this regard, open plan offices pose problems of a degree not found within the cellular concept. The negative aspects of visibility, however, are easier to handle as there are ways of not having to visually notice people passing by. But every action undertaken to make a visual situation calmer – such as erecting screens or turning one's back on thoroughfares – will restrict the positive side: the ability to look others in the eye and engage in interaction.

It is however aural exposure in office landscapes that is the primary cause of real problems, judging from the answers to our questionnaire in the Posten case. First we divided disturbances into two categories: a) Are you disturbed by others interrupting you? b) Are you disturbed by other people chatting nearby? We also asked about having the opportunity to talk undisturbed to other people at one's own workstation and the related feeling of disturbing others and perhaps restricting conversations.

Looking at our depthmap analysis of the three floor plans at Posten, we do not find any correlation between spatial values and answers concerning disturbance through interruptions, by other people talking, or the possibility of talking at one's own workstation.

In order to further test the impact of spatial properties we divided all workstations into two groups: workstations adjacent to main thoroughfares and those not adjacent. Of respondents with workstations adjacent to main thoroughfares, 27% replied that they were disturbed several times per day. Fewer respondents in the second group, 23%, reported several daily disturbances. When asked whether they were disturbed by other people talking, the distribution among respondents was similar: 38% in the adjacent group were disturbed several times per day, as opposed to 31% for the non-adjacent group.

Regarding the possibility of being able to talk undisturbed at one's own workstation, the distribution of responses was somewhat surprising: 82% of people sitting adjacent to thoroughfares said "no" compared to 86% of people in deeper office positions.

In conclusion, the division into two simple spatial dimensions did not produce the anticipated differences in an obvious way.

However, when we cross check different data from the questionnaires about disturbances and work content, we find that disturbances are experienced most acutely by respondents indicating a need to work undisturbed. The answers suggest that respondents experience disturbances to a greater extent when their work requires a high degree of concentration.

### **3.4 The interpretation of our results**

It is often said that the problems (some) people express regarding noise disturbance are an effect of individual characteristics. To some extent this is of course true. I will, however, argue that work content is the key factor behind the experience of disturbance. To this end, I will return to the discussion of the two categories of knowledge.

In my opinion, it makes a lot of sense to describe work processes as consisting of tasks that deal with either long or short questions. Long questions pertain to tasks requiring consideration and are of the kind described above as judgement-related knowledge. Questions of this kind necessitate a juggling of ideas, either in one's own head or in league with others. This is



because long questions must be understood in their context – with implications changing as the context changes – which demands a chain of thought.

Short questions are simpler to process: they consist of shorter chains of thought and more fact-related knowledge. I think it's reasonable to surmise that work processes of this kind are more predictable.

Of course you will find both kinds of questions in most roles in an office. The point is, however, that work dominated by long questions will have more negative interaction effects than work dominated by short questions, which can utilize the positive aspects of interaction to a greater degree. It is notable that half of Posten's office workers stated that they often received useful information through listening to other people's conversation.

According to our findings, the negative aspects of interaction result mainly from exposure to sound and will above all affect people with long questions. In aurally open spaces there is a risk of lower efficiency, both due to interruptions and restrictions on more complex conversation that could lead to others being disturbed. These problems can be hidden behind the fact that there are obvious knowledge exchange processes at play in open plan offices – but perhaps this interaction over-stimulates the homogenizing of knowledge and the reproduction of social systems, rather than enhancing the kind of knowledge development that will lead to strategic development for the organisation as a whole (Becker and Steele 1995, Duffy 1997).

Visual exposure seems to play a more positive role, and perhaps a relatively active role, as mentioned above. Seeing other people, seeing that they are available for interaction, and being reminded of the value of talking to a particular person – all of these qualities are positive, we believe, in terms of the efficiency of work processes. Indeed, this forms the backdrop to our development of the Spatial Positioning Tool (SPOT), which is intended to be both an analytical and a design tool (Markhede and Koch 2007, Markhede and Miranda 2007).

## 4. New conclusions

In our earlier papers we have concluded that new spatial solutions are necessary in order to manage the balance between visual and aural openness. We have also said that creative and development processes within an organisation are hampered by the fact that so much of the interaction is performed within the organisational units. On the one hand, it is very efficient if people keep to the current paradigm, which represents order and ensures people know what tasks to perform. On the other hand, we do not want the group to be too isolated, and feel too safe, to the extent that they might not notice the changing context (Allen 1977). We have often seen that office managers have a well-established method for handling this dilemma: the organisation is changed regularly, forcing the development of new relationships between co-workers. The negative side of this strategy is the loss of knowledge and competence. No one really knows the value of what is thrown out with the bathwater.

Is it possible to find another strategy that does not have unnecessary negative consequences for production?

When it comes to the spatial aspect, we can design a system that makes people likely to be in the same space at the same time. But there is obviously no guarantee that interaction will occur across organisational boundaries. For various reasons, a spatial system cannot be tailor-made for just one organisational concept; it must be more generic and useful for different kinds of organisations. In the same way, it should be possible to build up a social artefact of a more general nature, which provides an organisation with situations in which different units interact in the resolution of issues which are both broad and deep in relation to the core of the business. Situations can of course vary, and might include hearings or workshops for instance, but the main idea should be the same: telling other people about the main issues you are tackling in your work and receiving questions geared towards challenging established ways of thinking and sharpening minds.

In my earlier thinking on this social artefact, I was convinced that each specific organisation should form an organisational design in the way it deemed most appropriate. Subsequent experience has taught me however that, for many reasons, this is not a workable strategy. First of all, the time spent seeking solutions must be balanced in terms of output, which requires managers taking a long-term perspective. Another obstacle is the detailed level of knowledge-exchange required, which can reinforce a situation in which people are mired in their own context, failing to see the main issues and overarching similarities.

My experience leads me to the conclusion that the facility management sector should play an important role in the construction of social artefacts for internal interaction across organisational units. In the same way that office organisations need help designing their configuration of space to ensure robustness over time, so too do they require assistance designing the social configuration, which will create a solid base for knowledge-sharing.

The FM sector does not currently have enough experience or knowledge to support the design process for the social artefact. But because facility management is a practical field in which knowledge is accumulated by comparing the situations of many parallel clients, and because there is a need for standardized behaviour, this represents a very interesting and challenging task for the sector.

## References

Allen, T. (1977), *Managing the Flow of Technology*, MIT Press, Cambridge, MA. ISBN 0-262-01048-8

Becker, F. and Steele, F. (1995), *Workplace by design: Mapping the High-performance Workplace*, Jossey-Bass, San Francisco, CA, ISBN 0-7879-0047-8

Blombergsson, M. and Wiklander, J. (2006), "Spatial Support for Key Usability Factors: Spatial Influence on Interaction Patterns for 800 Office Workers", in Proceedings for Trondheim International Symposium CIB W70, 12-14 June 2006: Changing User Demands on Buildings, pp 542-550, edited by Haugen, T., Moum, A. and Bröchner, J., Trondheim 2006, ISBN 82-7551-031-7

Duffy, F. (1997), *The New Office*, Conran Octopus Ltd, London, ISBN 1-85029-891-2

Grajewski, T. (1993), "The SAS Head Office – Spatial Configuration and interaction Patterns", in *Nordisk arkitekturforskning 1993:2*

Hillier, B. (1996), *Space is the Machine – a Configurational Theory of Architecture*, Cambridge University Press, UK, ISBN 0-521-56039X

Markhede, H. and Steen, J. (2006), "Analysing Open Space Offices", in Proceedings for Trondheim International Symposium CIB W70, 12-14 June 2006: Changing User Demands on Buildings, pp 533-541, edited by Haugen, T., Moum, A. and Bröchner, J., Trondheim 2006, ISBN 82-7551-031-7

Markhede, H. and Koch, D. (2007), "Positioning Analyses: social structures in configurative modelling", in Proceedings for the 6th International Space Syntax Symposium in Istanbul June 2007, vol. 2, no 069, edited by Kubat, A. S., Ertekin, Ö., Güney, Y. I., Eyüboğlu, E., Istanbul 2007, ISBN 978-975-561-305-5 (v.2)

Markhede, H. and Miranda, P. (2007), "Spatial Positioning Tool: a prototype software and some background correlation data", in Proceedings for the 6th International Space Syntax Symposium in Istanbul June 2007, vol. 2, no 102, edited by Kubat, A. S., Ertekin, Ö., Güney, Y. I., Eyüboğlu, E., Istanbul 2007, ISBN 978-975-561-305-5 (v.2)

Penn, A., Desyllas, J. and Vaughan, L. (1999), "The Space of innovation: Interaction and Communication in the Work Environment", in *Environment and Planning B: Planning and Design 1999*, vol. 6

Steen, J. (2001) "The Office: Form and Space for Action". Proceedings, 3rd International Space Syntax Symposium, Atlanta, pp. 45.1- 45.12.

Steen, J., Blombergsson, M. and Wiklander, J. (2005) "Useful Buildings for Office Activities", in *Facilities*, Vol. 23, no ¾, pp 176-186, available at [www.emeraldinsight.com](http://www.emeraldinsight.com), presented at Euro-FM, Rotterdam 2003

Steen, J. and Markhede, H. (2008) "Creativity demands New Office Designs". Proceedings, CIB W70, European Facility Management Conference, Healthy and Creative Facilities, Edinburgh, pp. 313-320

Steen, J. (2009) "Spatial and Social Configurations in Offices". Proceedings, 7<sup>th</sup> International Space Syntax Symposium, edited by Koch, D., Marcus, L. and Steen, J. ISBN 978-91-7415-347-7



## Session B - Key Note

**Professor Edward F. Finch**

University of Salford - Centre for Facilities Management - Salford/UK

### **Facility Management: A Crossroad**

Professor Kathy O. Roper

Georgia Institute of Technology - Atlanta, USA

215

## Session B - CIB W070 Open Forum

**Professor Edward F. Finch<sup>1</sup> & Prof. Danny Shiem-Shin Then<sup>2</sup>**

<sup>1</sup>University of Salford - Centre for Facilities Management - Salford/UK

<sup>2</sup>The Hong-Kong Polytechnic University - Hong Kong/China

### **Facilities Management and Added Value: An Euro FM Research Initiative**

Per Anker Jensen

Technical University of Denmark

217



### **Facility Management: A Crossroad (\*)**

Professor Kathy O. Roper, CFM, MCR, LEED AP, IFMA Fellow



With over 20 years in practice, Professor Roper now leads the Integrated Facility and Property Management graduate program at Georgia Institute of Technology. Leadership positions prior to teaching provided her wide experiences with corporate, government and non-profit business models of FM and Corporate Real Estate, which she incorporates into her teaching and research. She teaches graduate sustainable facility and property management, facility planning, project management, benchmarking, and corporate real estate courses, while researching workplace and healthcare facility management issues, as well as working with students to enrich their career potential and match employers with interns and recent graduates.

Professor Roper is an active member of the International Facility Management Association (IFMA) and currently serves as Vice Chair of the Board of Directors, and holds the Certified Facility Manager designation. She was recognized as an IFMA Fellow in 2007. She is a LEED Accredited Professional with the U.S. Green Building Council and an elected member of the USGBC Education Steering Committee. She is also an Advisory Board member of the CIB W70 Facilities Management working group.

With over a dozen scholarly publications and multiple magazine and newsletter articles published, as well as being co-author of The Facility Management Handbook, Third edition, Professor Roper also co-founded and co-edits the new open access International Journal of Facility Management ([www.ijfm.net](http://www.ijfm.net)). Along with her students, she is highly awarded, winning the 2005 IFMA Distinguished Educator Award of Excellence and the 2007 IFMA Distinguished Author Award of Excellence, and her College of Architecture's Early Career Achievement Award in 2006 and Faculty Service Award in 2007.

(\*)Presentations are available for download in <http://www.fmresearch.co.uk/events.html>





# Facilities Management and Added Value: An EuroFM Research Initiative

**Per Anker Jensen**

Technical University of Denmark

pank@man.dtu.dk

## Abstract

**Aim:** This paper aims to present different models of the concept of the added value of Facilities Management (FM), including the FM Value Map, which forms the basis of research group in EuroFM, and to present some of the results of this research collaboration.

**Approach and methodology:** The paper is based on literature reviews of the most influential journals within the academic fields of FM, Corporate Real Estate Management and Business to Business Marketing and discussions between participants of the research group working on a further exploration and testing of the FM Value Map.

**Conclusions:** The research shows a number of different definitions and focus points of Added Value of FM, dependent on the academic field and the area of application. The different research perspectives explored a holistic view on the added value of FM by the integration of an external market based view (with a focus on the aimed output) and the internal resource based view (with a focus on the input from FM and RE). Good relationship management and building on trust shows to be equally important as delivering the agreed services. In order to measure the multi-dimensional components of adding value both qualitative and quantitative approaches are needed.

**Keywords:** Facilities Management, Corporate Real Estate Management, Added Value, Strategic Mapping, Service Marketing.

## 1. Introduction

Both from an academic point of view as well as in daily practice there is a need to improve our understanding of how FM can become more effective and add value to the core business and different stakeholders. For this reason the EuroFM Research Network Group established a working party on this topic to search for answers on the following questions:

- What is (or could be) the added value of FM?
- How is added-value defined in the literature?
- What kind of data are used to document and measure the added value of FM?
- What are the methodological potentials and barriers of measuring the added value of FM?

The group includes researchers from Denmark, the Netherlands, Norway, Finland, Switzerland, and the UK. Participants have met at workshops in Copenhagen on 11-12 May, in Helsinki on 21 October 2009, and in Madrid 31 May 2010. The first meeting started with discussions and reflections on a variety of definitions and theoretical frameworks to conceptualise the added value of FM, in order to reach a more coherent understanding. It was decided to divide in sub-groups, one group with a focus on comparing and testing frameworks for mapping added value of FM and another group with a focus on comparing and testing frameworks for value chains in FM. The first results were presented at the conference EFMC2019 in Madrid 1-2 June 2010 (Jensen et al., 2010).

One starting point for the research group has been the FM Value Map, which was presented at the research symposium during EFMC 2009 in a paper by Jensen (2009), see Figure 4. The FM Value Map is a conceptual framework to understand and explain the different ways that FM can create value for a core business as well as the surroundings for the benefits of multiple stakeholders: owners, staff, customers and society.

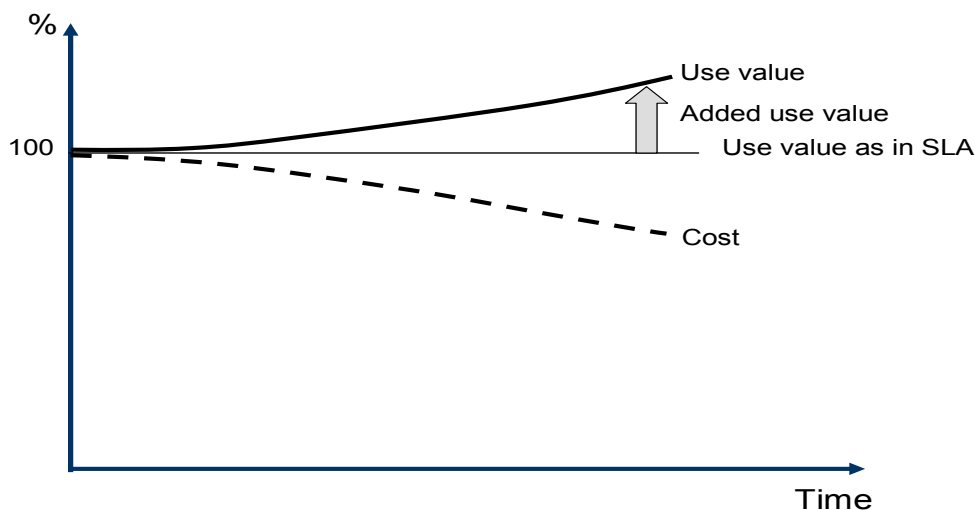
Literature reviews of recent volumes of the most influential journals within the academic fields were made divided between the group members. It was clear from the outset, that the researchers had different academic and theoretical backgrounds. Even though they all did research in relation to FM, some of the researchers were more engaged in the related field of Corporate Real Estate Management (CREM). There were also differences with some researchers from architectural and engineering backgrounds and others from Service Marketing and other marketing related backgrounds. These different backgrounds were seen as fruitful in providing different types of insights and frameworks and challenges in reaching common understanding of the benefits and shortcoming of the different theoretical frameworks and if possible develop a common framework to explain the different ways of how FM can create added value. The full literature review is included in Jensen et al. (2010).

This paper presents different models of the concept of the added value of Facilities Management (FM), including the FM Value Map, and presents some of the results of this research collaboration.

## 2. Cost Reduction or Added Value?

An investigation of 36 cases of best practice in FM from the Nordic countries concluded that there has been a change in recent years from mostly focusing on cost reduction towards a need to also focus on adding value. The case studies were made in 2006-7 and published in a book in English (Jensen et al., 2008). This conclusion was evident both for in-house FM organizations and external FM providers. The trend towards outsourcing has been very strong within FM over the last 15 years, which is the reason for the large and fast growing market. The possibility to reduce cost has been a dominating driver behind this trend.

The difference between added use value and cost reduction is illustrated in Figure 1. It shows the relative development over time of cost and use value of a service compared to a base line with use value as specified in a Service Level Agreement (SLA). The use value of the service can for instance be measured by a Key Performance Indicator (KPI) with a minimum level of customer satisfaction. A cost reduction occurs, if the cost/price of the service over time goes down without lowering the customer satisfaction below the minimum level. Contrarily, an increase in use value will occur, if the customer satisfaction over time gets higher than the minimum level of customer satisfaction. This does not necessary involve a change in the SLA, but it means that added use value is created.



*Figure 1: Added use value and cost reductions*

The current financial crisis has probably for a period changed the focus back to again being mostly on cost reductions. However, there is for me no doubt that the FM profession and industry need to increase their competencies towards adding value. It is a necessity, if we want to become a more important industry, capable of getting attention from top managers and attracting demanding youngsters. This change has some important impacts on the knowledge and competences needed for FM. To reduce cost we can use past experiences and similar management tools and methods like outsourcing, benchmarking and process development as many other management fields. To add value we need to develop new knowledge and competences specific to our field. Research and development will become more and more

important. So far the FM providers have been able to expand into new market areas without being forced to innovate. This situation will change when the market becomes more mature and saturated.

### 3. Models for Added Value

There has both within research and in practice been quite a lot of efforts to develop models and methods to investigate and measure the added value of real estate and FM. Corporate Real Estate Management (CREM) is a field closely related to FM, where there has been several suggestions for models to investigate added value. A seminal work within CREM was published by Joroff (1993) in the US introducing the concept of the fifth resource proposing that real estate is a corporate resource in line with capital, human resources, technology and knowledge, which had been more or less neglected so far and needs to be managed in a more professional way.

One of the models within the field of CREM was developed by Lindholm (2008) in Finland as part of a PhD-study including investigation of case studies in several European countries and the US. The model is shown in figure 2. It is based on strategic mapping (Kaplan & Norton, 2001) from Balanced Scorecard methodology and identifies 7 different real estate strategies that can increase revenue and/or productivity and thereby lead to shareholder wealth.

In the Netherlands there has been a number of attempts to develop such models and the most recent one shown in figure 3 was developed by De Vries et al. (2007) also based on a PhD study. The concept of real estate as the fifth resource is included in this model which is based on input-process-output. A main difference to the Finnish model is the inclusion of multiple stakeholders and not only shareholders.

A third model was developed from research in the field of FM as an outcome of the study mentioned above of 36 cases from the Nordic countries in Europe (Jensen et al., 2008) as well as from discussion in a work group with practitioners in the NordicFM network. It is called the FM Value Map and is shown in figure 4. It is a conceptual framework to understand and explain the different ways that FM can create value for a core business as well as the surroundings for the benefits of multiple stakeholders: owners, staff, customers and society. It maps which resources FM uses as inputs into the internal processes to produce outputs like space, services, development and relations, and which impacts the provisions from FM can have on core business in terms of satisfaction, cost, productivity, reliability, adaption, and culture, and on the surroundings in terms of economical, social, spatial and environmental aspects.

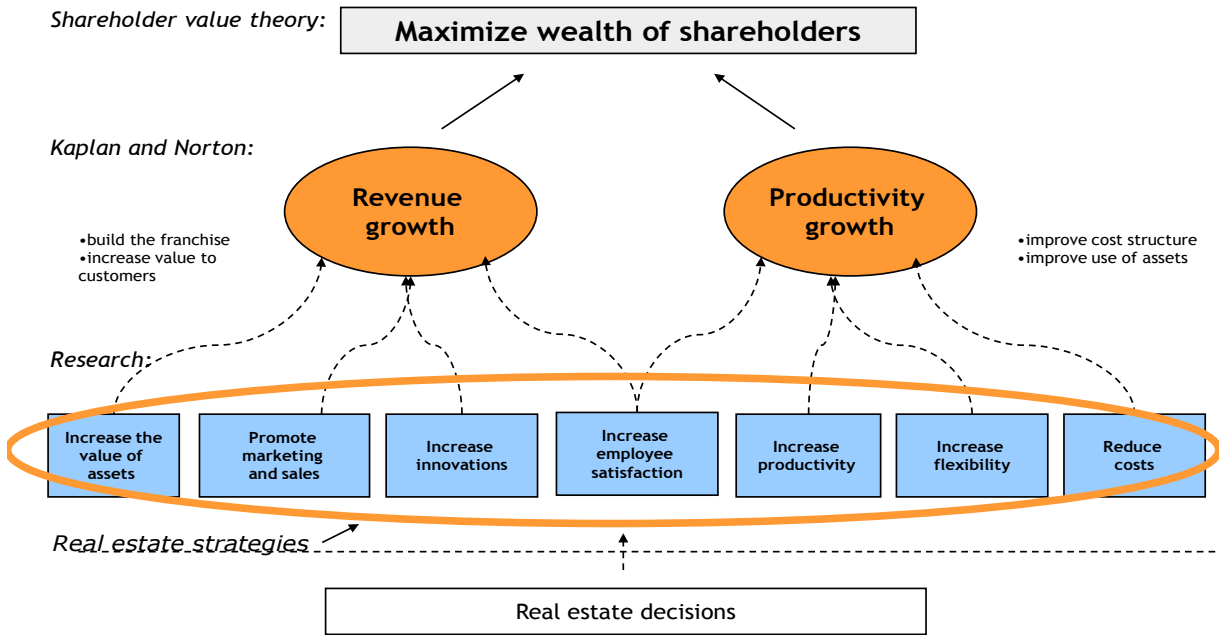
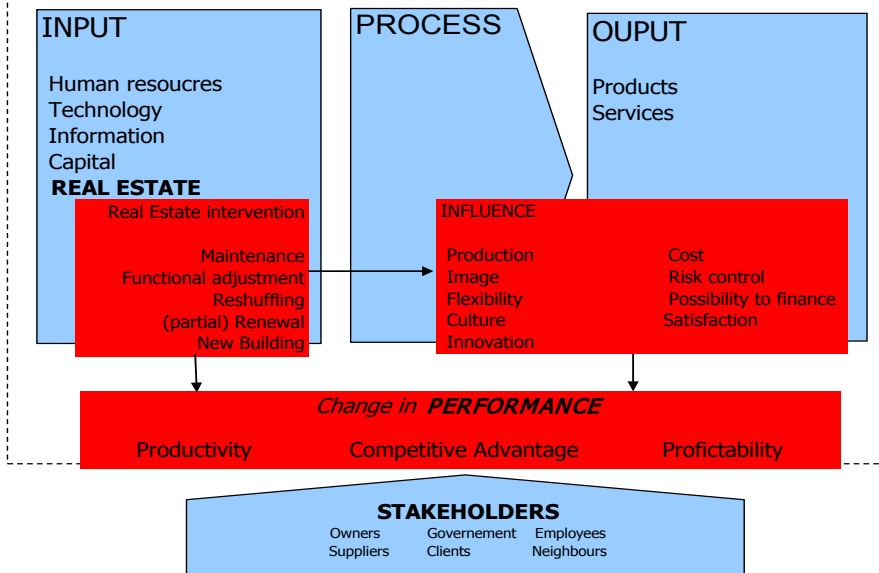


Figure 2: Model for Added Value of CREM from Finland

CONTEXT: Legislation, society, market, demography

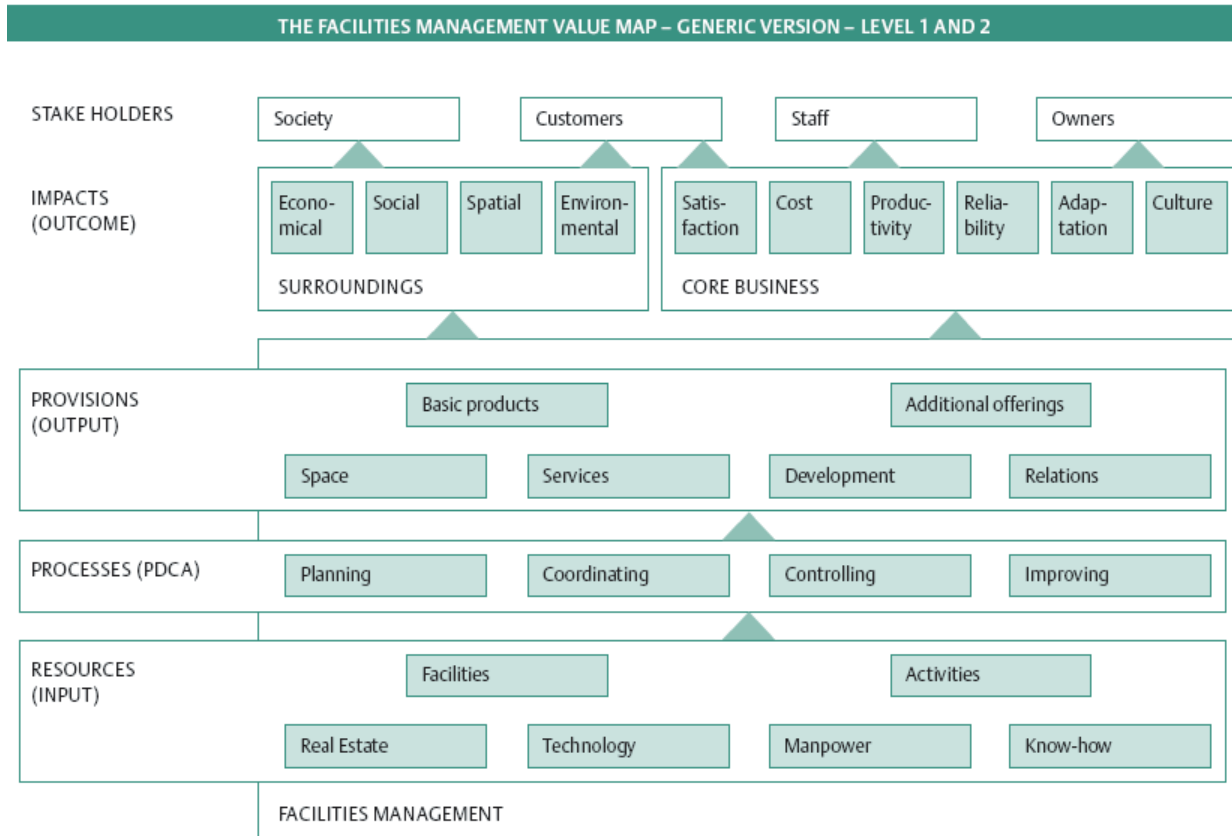
ORGANISATION: Culture / structure / aims and objectives



2

Figure 3: Model for Added Value of CREM from the Netherlands

The FM Value Map was developed from inductive reasoning based on case studies of FM best practice in the Nordic countries in Europe (Jensen et al., 2008). It is like the Finnish model developed by inspiration from strategic mapping in Balanced Scorecard methodology (Kaplan and Norton, 2000). It includes input-process-output like the model from the Netherlands, but with a separation between FM and core business, which is crucial in FM theory. It distinguishes between the impacts of FM on the core business and on the surroundings. Like the Dutch model is operates with multiple stakeholders.



**Figure 4: The FM Value Map**

A comparison shows that quite different parameters have been used in the three models. However, a closer analysis reveals that all the parameters can be grouped in the following three main categories related to impacts on core business: People, processes and economy. The exception is that only the FM Value Map includes a category for impacts on the surroundings. The results of the comparison are shown in Table 2.

*Table 2: Comparison of parameters of FM value adding*

	<b>Lindholm (2008)</b>	<b>Vries et al. (2008)</b>	<b>Jensen et al. (2008)</b>
<b>People</b>	Increase employee satisfaction	Image Culture Satisfaction	Satisfaction Culture
<b>Process</b>	Increase innovation Increase productivity Increase flexibility	Production Flexibility Innovation Risk control	Productivity Reliability Adaptability
<b>Economy</b>	Increase value of assets Promote marketing and sale Reduce cost	Cost Possibility to finance	Cost
<b>Surroundings</b>			Economical Social Spatial Environmental

#### 4. Measurements of Added Value in Corporations

Within the field of marketing Heskett et al. (1994) have presented an equation to measure customer value:

$$\text{Customer value} = \frac{\text{Results produced for the customer} + \text{service process quality}}{\text{Price to the customer} + \text{cost and effort in acquiring the service}}$$

By inspiration from this customer value equation the Danish financial corporation Nykredit, has defined a so-called user value ratio:

$$\text{User value} = \text{Quality \& Process} / \text{Price \& Difficulties}$$

The user value ratio was introduced to supplement the cost related factors in the internal decision making process to force the decision makers to take a broader value oriented perspective. It was not developed into a quantifiable tool, although the manager who introduced it did have intentions to do so. It was used as a situation specific, qualitative tool to assist decision making (Jensen et al., 2008).

An example of a company, who have gone further to quantify measurements of added value comes from the Danish based LEGO corporation, where the FM organisation has found a specific way to quantify their contribution to the core business as value add. The LEGO Service Centre has value creation as one out of five strategic focus areas – the other being customers, processes, innovation, and employees – and uses Balanced Scorecard as a management tool. They have defined that their key objective is to deliver a minimum of 5% value add every year. To measure this, they have defined the following value equation:

$$\text{Value add} = \text{Volume} * \text{Quality} * \text{Flexibility} / \text{Cost}.$$

Volume represents the level of scalability and is calculated as the number of standard services (part of the service catalogue) delivered. Quality is the user perceived quality measured by use of surveys among randomly selected users. Flexibility concerns the number of not standardised services delivered. Cost covers the total company cost of providing services (Møllebjerger, 2009).

## 5. Perspectives on FM and Added Value

The literature review revealed the following points of interest:

### 1. *The concept of added value puts focus on the strategic aspects of FM*

FM is often considered as management of mainly operational services, but by introducing the concept of added value the focus can be changed towards the business impacts and effects of FM. Thereby, it becomes easier to address the corporate top management, because adding value relates to their language and perspective.

### 2. *The focus has changed from economical value towards a more holistic value concept*

This is particular the case within the fields of FM and CREM and can be related to the phases in the development of FM. This changing focus is reflected in the fact that whereas previously shareholder value was the main perspective, nowadays a more holistic stakeholder perspective as included in the FM Value Map has become more accepted.



Inspirations for value mapping has been found in management models like Balanced Score Card and EFQM Excellence Model.

**3. *FM value is a result of linking input and throughput to output***

Most of the issues from marketing and relationship management concern the top of the value map, thus focusing on an external market-based view of value perception. As such this field adds an outside-in perspective to the inside-out perspective of most FM and CREM literature with a focus on an internal resource based-view. Both approaches should not be considered as contradicting extremes but as complementing elements of a holistic view.

**4. *FM value is multi-dimensional***

Research on value conceptualisation in relationship management literature shows very explicit portraits of benefits and cost dimensions. E.g., authors describe the differences between “core benefits” and “add-on benefits” as well as “acquisition costs”, “operations costs”, and “purchase price”. In addition, it is worth considering that relationship benefits are stronger correlated with value measures than relationship sacrifices. This distinguished characterisation of various value dimensions helps to differentiate between several FM-specific dimensions of benefits and costs.

**5. *FM value is relationship value***

When considering the value of FM, FM has to be acknowledged as a relationship management discipline. On a high level of abstraction, FM is the management of internal or external customer/client-supplier-relationships. Perceived value can only exist and be produced within this specific network of relationships.

**6. *FM value is subjective***

The character of value within these relationships includes a strong subjective element that is dependent on the customer's/client's perception. As pointed out by the presented research on the value of relationships, customer organisations tend to emphasise relationship benefits, whereas suppliers mainly focus on sacrifices. Only the subjective perception of the customer/client determines the value of the relationships within FM and the rule “perception is reality” applies here as well.

**7. *FM value depends on conditions***

In addition, the subjective value of FM can be very different, depending on market settings, type of relationship, industry sector, specific situation, etc. This leads to a major challenge when conceptualising a holistic formula for determining the value of FM.

**8. *FM value research needs both qualitative and quantitative research methods***

To determine the multidimensional and subjectively perceived value of FM, surveys are needed that integrate the different perspectives mentioned above, with differentiated measurement methods such as using multi-item scales and structural equation modelling

(SEM). Quantitative surveys should be triangulated by applying qualitative data collection methods such as personal interviews, focus groups with professionals, and content analysis.

In relation to the FM Value Map the focus on broad stakeholder value rather than shareholder value has been supported by the recent development in FM and CREM research, while the focus in Business to Business Management is mostly limited to customers and clients/owners. The crucial part of value adding lies in the interface between provisions from FM and the impact on the core business as perceived by the stakeholders. Business to Business Management puts particular focus on the relationship aspects of this interface. There are some examples on categorising the performance indicators for the core business impacts, particularly within CREM, while both FM and Business to Business Management provide examples of ratios to measure the added value, including the very interesting example from LEGO.

These differences between the different academic fields give good promises for the possibilities and benefits of developing a common trans-disciplinary framework of mapping added value. The categorisation of the impact parameters in the FM Value Map can be further refined in this process. The FM Value Map is unique in including the impacts on the surroundings, and the general increase in the focus on sustainability and corporate social responsibility supports the importance on including such parameters.

## 6. Conclusion

FM has become an important industry and profession. Outsourcing and cost reduction has been and still is an important trend within FM, but in recent years this has been combined with a new trend with more focus on adding value to corporations and increasingly also for society at large as sustainability and corporate social responsibility has become an important concern for both public and private corporations. This change in focus is evident not only in the field of research but also as a practical reality in corporations. There are even examples of corporations, where the FM organisations are developing both qualitative and quantitative measures to document how and how much they add value. This shows that the most forward looking facilities managers are beginning to talk the language of top management and want to be taken serious at the strategic levels in corporation.

From the findings from the fields of FM and CREM it is interesting to see that the FM Value Map provides a very broad and qualitative framework, while from relationship marketing and practice cases several examples came up of more simplified equations and ratios with attempts to quantify the results in various degrees. The case from LEGO represents a unique example of a quantification of added value of FM. It is a very recent development and it will be interesting to see what the experience over time will be and whether other organisations will take up similar models of managing and measuring the added value of FM. Whereas quantification is an important mean to simplify and put all factors on a comparable footing, the intentions with the value map are to be able to explain the different ways that FM can create added value. In

combination, the equations or ratios can give inspiration to further development of the FM Value Map.

The research shows a number of different definitions and focus points of Added Value of FM, dependent on the academic field and the area of application. Good relationship management and building on trust shows to be equally important as delivering the agreed services. In order to measure the multi-dimensional components of adding value both qualitative and quantitative approaches are needed. Usually the concept of Added Value is discussed from a mono-disciplinary point of view. The different research perspectives presented in this research review provides in combination a holistic view on the added value of FM by the integration of an external market based view (with a focus on the aimed output) and the internal resource based view (with a focus on the input from FM and RE). The findings have improved our understanding of the added value of FM, both on a conceptual level and from an instrumental point of view.

This is of great importance to FM-research and evidence-based FM as a sound basis for the long term recognition of FM. The differences between the different academic fields represented in the research group give good promises for the possibilities and benefits of developing a common trans-disciplinary framework of mapping added value. So far this collaborative research includes joint discussions and reflections on definitions and research findings to be found in international journals. A next step will be to start case studies in different countries with comparable research methods.

## References

- Heskett, J.L., Jones, T.O., Loveman, G.W., Sasser, E.W. and Schlesinger, L.A. (1994), "Putting the service-profit chain to work", *Harvard Business Review*, March-April, pp. 164-74.
- Jensen, P. A. (2009), "Theoretical Model Demonstrating the Value Adding Contribution of Facilities Management", Paper presented at Research Symposium of EFMC2009, 16-18 June 2009, Amsterdam.
- Jensen, P.A., Nielsen, K. and Nielsen, S.B. (2008), *Facilities Management Best Practice in the Nordic Countries – 36 cases*. Centre for Facilities Management – Realdania Research.
- Jensen, P.A., van der Voordt, T., Coenen, C, von Felten, D, Lindholm, A.-L., Nielsen, S.B., Riratanaphong, C and Schmid, M. (2010), *The Added Value of FM: Different Research Perspectives*, EFMC2010, 1-2 June 2010, Madrid.
- Joroff, M., Louargand, M., Lambert, S. and Becker, F. (1993), *Strategic Management of the Fifth Resource: Corporate Real Estate*, Corporate Real Estate 2000 Series report number 49, IDRC.

Kaplan, R.S. and Norton, D.P. (2000), Having Trouble with Your Strategy? Then Map It. *Harvard Business Review*, September-October 2000.

Lindholm, A.-L. (2008), "A constructive study on creating core business relevant CREM strategy and performance measures.", *Facilities*, Vol. 26, No. 7/8, pp. 343-358.

Møllebjerg, L. (2009), "Facility Management Value Add", Presentation at Business Conference of EFMC2009, 16-18 June 2009, Amsterdam.

De Vries, J., de Jonge, H. and van der Voordt, D.J.M. (2008), "Impact of real estate interventions on organisational performance", *Journal of Corporate Real Estate*, Vol. 10, No. 3, 2008

## Session 4 - Case Studies in FM

Prof. Dr. Igal M. Shohet<sup>1</sup> & Prof. Dr. Silvio Burratino Melhado<sup>2</sup>

<sup>1</sup>Ben Gurion University - Beer Sheva/Israel

<sup>2</sup>EPUSP Escola Politécnica, University of São Paulo - São Paulo/Brazil

<b>Samarco Mineração S.A. Case Study: a contract management tool applied to facilities</b>	<b>231</b>
PEREIRA, Monick Porto; RICARDO, Sergio; TOLEDO, Antonio; MERIGUETI, Fabio Samarco Mineração S/A	
<b>The Influence of the Structure and Work Organization on service Delivery: A Case Study in Facilities Services</b>	<b>243</b>
JUNGMAN, Milton Accenture, Brazil	
<b>Facilities Management in Industries and the Master Service Catalogue as a tool to achieve a positive user experience</b>	<b>255</b>
CAMPOS, Mauro Sérgio Kyriazi Escola Politécnica da Universidade de São Paulo	
<b>ICT initiatives in primary education: the case of Plan Ceibal in Uruguay</b>	<b>267</b>
ÇARDELLINO, Paula ; LEIRINGER, Roine <sup>2</sup> <sup>1</sup> Facultad de Arquitectura, Universidad ORT, Montevideo, Uruguay <sup>2</sup> Construction Management, Chalmers University of Technology, Gothenburg, Sweden	
<b>A survey of Information Technology Applications in Palestine</b>	<b>281</b>
ENSHASSI, Adnan; ABED, Kaerm School of Civil Engineering, IUG, Palestine	
<b>Implementation of a quality management system in architecture offices: case studies at Rio de Janeiro</b>	<b>295</b>
SALGADO, Mônica Santos Federal University of Rio de Janeiro	



## **Samarco Mineração S.A. Case Study: a contract management tool applied to facilities**

**Monick Porto Pereira**  
Samarco Mineração S/A  
monick.porto@samarco.com

**Sérgio Ricardo Cruz**  
Samarco Mineração S/A  
sricardo@samarco.com

### **Abstract**

This paper aims at presenting the evolution of the contract management tools applied to facilities. The ERPs do not focus specifically towards controlling the services related to infrastructure, which demands the acquisition of parallel software, which in its turn leads to an increase in costs and difficulties in integration. In order to maximize the use of ERP SAP the PM module has been adapted to the necessities of the Facilities Management, which guarantees the synchronism and the reliability of the given information without increasing the costs.

**Keywords:** Management, Maximizing, Facilities, Costs, Control, SAP.

# 1. Introduction

Throughout the last few years Samarco Mineração S.A has been going through a continuous growth process. Due to technological advances and the expansion of the industrial units the volume of the operational routines has increased significantly. The dynamics of the processes made it necessary for the supporting areas to adapt, in order to cope with the amount of demands. In the absence of a computerized solution to the shared services management, the company used to be exposed to audits and thus risked losing financial control, which might lead to contractual finings and re-working.

## 2. Methodology

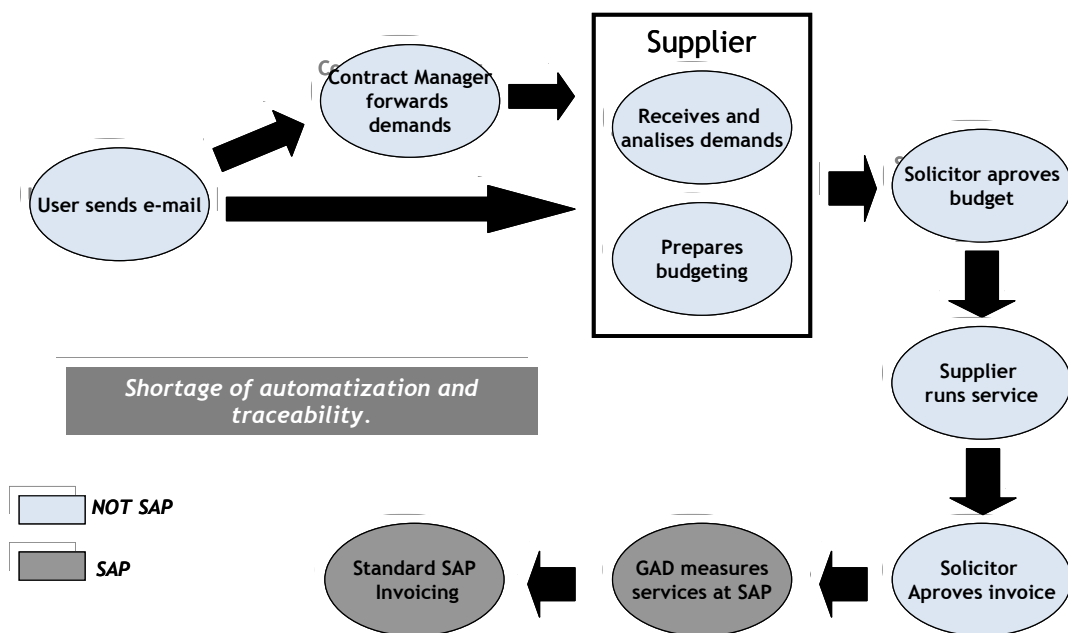
### 2.1 Mapping the client’s necessities

Seeking Excellence in management is one of the strategic aims of the company and the High Administration has perceived some possibilities for improvement. The model-process referred to Maintenance and Civil Conservation, performed upon request, which presented a great number of control data, thus being the main opportunity for improvement in the administrative management area.

Sotille, Menezes, Xavier and Pereira (2007) say that “in the world of business and of fast changes in which we live in nowadays, one must create patterns, techniques and tools in order to obtain results in a quick and efficient way.” (p.20)

There used not to be a centralizing channel to receive the internal client’s demands which used to cause loss of information, delay in services and client’s dissatisfaction. The demands used to be sent via e-mail or telephone, which used to cause serious problems related to filing and treating/sorting out information.

During the service, all the target control, deadlines, costs and quality control used to be made manually, which made the service level control and the tracking of the process difficult, according to picture no.1 below:



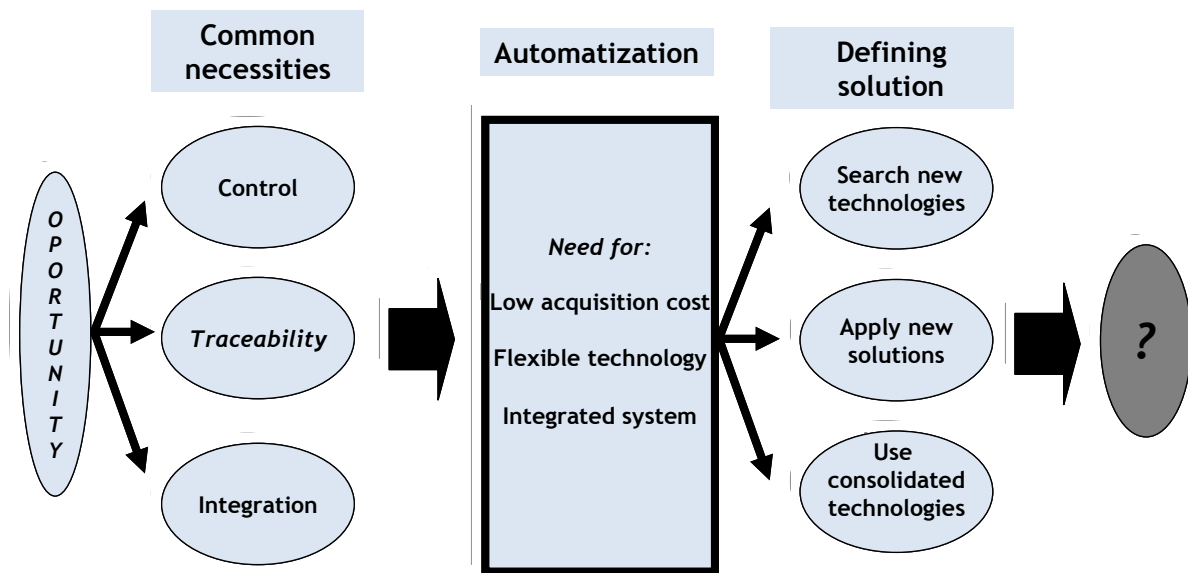
**Picture no.1: Process of Requiring Services at Civil Maintenance before the use of technology**



### 2.2 Searching alternative solutions

In order to find solutions that might solve the shortage between client’s necessities and the model in use, some benchmarking was initially used in other companies that already had implanted technological systems. To do so, the administrative process flux, the good management practices and the contract control were analyzed. About the identification of the adequate tool for the process (picture no.2) one has observed that few companies used an ERP (Enterprise Resource Planning) similar to SAP, a tool that has been used by Samarco since 2003, which should take this new demand.

After that, the analysis of the collected data began; considering the use of a Servicedesk for reception, sorting out and treatment of users’ demands. Another option would be the development or acquisition of a totally new and specific system for this need. However, these options were not validated, due to high costs and deadlines involved, besides a lack of integration with the company’s ERP.



Picture no. 2: Identification of the adequate tool

### 2.3 Definition for SAP solution

After assessing the existing alternatives, the ERP SAP’s module PM already used by the company, as Picture no.3 shows, was chosen to continue being used. This solution might present low need for investments, once the necessary software was available and the main user already had license and knowledge about the tool.<sup>1</sup>

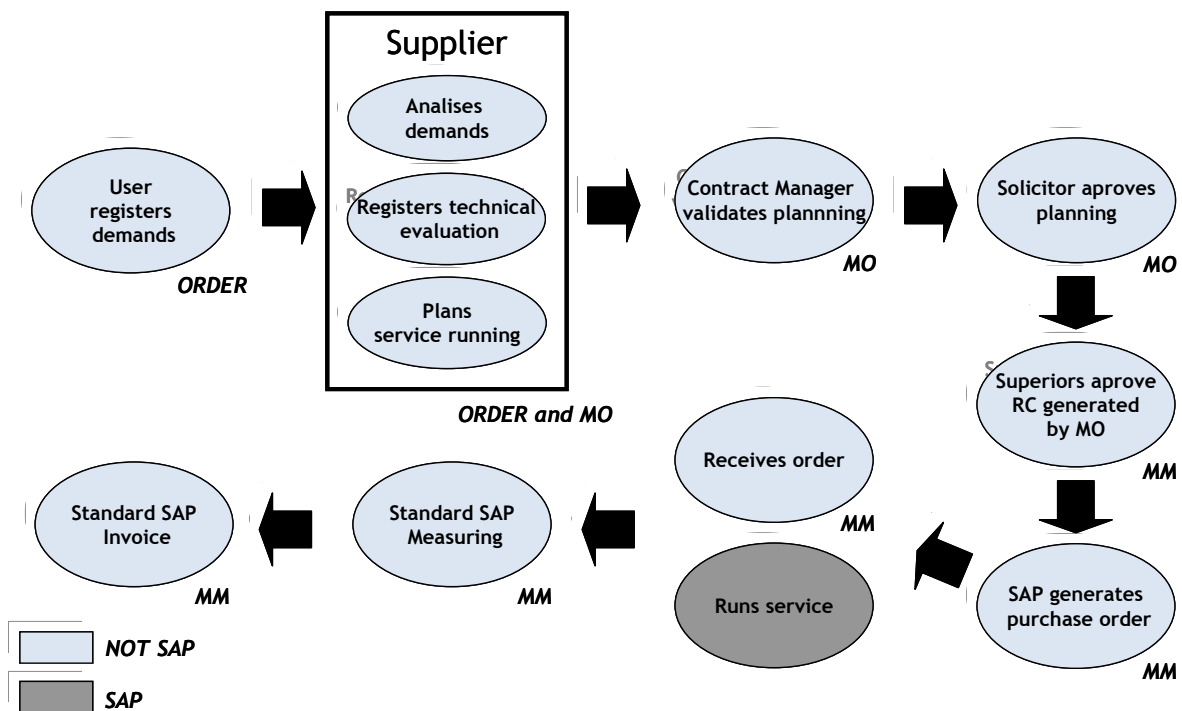
The entire standardization realized in ERP SAP version ECC 6.0 was performed by crew technically trained by means of official SAP courses mentioned in this paper.

<sup>1</sup> The model of the business which was standardized in SAP was based on Unit 5 (Corrective Maintenance) from the SAP support and training manual “Business Process in Plant Maintenance” – Course SAP PLM300 6.0.

## 2.4 Integrating other SAP modules

SAP is a system that offers information processing on real time at the company. Due to its easy configuration it becomes compatible with all the segments, generating integration among the SAP modules themselves. Thus, there is a smaller possibility of communication breakdown occurrences, which speeds up the entire process.

In the solution mentioned, one can perceive the integration between the Financial, Supply and Maintenance modules by means of soliciting for a service to its conclusion, including measuring and invoiced revenues.



Picture no 3: Currently used process of Requiring Services at Civil Maintenance

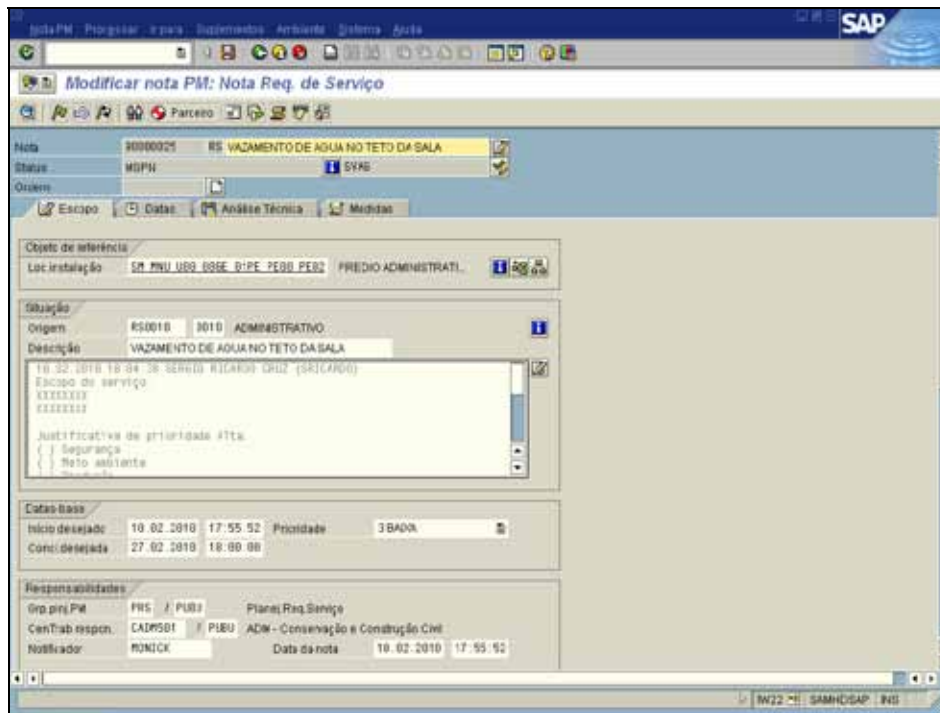
## 3. Results

### 3.1 The process of developing the solution

By observing the similarity of the Maintenance processes (Mechanic, Electrical and Instrumentation) with the Facilities Management process, the professionals of the Maintenance and Information Technology areas were invited to acknowledge the needs of the shared services area.

The Maintenance and Civil Conservation service was used as a model, by means of the PM (Plant Maintenance) SAP module.

In order to receive the demands there has been defined a single channel that contemplates sorting out and treatment by using Technical Orders. The solicitor opens the order at SAP and informs place, service target, debt site and desired date for a visit, as seen on picture no. 4 <sup>2</sup>

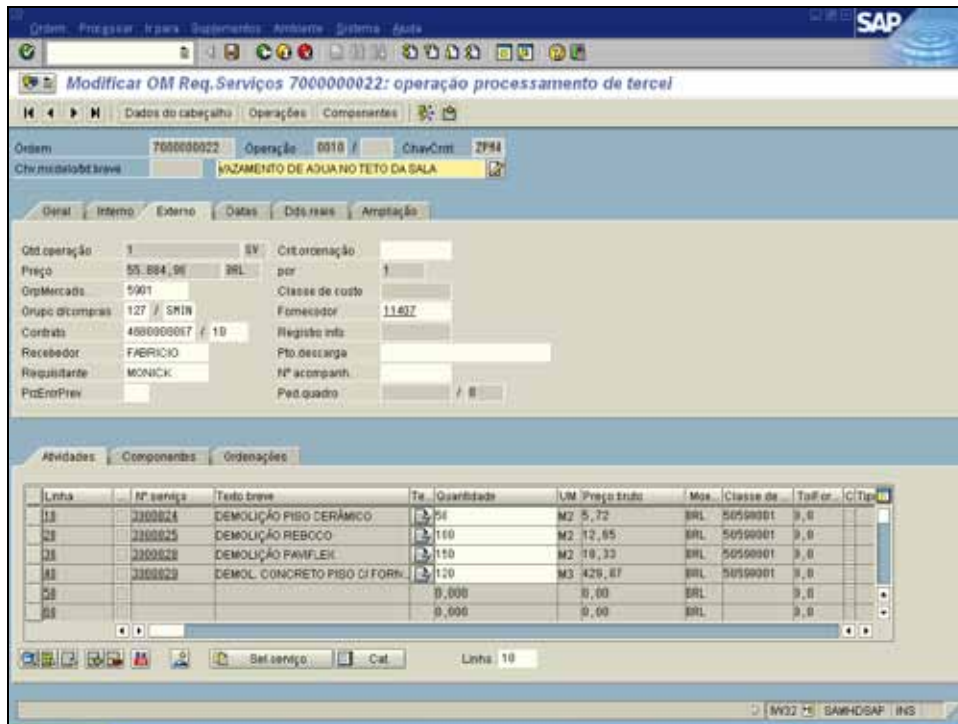


*Picture no.4: Initial screen of a Technical Order*

- The demands are treated by the contracted company, which is responsible for the register of all the technical information of the service Order. Service planning is based on contract and it is not possible for the contracted company to alter the pre-defined prices thus this information being registered at the Maintenance Order, as shown in picture no.5: <sup>3</sup>

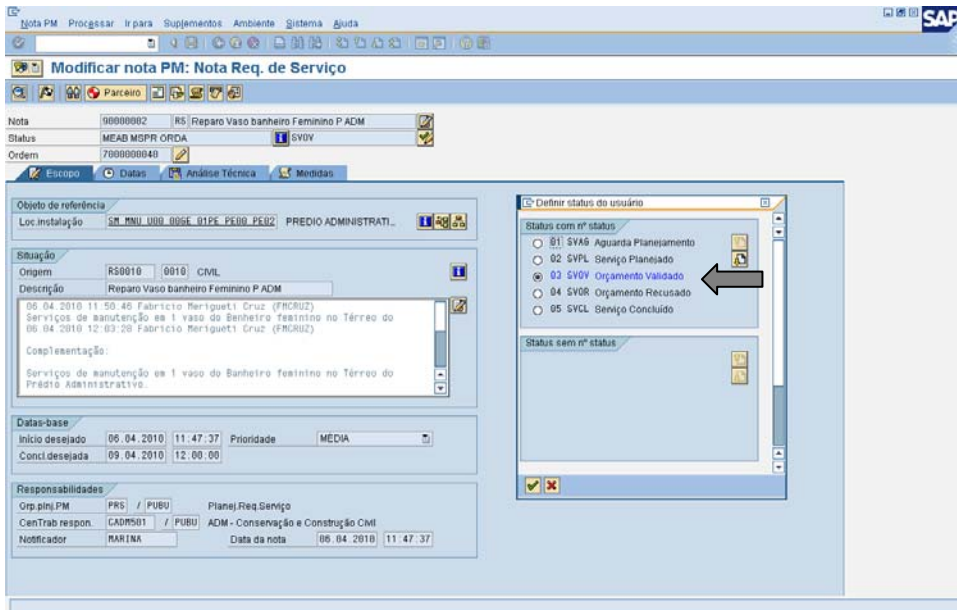
<sup>2</sup> The configuration of this business model in SAP was based on Unit 1 (Setting Up a Notification Type) from the SAP support and training manual “Maintenance Processing: Operating Functions” – Course SAP PLM315 6.0.

<sup>3</sup> The configuration of this business model was based on Unit 2 from the SAP support and training manual “Maintenance Processing: Operating Functions” – Course SAP PLM315 6.0.



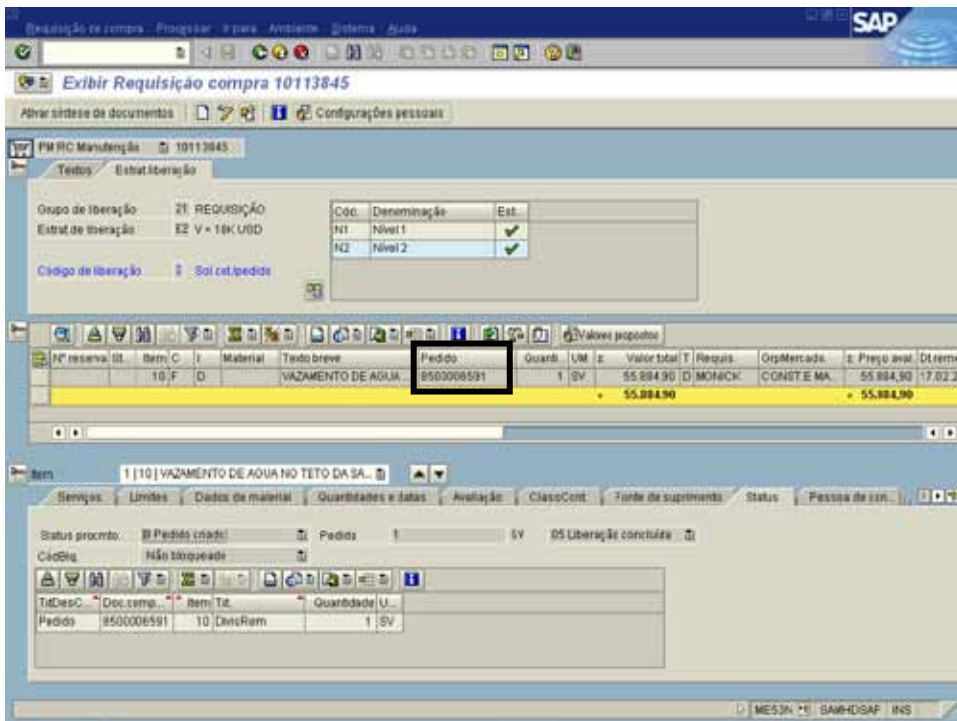
*Picture no.5: Initial Screen of a Maintenance Order*

- ➔ The approval is made by the solicitor, who liberates the Order only after the validation of the Contract Manager. Purchase Requisitions are generated, which must be approved by the solicitor's Immediate Superiors, as evidenced in picture 6.



Picture no.6: Contract Manager’s Approval Screen

- ➔ After the approval of the Purchase Order, where the levels of approval vary according to the cost of the service, SAP automatically generates a buy order which is sent to the supplier, who is authorized to execute the service as shown in picture no.7



Picture no.7: Purchase Requisition and Purchase Order Screen.

- ➔ After validating the service, one realizes the measure based on Purchase Order and the invoice is registered accounting all the orders concluded and validated within the pre-defined period.
- ➔ Throughout the entire process the Solicitor, the Contracting company and the Contract manager receive e-mail communication about the development of the demand, based on the situation registered on the Order, as picture no.8 shows:

<b>Order</b>	000090000135
<b>Description:</b>	Unclogging toilets from PU1 modules
<b>Creation Date:</b>	29.04.2010
<b>Creator Name:</b>	PSTRUTZ-PIETRA STRUTZ MULLER

<b>System's Active Status:</b>	
MSPN	Pending Message

<b>User's Active Status:</b>	
SVAG	Awaiting Planning

<b>Order's detailed text:</b>
<p>* 29.04.2010 09:07:03 PIETRA STRUTZ MULLER (PSTRUTZ)</p> <p>*Service Target:</p> <p>* Unclog toilets and check if flushes need maintenance.</p> <p>* Sanitary modules located for PU1-extra.</p> <p>* Installed near ventilator 1 and ventilator 2.</p> <p>* Justifying high priority: Mill 1 Station extra</p> <p>* ( ) Security</p> <p>* ( ) Environment</p> <p>* ( ) Production</p> <p>* (x) Others – Detailing: Health and Hyene of contracted employees to work at Mill 1</p> <p>* Solicitor: Pietra Ramal: 9192</p> <p>* Department: Maintenance Engineering</p> <p>* Cost Center: 12203010</p>

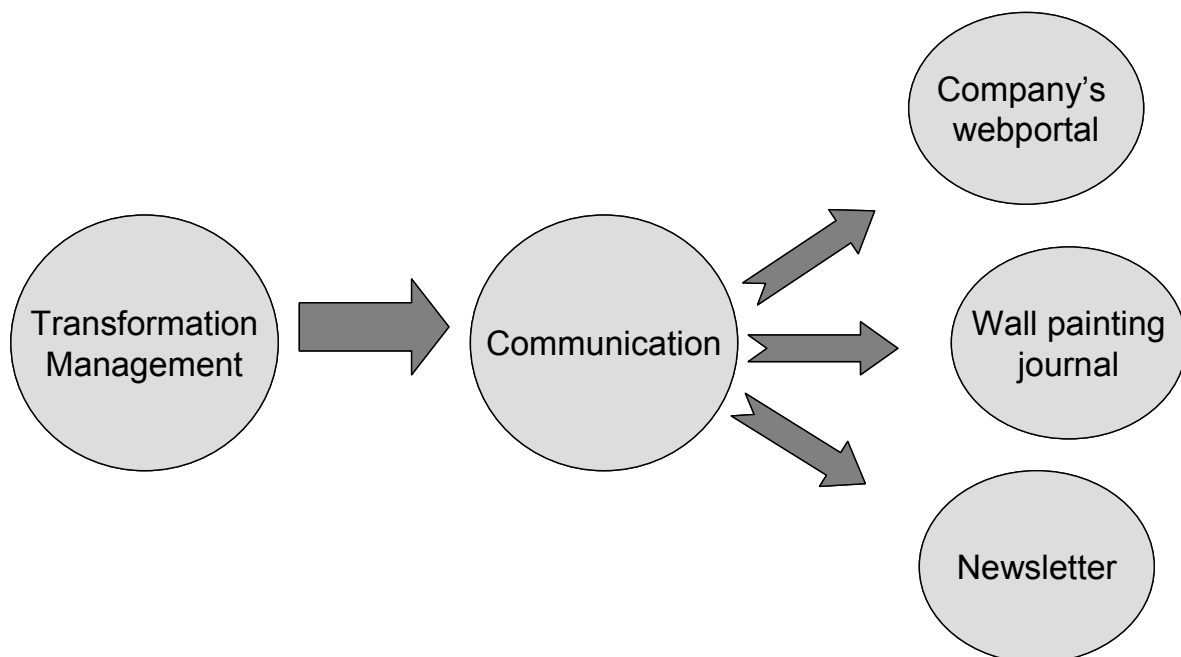
*Picture no.8: E-mail format sent by SAP*

## 4. The Transformation Management Process (Communication and Training)

The entire process of communication and training was supervised by the Transformation Management team. There have been group presentations, from personalized communication with High Administration and the Solicitors to the mass communication channels such as internal communication newspapers and Intranet to the technical-operational group's knowledge, as one can see on Picture no.9;

Chaves, Neto, Pech and Carneiro (2007) define that “projects are performed by people who make use of communication in order to realize the way in which they must perform tasks and accomplish objectives established by these projects. Thus, communication makes use of exchanging and sharing resources which are capable of promoting mutual comprehension, an essential element in the management of any project.” (p.17-18)

At least one representative of each administrative or operational building from Germano (MG) and Ponta Ubu (ES) has been trained, so that all areas would be covered by the solution.



*Picture no.9: Internal Communication Process*

## 5. Development Conclusions for future services

### 5.1 Among the mapped benefits, the following can be mentioned:

Gains in the management process of user areas demands:

- ➔ Supporting future audits, this being due to the reliability and traceability of all the process of coping with the demand, from solicitation to invoicing.
- ➔ Demands monitored by the solicitor itself with step-by-step supervision of each process's phase situation including register of the responsible people, dates and modification historic.

- ➔ Registering necessary information for future cost analysis and appliance form of resources by area, by service modality, by type of attendance, by time consumed.
- ➔ Information about performed attendance in order to control the Service Level (SLA) of the contracted companies aiming the treatment of those which under-performed or the awarding of the superior performances.

Using ERP SAP as an integrated shared services management tool optimizing a technology resource which is already existent and licensed in the company.

- ➔ Using the SAP-PM module (Maintenance) through demand registering of user areas in Technical Orders and planning of the attendance in the Service Orders.
- ➔ Integration of the SAP-MM module (Supplies) through the automatic creation of Purchase Requisitions, Purchase Orders based in contracts and Measuring of services based on purchase orders.
- ➔ Integration with the SAP-FI module (Finances) through the Invoicing as referred in the performed measuring

Extension of the model adopted in Maintenance and Civil Conservation in other processes of facilities with low effort and cost:

- ➔ Administrative cleaning,
- ➔ Maintenance of Green Areas,
- ➔ Patrimonial Security,
- ➔ Crew Transportation,
- ➔ Light Vehicles, among others.



## References

Chaves Lúcio, Neto Fernando, Pech Gerson and Carneiro Margareth (2007) “Gerenciamento da comunicação em projetos”. Editora FGV

Sotille Mauro, Menezes Luís César, Xavier Luiz Fernando and Pereira Mário (2007) “Gerenciamento do escopo em projetos”. Editora FGV

Junior Isnard, Cierco Agliberto, Rocha Alexandre, Mota Edmarson, Leusin Sérgio (2006) “Gestão da qualidade”. Editora FGV

Turner, J. Rodney. The Handbook of Project-Based Management [O guia de gerenciamento baseado em projetos]. Nova York: McGraw-Hill, 1992.

SAP AG. Business Process in Plant Maintenance – Participant Handbook Course PLM300 6.0 – 2006

SAP AG. Maintenance Processing: Operational Functions - Participant Handbook Course PLM315 6.0 – 2006



# The Influence of the Structure and Work Organization on Service Delivery: A Case Study in Facilities Services

**Milton Jungman**  
Accenture, Brazil  
milton.jungman@accenture.com

## Abstract

The decentralized operation of services has its own particular characteristics. Such characteristics have received little attention in literature, especially regarding the way in which some organizational elements relate to each other: work organization, structure, technology, and strategy. It is clear that, regarding work organization, literature has focused on the issue of autonomy in the industrial sector – specifically, past and recent studies have addressed the role factory employees' play in industry. However, there is still a lack of discussion of autonomy related to the performance of both the managerial level of employees and service organization employees. For a corporation to guarantee a successful and high quality delivery of its services, it must thoroughly analyze and understand the behavior of its front-office employees. This study investigates work organizations, the autonomy of the managerial level employee, the possible organization structures available and the ways in which the manager's behavior can be significant when it comes to the client's final perception of quality. The research adopts a case-study of a company whose core business is building management. It was verified that there are many beneficial outcomes for the company that invests in the autonomy of its front-office employees – which in fact is the studied company's strategic position. Nevertheless, the choice of the appropriate organizational structure should be the subject matter of further studies. The main implementation problem of the new organizational model in the case-study lies in the technology, the structure and the work organization particular to that case.

**Keywords:** work organization; building management; services

## 1. Introduction

The article that follows is based on the mastership paper presented to the Production Engineering Department of the University of São Paulo (Jungman, 2000). It is a case study developed in a company specialized in building and facilities management in Brazil. The study focused on analyzing the relationship of front line employees demands and the company structure organization.

## 2. Objectives

A large part of the types of existing services has as one of its main features the fact that they are supplied in direct contact with the customer (Silva, 1995). The meeting between the customer and the employee responsible for supplying the services in the frontline is a core and critical point for the final result of the service supplied. Due to its importance, this meeting is named in the literature as “moment of the truth”, according to Correa and Gianesi, (1994), (HESKETT, et al. 1994). Thus, it can be surely asserted that the customer’s point of contact, that is, the frontline employee, is a figure of extreme importance in certain services organizations.

The supplying of the services may take place directly at the company’s facilities (a restaurant, a hospital) as well as through advanced sites (or branch) of the company itself, occasionally organized as smaller cells of the company. This form of decentralized services operation has several peculiarities, since there is a physical distance between the place where the contact with the customer takes place and the place where the core of the organization generating the service is located. Due to such distance, the frontline employee needs to control this advanced operation site, most of the times taking decisions without the presence of a senior representative of the company’s central staff. Thus, he could potentially be acting independently.

The logic analysis by which such employee interacts with the customer and with the central organization, the way the central organization is structured to interact with him and how the frontline employee organizes his staff involve matters related to the study of employees’ autonomy of an organization, which study is relevant for the subject of work organization, studying the way the employee – key for success of a service operation interacts with his peers, with his own company and mainly with the customer, who is the one finally evaluating the quality of the company’s service.

Due to the relevance of the frontline employee’s and his staff’s acting with the customer, his acting in the service operation influences directly with the company’s strategy and vice-versa. Thus, the relation between the way such employee acts and the company’s strategy, as well as the relation of such aspects with other important components of the organizations – such as the company’s structure and technological operations base -, are the points of interest of this work. To generate elements of analysis of the points above, a research in the way of case study has been developed in a company specialized in building management. As this type of service is still little studied in Brazil, some of the frontline acting employee’s characteristics of such

organizations have been also examined, which characteristics are critical factors for the success of the operation of such service.

Thus, some questions being posed for such analysis were: Is autonomy important in this type of organization? Is it a strategic decision of the company? How should the company be organized to provide the maximum productivity of such employee and, accordingly, quality for the customer? How are or should be the interactions between the main parties comprising the organization (starting with the interaction between the frontline employee and the customer)? How does the interaction among some important organization's magnitudes take place – such as its work organization -, the structure, and strategy and company's technology?

The purpose of this research was to examine such questions in details, trying to contribute with some advancements for the discussion of solutions providing efficient structures to this type of organization, with personnel ordered in a way to supply services of quality perceivable to different customers, in the several service “delivery sites” (both referring to the organization of services generally and to the aforementioned characteristics, and more specifically for building management companies, which is the case studied in this paper).

The work organization, the issue of autonomy of this type of employee, the organizational structures liable to being chosen by the company are approached, and in which manner the building manager's action is a determining factor for the perception of the final quality felt by the customer. The manager is responsible for both: customer's service and managing the building management staff. The frontline employee is a core figure in this research “Building Manager” or “BM”). In Brazil, this type of professional is a novelty and, as any frontline employee in a service organization, it is a critical factor for the success in the building management sector (Quinn, (1996).

Commercial building management service companies (offices, shopping malls and industries) have important organizational characteristics to be studied, such as the fact that they are service companies, established in a decentralized manner, which generates the decision-making with the customer away from the central structure, in addition to also having characteristics typical of an organization.

The case study examines a company with the characteristics above. This company has as one of the strategic purposes to offer solutions more comprehensive than those provided by a conventional building management company (in case of Brazil and Latin America), presenting an array of services that would provide with the maximum comfort in its broad meaning, that is, a work environment (infrastructure of equipment and services) with high productive conditions to occupants and owners. It is observed in the work that the frontline service assistant, in the case under study, is the service manager himself. This brings challenges to his work, since he needs to perform two functions – manager and front line employee - almost simultaneously.

To accomplish the objectives proposed for this paper, a bibliographic revision of the literature related to the service organizations was carried out at first. Then, after a study of case in a building management company was made, in which problems and solutions related to the

questions raised in the referring chapter are examined, and, based on the concepts found in such bibliographic revision, the adherence (or not) of the practical case with the concepts initially raised could be verified.

### **3. Metodology**

A case study research was carried out. A research problem that came up was related to the data (number of cases) available, as it is an innovative activity in Brazil. Therefore, the case study in which there are observations based on the author's personal experience were used as a data source, which had been supported by the data from interview with frontline and supporting employees, as well as with the company's customers.

Thus, first the identification of the problem was attempted. Once the problem was identified, a revision of the literature about the concepts of interest for the study of the problem presented was carried out. Then the case was observed; this phase had been facilitated very much due to the fact that the author already had a lot of the company's historic information, as he has been working with the company since its establishment in Brazil. In order to bring new information, interviews with the company's customers and employees were made. They brought external data and new perspective to the analysis, leading to important conclusions for the paper.

This paper was not intended to reach final conclusions, but instead to point out some ways to solution, and tried to contribute to a depth in the study of a theory on this service management modality.

### **4. Case Study Conclusions**

One of the first conclusions that can be drawn about the case studied is that there is a close relationship between the organizational model adopted by the company and identified in this research, to accomplish the quality of services expected by the customers, and the way the customer expects to be serviced by the company. This conclusion can be drawn from the interviews made with the company's customers, by crossing them with the bibliographic analysis and revisions made.

This is true for the four main aspects of the organization examined in this work: the company's operational strategy, its technology, its structure and the frontline employees' work organization. On the other hand it can also be concluded, by the same interviews, that although the company's model is close to its customers' desire, problems with implementing this model are taking place, with respect to making this model actually satisfy the customer in its daily interaction with the company. The main conclusions that can be drawn with regard to the benefits and problems of the company's organizational model studied are described below.

1) The company's operating strategy is recognized by the customers as correct, that is, focusing on their necessities.

2) Another almost unanimous, positive answer was related to the technology. Practically all the customers interviewed recognize that the data and communications are presented in a structured manner, which suggests the existence of information technology handling such data, as well as training to parameterize the communication and the organization, characteristics referring to the company's technology.

The issues pointed out by the customers as being the faultiest ones refer to human and subjective aspects of the organization. The criticisms were focused on aspects referring to the BM's acting manner (autonomy, work organization), the feeling that the customer has about the way the company is organized to service him, and the structure (the customers pointed out that they are in contact with other interlocutors of the company besides the BM).

3) With regard to the acting and organization of the frontline manager's work (BM), it was found that there are benefits in providing him with work autonomy. This conclusion was reached from the analysis based on the literature researched, confronting the concepts with the reality found in the case through interviews carried out as well.

There is autonomy in this organization, since it is a necessity, and not an option of the company's management style. It is part of the company's operations strategy so as to service the customer quickly, with service quality and consistence.

First, due to a physical matter, the presence of a management staff in each building is necessary, thus generating a decentralization of the staff. This physical dispersion and the customers' demand for flexibility and promptness lead to the necessity for decisions to be taken directly by the BM quickly and with a customized service for the customer (due to a very close coexistence with him). This situation requires a vertical and horizontal decentralization of the decision making process.

Then the problems and solutions resulting from the adoption of autonomy as a way of work organization were analyzed.

With respect to the dilemmas found in the case study, one of the main ones is the interaction between the BM and the central organization. This dynamics has a number of characteristics that, on one side are due to the fact that the BM "lives" practically in the customer's "house", thus creating a very strong bond bringing some important developments, and, on the other side, to the fact that the interaction with some areas of the company's staff has different facets, since he acts both as a support or as a supervisor of his work. Because of these relationships "duality" (which is one of the characteristics of forms of matrix-type interconnection), the setting of clear rules is the critical point for the success of the operation studied.

With regard to the relationship between the BM and the client, it was found that the loyalty and reliance are relevant aspects highlighted in the paper. In this relationship, the relevance of formalizing the information exchanged between them was emphasized and, where possible, it is to be based on parameterized data, due to the level of these services intangibility. Such formalization strengthens the bond of loyalty, since it minimizes the likelihood of disagreement

regarding the information and operational decisions taken. The existence of loyalty is a positive aspect for the success of the service, as emphasized by the literature (Bowen, 1992).

Some important points are verified in the BM and the staff relationship. First, it was found that the company's central organization (staff) works playing a double role (supporting the frontline and, at the same time, playing the role of expert-supervisor).

Then the acting of the staff as expert in addition to its traditional function of supporting and inspecting was discussed in depth. It was stressed out the necessity for the BM, to accept this type of interference, despite his autonomy, since it is a technical character, and does not take the managerial authority from the BM over the process, which is the typical interconnection relation being established in a matrix structure and that requires care and maturity in this relationship.

Within the studies of autonomy and relationships that the BM experiences in his daily routine, some types of relationships being established in the frontline, through a model proposed by BOWEN et al. (1992) were studied, which analyzes the relations under a prism of several contingencies. By this analysis it was concluded that the BM acts in parallel through two different types of autonomy. In one of these different acting's he receives (from the company's staff) the encouragement of autonomy and in the other he is the one promoting the autonomy (of his employees in the building).

It was verified, from the interviews made with the BM's, a tendency of their recognition in their own building staff of the need for existing a work organization where there can be autonomy, almost on the same level of that the BM's themselves receive (or should receive) from the central organization. This is an important and positive finding towards his turning his staff into an organization and he being supported by it in order to act as a real manager of a business unit and also being able to focus more on servicing the customer than on controlling his own staff, which is how the company under study intends to see his frontline employee. This is also an important difference between the BM and his peer in the hotel industry – to perform the service and interact with the customer while managing his staff.

Another interesting observation is that the company's board of directors evaluated, in the application of the contingencies table from the model of BOWEN and LAWLER III (1992), a very restricted autonomy (production line) for the interaction between the BM and his staff. The contrast of this answer with the interview made with the BM's themselves shows that the company's board may be underestimating the capacity of them preparing better their own staff for a work of more initiative, autonomy and, thus, of major benefits for the final customers.

Still with regard to the GP's autonomy, the customers indicated, mainly in the interviews made, that they miss the power of decision on the part of the BM. After analyzing these issues, it was suggested that the solutions for the matter undergo the points below:

More training to the BM's.



More suitability of some BM’s for the function.

Better internal promotion of the company’s performance, as well as the award policies based on the action and performance of the company and of the buildings as business units.

More enhancement of the team spirit between the BM’s – team work.

Clearer definition, on the part of the company, about the limit of the BM’s specific action in relation to his autonomy in the different situations he comes across in this operational routine.

As a tool to facilitate the implantation of the last solution referred to above, the table below was suggested in this paper, which attempts to provide guidelines for the establishment of the BM’s acting limits using a definition by BOWEN and LAWLER III (1992) with concepts for different levels of autonomy to be applied to three typical operational situations. The criteria adopted to create such table, that includes the GP’s and experts’ suggestions, have as prerequisite that the limit of action adopted always has in view the major final benefit to the customer in the manner of service.

*Table - AUTONOMOUS ACTING LEVELS*

*Source: prepared by the author.*

<i>INVOLVEMENT GUIDELINE</i>	<i>SITUATION IN THE COMPANY UNDER STUDY</i>
<i>Highly involved</i>	<i>Daily operational actions, expected and adherent to the company’s procedures, formalized through manuals and training. Example: cleaning complaints, air-conditioner settings, reception problems.</i>
<i>Involvement in work</i>	<i>Emergency actions even if not adherent to the company’s procedures, but which do not involve vital aspects of the building. Example: hydraulic pipe breakage – need of immediate action.</i>
<i>Involvement by suggestions</i>	<i>Actions depending on additional nonusual technical decisions involving vital aspects of the building. Example: replacement of an important component of the central air conditioner system.</i>

Implementing this table may be an important contribution so as to better clarify the limits and responsibilities of the BM and the staff and experts generally, but additional solutions related to the company’s structure are also necessary, such as:

The issue regarding the company’s structure is also a point that should continue to be a reason for attention and care, due to its very nature, since it is a hybrid model of reversed structure and professional bureaucracy, with elements of interconnection of a matrix structure. Each one of the three concepts comprising the model, individually, is indeed of difficult implementation. A

model where all these concepts are present also tends to be complex, thus requiring maturity on the part of the company's employees and the organization itself.

Training and disclosure for the company generally on how it is defined and how the company's structure is supposed to act (back-office, mainly), or of the business unit:

4) Another important point emphasized in the BM's action and which differentiates him from the other types of frontline employees is that, save for exceptions, the motivation for his work comes mainly from inside the company. This is due to the work features, which causes the results to be little noticed by the customer, justifying the demand perceived in the company studied of having a relevant focus on the motivation.

5) With regard to the organization of the company itself and its strategy, it has been noticed that the service of building management studied, though strongly rooted in procedures, technology and in well outlined organizational structure, where it is seen as outsourcing solution, it still is a lot dependent on a strong understanding of the way the customer acts and the suitability for this way of acting. Additionally, in the Brazilian market reality, a process of client's "education" on the concept of professional building management is still needed, in order for him to perceive an added value to the services he receives.

6) With regard to the consistence of the services, it has been concluded that this is demanded by the customers. It has been noticed in the case under study that it is still an important challenge to obtain, despite the intense training, an efficient binomium in order for a BM to perform his functions with a high level of autonomy and creativity, keeping high consistence of services to the customers.

## 5. General Conclusions

The following conclusions have been obtained in this paper:

1) As mentioned in the case conclusions chapter, one of the main conclusions that can be reached for the studied case is that, after the theoretical analysis and the interviews carried out with the company's customers and employees, the model adopted for the nexus of the studied company's organization is compatible with the quality of services expected by the costumers. Several important aspects of this model are detailed in the case conclusions.

On the other hand, another important issue expressed by the customers that deserved an in-depth study is that, although the customers have spoken of the model as being a correct one, they have also expressed clearly several frustrations regarding the service received, which denotes that the identification of a correct service model is necessary, but not enough to satisfy a customer. The big challenge left is, once the model is identified, to implement it correctly.

By the study carried out, one can conclude that the main implementation challenges are generally within the sphere of the elements of technology, work structure and organization.

Once defined, the company's strategy, delegates to the other elements the task of pursuing it correctly, thus promoting the services quality.

The implementation of technology requires definition of the correct tools and the resources to install them. In the case studied some tools (training, operation procedure and operation systems) providing a range and a form of information suitable for customers' needs were identified in the company. On the other hand, it is important to emphasize that this is always an important challenge, which can be also evidenced in the company's strategy change phase in which the technology plays a crucial supporting role to render the changes carried out feasible.

The main problems when implementing an organizational model detected in the company studied and which can be generalized are indeed in the company's structure and in the work organization.

2) It has been verified that the company chose to adopt a hybrid form of organization, comprised of characteristics of reversed structure and professional bureaucracy and elements of matrix organization interconnection. The combination of such elements has provided better conditions for the frontline employee to act efficiently supplying services of quality to the client.

On the other hand, implementing such services is a task that still has a number of challenges of organization generally, difficulties that could be pointed out by the researches themselves which were carried out, as seen below:

3) By studying the reversed structure proposal made by the literature, it was observed that such structure is very much interesting in providing the key-employees with motivation and initiative, but:

The literature does not describe in many details how the dynamics of such structure is, by not clarifying how the "power relation" that arises when the frontline employee is assigned the hierarchic pyramid top position can be managed. The fact that the frontline employee is considered the "most important" person within the organization to he belongs to requires from him and from the organization itself a high level of maturity. This is because such employee keeps on reporting to the organization formal responsible persons (medium management or board of directors). Such fact can also be corroborated by the interviews carried out with the employees themselves, who pointed out difficulties of several sorts to exercise such power. It was concluded that the need for balancing the power is one of the most sensitive issues in adopting the "reversed form" of organization.

Some questions posed by the literature with respect to such structure remain open. Quinn (1996) mentions for example that these first line executives' action, in a reversed organization, is not only a trick, and that they are genuinely treated as "bosses" by the rest of the company. The literature does not leave clear how it in fact takes place, nor can it be clarified in the practical study how the company's internal relations are, which are the limits of the power, and even questions of how and by whom their performance evaluation is made.

On the other hand, in this work it was possible to go a little deeper in one analysis of one example of reversed form application, such as the BM relation with the staff, the technology role in the employees' autonomy and other elements such as the expert's action and the search for defining the limits of action between the latter and the BM.

By the case study, it can be also verified that the practical application of this organizational form is complex and it still depends very much on more definitions with regard to the company setting more clearly methods of implementing the autonomy of work in the organization and thus bringing more efficiency into the frontline employees' action. For example, it was attempted to set out practical rules of power limits between the frontline employees and the back-office, but such movements are yet very preliminary as to an effective practical solution for implementing a structure that would provide power to this type of employee.

It can also be suggested that the organizations such as the reversed structure and professional bureaucracy should be better analyzed, discussed and define or that perhaps that there may appear more efficient organizational forms that would promote autonomy and that would solve better the issue of providing autonomy to key-employees of organizations as the one studied. In the case at issue it is also suggested that the matrix structure can bring interesting contributions.

A practical example of application of these types of organizational structures, mentioned by MINTZBERG (1995) is that of regional administrations in a city, in which he references the matrix relation existing between the regional administrator and the heads of the department of the city in charge of the sectors such as cleaning, gardening, works, etc.

4) The BM figure studied is a novelty and lies in the fact that the BM is a professional acting as an assistant, services manager and as a true manager of a business unit (buildings), different from the hotel industry, for example, in which the manager does not play the role of assistant and the assistant is not the staff manager. This combination of roles is very complex, but in the case studied it can be concluded that it is a function that has in the autonomy a distinguishing feature, with power to make decisions, and that is very critical and determining for the organization success.

It was even confirmed in the interviews carried out by the BM's that they have been attempting to provide their staff in the building with a similar form of autonomy relation as that received from the central organization, in a movement that releases him in order for him to better devote to the activity of assisting his customer, strengthening his relationship with him (seeking for the effect of "mirror of satisfaction" (HESKETT, 1997).

This work attempts to set some parameters, or practical rules, to better outline the BM acting limits regarding his autonomy in different situations, and with regard to the other members of the central organization.

Even though practical rules have been prepared in this work, this is a discussion intended to be deepened, as its limits may be defined more clearly, using a better parametrization that can

culminate in the creation of a more complete model of analysis and assignments autonomy levels.

5) Another important characteristic has also been identified that the services manager of the organization studied has and is, for example, different from that of other assistants and managers of services with similar roles mentioned (such as the hotel industry) by the literature researched. The services manager (BM) studied performs a work different from the hotel manager first because his “guest” (customer) is permanent, different from the hotel industry customer that stays only some days in the hotel and does not establish any lasting relationship with the assistant.

6) As mentioned in the case conclusion chapter, in the relationship BM with the staff, one important point is the action of the staff bodies as experts, in addition to their function of supporting and inspecting. The issue involving the figure of the technical arbitrator has been mentioned, but little discussed in the literature examined (only MINTZBERG, 1995) explores this figure a little) with respect to the manner the expert acts in situations similar to the case examined. In this study its action was discussed in more details and it was evidenced that they are very useful figures in the type of decentralized structure that strongly promotes the autonomy of a frontline employee, but such employee is not provided with all the technical knowledge involved in the service process. On the other hand, though the expert, contributes very much to the organizational dynamics, he is a figure having a potentially controversial and disaggregating action, since he occasionally reaches a limit very close to being allowed to question the frontline employee managerial authority (or be so interpreted), it being one of the reasons that it is necessary to define the autonomy limits of the service managers more clearly.

Such a “controversial action” can be evidenced also by the interviews carried out with the BM’s, by finding that the limit of action between the expert and the BM is not clear. As aforementioned, by examining the relations and using the matrix structure concepts, it is possible to find a balanced way of acting, but at first it was clear that, save for rare exceptions, the decision, the final power, should be with the frontline employee.

7) The case studied confirms what the literature asserts about the role of the technology in the autonomy of the frontline employee in the services organizations (according to Quinn (1996): where the technology is an important part of the global solution of services, it can enlarge the capacity of a frontline employee of working with autonomy. This phenomenon is different from the other situations in which the application of technology is restricted to the frontline employee’s action level (such as in a call-center operator), as mentioned by Bowen and Lawler III (1992).

8) With respect to the perspective of study, it was interesting to notice that it occurs from an outsourced services company, which is a new approach in respect to what the researched literature presents, since it discussed more about the outsourcing process itself, instead of the organization in charge of the outsourced services.

Additionally, one of the main discussions and conclusions out of this item is that, on one hand, a great need of a company to quality so as to perceive, understand and know the way of client's actuation to fit his organization and services to his demands and, on the other hand, the need of a company to "educate" the client (who has once already rendered the same services internally), leading him to understand that there are new forms of doing the same thing, and that paradigms can be broken.

9) This "client education" process is interesting. As mentioned in the theoretical part of this paper, an issue to be reminded is the very definition of professional services, which are "those in which the client is usually seeking in the service supplier a qualification he does not have". As we could see, the seeking of said qualification by client many times does not seem too objective, since there is no unanimous acknowledgement in the building management market that there is an additional qualification to be searched.

10) In the case of the building management this can become even more difficult because of the relation of additional Power being established with the customer having the service rendered "at his home".

## References

- Bowen, David E. Lawler III, Edward E., 1992. The Empowerment of Service Workers: What, Why, How and When. Sloan Management Review, Spring 1992, Pg 31 a Pg. 39.
- Correa, Henrique L. Gianesi, Irineu Gustavo N, 1994. Administração Estratégica de Serviços - Operações para a Satisfação do Cliente. São Paulo, Editora Atlas, 1994.
- Heskett, James.; Sasser Jr.; W. Earl & Hart, Christopher W.L., 1994. Serviços revolucionários. São Paulo, Pioneira, 1994.
- Heskett, James, Sasser Jr., W. Earl & Schlesinger, L, 1997. The Service Profit Chain, New York, The Free Press.
- Jungman, Milton, 2000. The influence of the Structure and Work Organization on Service Delivery: A Case Study in Services. Mastership paper, Production Engineering Department of the Polytechnical School, University of São Paulo.
- Mintzberg, Henry (1995). Criando Organizações Eficazes. Estruturas em cinco configurações. São Paulo. Editora Atlas S. A. 1995.
- Quinn, James B. Empresas muito mais inteligentes. Makron Books, 1996.
- Silva Márcia Terra. Organização do Trabalho em Serviços. A questão da autonomia em postos de serviços. Tese de Doutorado - EPUSP. São Paulo, 1995.

# Facilities Management in Industries and the Master Service Catalogue as a tool to achieve a positive user experience

**Mauro Sérgio Kyriazi Campos**

Escola Politécnica da Universidade de São Paulo – MBA Gerenciamento de Facilidades.  
mauro.kyriazi@uol.com.br

## Abstract

The following paper analyzes the Facilities Management in industries and the benefits of having a Master Service Catalogue as a tool to achieve a user experience. Cross functional work between Facilities Management, Finance and Purchasing are presented with the objective to show that a better work can be developed by clarifying responsibilities and expectations using the Catalogue. The Master Service Catalogue is presented in a real case of a Chemical Industry that has a Facility management department organized at a Global level.

Facilities Management is an interdisciplinary field devoted to the creation, maintenance and care of a company's sites, buildings and equipments. In Industries, Facilities Management performs these duties during the total life-cycle of the assets, focusing on improving its support to core business representatives; ensuring design and construction phases of sites/buildings and services are properly informed about technical, operational and human requirements. It aims to do this in a cost-effective manner, compliant with regulations and stakeholder satisfaction.

The methodology applied is to organize the services provided by the Facilities Management department in an Industry under a unique Services Catalogue and to highlight the main aspects that it contains. The work is to prepare a list of topics then to continue filling each topic with the respective activity performed to comply with the requisites of the department. After the first round the Catalogue should be reviewed by external partner to be challenged about missing aspects or wrong classifications.

The present paper is not generalist because it represents a work done for a specific industry but it can be modify or adapted by other to introduce the same idea in the activity of other Facilities Managers. Communication is another highlight of the actual role of Facilities Managers, so it is indispensable tool and must be well developed. The paper will provide a classification to help Facility Managers to communicate better. User Experience in Facilities Management is the next challenge for the managers of today because it is a new paradigm and so, is better if the job can be organized first; the expectative of the stakeholders are aligned with the mission, vision and values of the Facilities Management department. The Master Service Catalogue is one of the start points to better organize the job and to open the path to help Facilities Managers in their day by day routine.

**Keywords:** Facilities Management Service Catalogue, Facilities Management in Industries, User experience in Facilities Management, Communication in Facilities Management

## 1. Introduction - Facilities Management in industries

Facilities Management (FACM) is an interdisciplinary field devoted to the creation, maintenance and care of a company's sites, buildings and equipments. In Industries, Facilities Management performs these duties during the total life-cycle of the assets, focusing on improving its support to core business representatives; ensuring design and construction phases of sites/buildings and services are properly informed about technical, operational and human requirements. It aims to do this in a cost-effective manner, compliant with regulations and stakeholder satisfaction.

Buildings exist because of the people, users or customers. The building should be organized to provide basic conditions so that users can perform their daily functions. These basic requirements, according to ISO 6241 are:

### Security

- Structural
- Against Fire
- As Use

### Habitability

- Leak free
- Hygrothermal Comfort
- Acoustic Comfort
- Visual Comfort
- Tactile Comfort
- Functionality and Adaptability
- Health and Hygiene
- Air Quality

### Sustainability

- Durability
- Maintainability
- Environmental Management

To meet these requirements the department of Facilities Management (FACM) must take part of all the conceptual design of the building, construction phase and, of course, the operational phase that last until the decommissioning (this is called life cycle of the facility). FACM must organize a system to ensure the attendance of routine work, corrective calls,



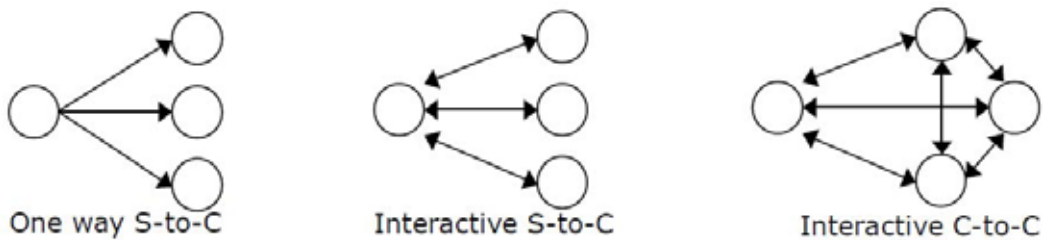
preventive maintenance and a full range of services. In this paper the operational phase will be highlighted in accordance to the title.

This paper will emphasize that the proper implementation of service catalogues can go further, helping FACM run as a business through improved communication, easier access to FACM services, and process of continuous improvement. This paper shows a case of successful service catalogue implementation and illustrates the benefits of service catalogues for user’s experience.

### 1.1 Improved communication in Facilities Management

In many large organizations, the role of FACM function is poorly communicated and hence misunderstood. FACM department often view business users as overly demanding, while users perceive FACM as reactive and defensive. Making the experience more positive to users demands better communication. To better communicate one must first understand how the communication happens in FACM, because there is a direct relationship between communication and satisfaction.

Kokuryo (1997), categorises the communication generally in seller (S) and customer (C) into three types (Fig 1-2):



**-One way S-to-C:** one-way from seller to customers such as, providing product feature and availability.

**-Interactive S-to-C:** interacting between seller and customers such as help desks, and customer service.

**-Interactive C-to-C:** interacting among customers such as reputation and forum on the Internet.

### One way S-to-C

The type of communication is conveying information that facility managers want users to know.

Following are included in this type:

- **Services catalogue:** Explaining what kind of services are provided and what levels they are; such as quality, frequency, or price (cost) all services and level of each services.
- **Campaign:** Trying to make users do some actions in a certain period. For instance, accelerating to use new services just after it has launched.
- **Notice (routine):** Taking attention for some rules, safety, security and others. E.g. the rules of disposal, the place of fire exits, attention to wear ID etc.
- **Notice (occasional):** Informing users some changes and inconvenience at the occasion. For example, stopping some equipment for maintenance, changing place or delivery time of services.
- **FAQ (Frequent Asked Question):** Informing the answer of frequently asked question from users.

### Interactive S-to-C

The type of communication exchange information each other. The type can be categorized into two types; the one is that facility managers initiates it (here it is called outbound), another is that users initiate it. (called inbound).

- **Arrangement (outbound):** Facility manager initiates it for arranging his/her job; such as arranging space allocation, maintenance schedule, or others.
- **Answer to question (inbound):** User asks a question about of services; such as the details of a services, the status of his/her order, or others.
- **Requirement (inbound):** User requires some arrangement for services. For instance, requiring about space allocation, air condition and delivery schedule of a services.
- **Answer to complain (inbound):** Literally, complaining about the services; such as wrong or miss delivery of a service, the quality of a service, or the attitude of staff.

### Interactive C-to-C

The type of communication takes place without facility manager. Users may ask his/her colleagues for the detail of services, or he/she may make a rumor about the services or the facility manager or the staff.

- **Exchange (asking and teaching) information:** Users ask about services to colleagues not to facility services staff.

- **Rumor:** Users talk about bad reputation of facility services.

In this paper we focus on a topic that is the Service Catalogue that will fulfill the mission of communicating S-to-C one way.

## 2. Master Service Catalogue

Of course that having a call center and disclose that number for users in case of trouble or if something is found with dirt or in disagreement with the company image is an absolutely simple and extremely reactive behavior. That certainly will not produce the user confidence in the system. Another option is to perform some routine tasks of preventive maintenance and also rounds of verification, for example, leaving the users the task of communicating events that are not covered by preview activities.

Yet this is not enough to satisfy users who want to find the systems working as close to perfection most of the time. To achieve this state of “user experience” means to build a services catalogue where it is very clear what are the activities embraced by the FACM and thus can be demand by the company and users. The master catalogue is the basis for measuring performance of the department and to be able to format the teams, like as subcontractors, who will perform the activities listed. The master catalogue will also be a basis for discussion of improvements, since if they experience new activities to be carried out by the company is able to confirm whether or not they belong to the department of Facilities Management.

Figure 1 shows that Service Catalogue is part of a system that will manage the Facilities and move it to a superior service level. Talking about service catalogue in industries as a tool to help distinguish between various responsibilities in business areas one can say that at the company level often occurs that a matter is not treated simply because no one knows for sure who is in charge of that subject (accountability). But it is also the serious problem of ill-defined responsibility, where one doesn't have the visibility of the responsibility of others and how the other operates. On several occasions one came across someone of the Facility department asking, "I don't know if this is your job but see if you can help me ..." What is this? Lack of communication from the direction of the company to its employees or lack of clarity in defining accountabilities? Maybe both.

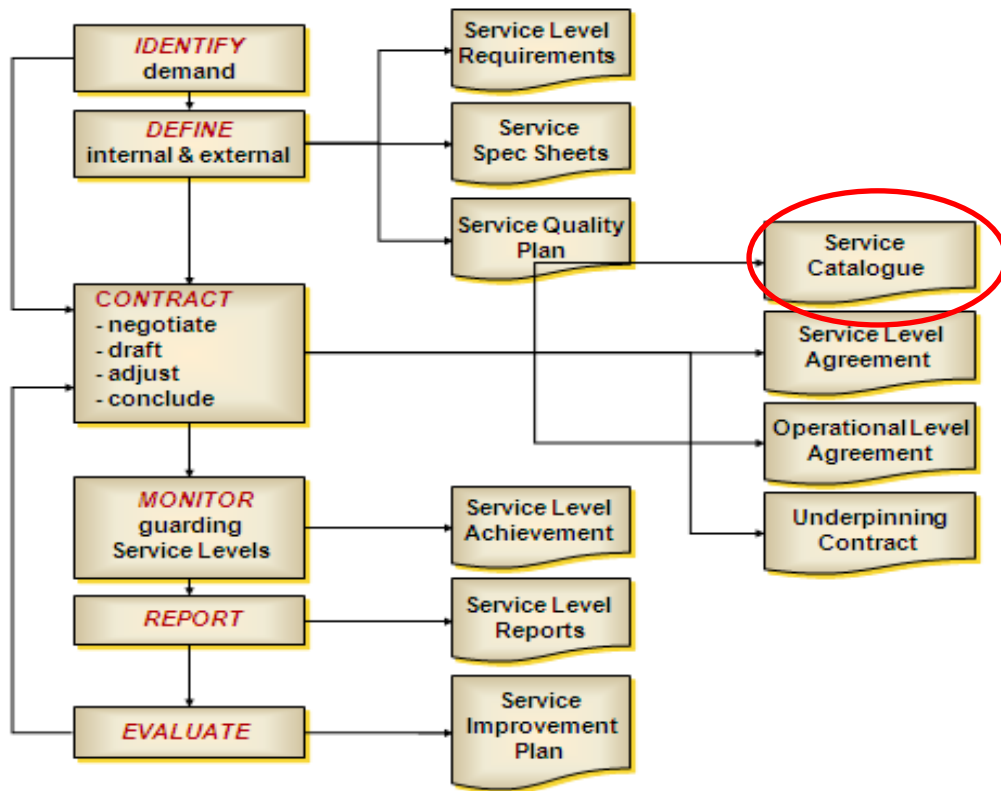


Figure 1 – Service Catalogue – Service Level Management approach for the delivery of Facility Services

When a company wants to improve its communication and benefit everyone with a better workplace environment is very important to first make a good survey of the needs and demands and putting it into a plan, then make a small array of activities versus responsibilities in order to get a clear catalogue of services. In Facility Management, where everything done is geared to the demands of users, not its own, it is imperative to make a correct determination of which activities will be met so that the company can be structured and make available the necessary tools.

To create the master service catalogue, first is necessary to involve the departments of the company at a meeting for exposure the goal (creating a services catalogue). At this meeting the representatives of the departments can expose their expectations. The expectations of users can be grouped by: Quality, Time, Quantity, Scope, Value, etc.

Another thing that representatives should make in this meeting is to present evidence of gaps in the company at that time. It will be the opportunity to say where Facilities department is not present, where it is felt the lack of someone to care for that activity. It is also time to

expose some desires that should be shared with the HR department of the company that differentiates itself and what are the benefits offered by the company (and managed by Facility) and what services are offered by the Department of Facility. That makes all the difference since the benefits offered by the company shall contain clear policies defined by the steering committee and must be managed, where appropriate, by the FACM department, but limited to that. Moreover, services that should be developed by Facility are those that meet the demands of the company classified in at least four areas: Real Estate, Site Maintenance, Site Development and Workplace. Each company may adopt, in its discretion, other divisions, but without losing focus on three core practice areas: People, Property and Information. That's because Facility always have people to be met through their processes. An example of a real Service Catalogue is provided here to help to provide a view of the format and range of coverage.

Facility managers should build relations of close cooperation with the purchasing department of the company. In this relationship must be established purchasing policies that FACM can buy goods and services with all possible support but always in a transparent manner, following established criteria. The Purchasing Department will help a lot if the focusing routine purchases and leave the post of FACM purchases of specific products or services that require urgency. There should always be a cutoff above which 100% of the purchases must be made by the Department of Purchasing. This also involves contracts where the value of the contract period exceed the established limit, Cotts (1998).

To build a services catalogue (industries) one method that can be used is to criticize several areas of the Facility in the industry, trying to group these areas as possible. After grouping the activities in the areas describe these activities in a few basic features such as level of responsibility is local, regional or global. Some activities may not be made locally.

A service catalogue can help users on their service requests in an integrated manner and can be used time measurements of customer service and quality that allow the creation of an agreement-level expectation (SLE), which unlike a SLA is based on averages that are changing with time and growing complexity of the company. The SLA is based on metrics agreed in a meeting through a negotiation but does not take into account (for which we do not know) the reality of everyday life that operation. With the services catalogue of this reality, that is changeable, can be accumulated to generate statistics and a photograph of the department's performance.



### 3. User experience in Facilities Management

But how to meet customer expectations? Perhaps only through knowledge of their expectations and providing services that precisely meet these expectations! To get this valuable information the Facility Manager must communicate better and better as well as get information and keep the client updated on the expectation

Take the user to an experience in Facilities is to make their daily lives in the building where he spends more time than in his own home, something enjoyable to do because you feel totally supported, served, protected and benefited the environment. For that, the workplace environment should be inspiring for its architecture, comfortable for its building systems, secure because of its shape and construction characteristics, functional by the adequacy of its furniture, layout etc and also reliable because of its maintenance.

According to Barrett (1995), There is never any objective measurement of a professional services, i.e. are the users that define whether a service is good or not and this has to do with the services provided by Facility are evaluated by users according to what they perceive, this is their reality.

### 4. Conclusions – Service Catalogue Benefit

The role mandate of a Facility manager is nowadays very wide and is understood by modern companies as strategic for the success and deployment of the core business. Every company wants to manage its assets in a cost effective approach and wants to retain its human talents by providing a workplace environment better than the competency. FACM can use the Master Service Catalogue to match many benefits as listed below and to cooperate for the strategic goals of the enterprise. FACM can leverage the company in the experience economy because a user can deliver more when feeling that the building is working with him and not against him.

Service catalogue deliver these tangible and intangible benefits:

1. Reduced call volumes improve client service and satisfaction.
2. Lower demand on departmental staff

3. Reduces routine workload and allows staff to focus on high-value strategic initiatives.
4. Automated tracking and documentation
5. fulfills compliance requirements and ensures process consistency.
6. Online forms, knowledge bases and FAQs provide employees with up-to-date information and reduce paper, printing and distribution costs.
7. Centralized electronic access to forms, procedures, and information contributes to business alignment objectives.
8. Complete, accessible information enables employees to make informed decisions and enhances job satisfaction.
9. Service catalog metrics can pinpoint gaps in processes or documentation, highlighting additional opportunities for operational improvement.
10. Service catalogs integrated with an existing help desk system improve accuracy and efficiency, and increase ROI for system investments.



## References

Barrett, Peter. (1995) facilities management. Backwell Science Ltd., London, UK.

Kokuryo, Jiro. (1997), “The Role of ‘Customer-to-Customer’ Interaction on Computer Networks” Online. Internet. 10<sup>th</sup> may, 2010. Available  
<http://www.jkokuryo.com/papers/1997002/c-c.htm>

Cotts, David G. (1998) The Facility Management Handbook 2<sup>nd</sup> edition. AMACOM, New York, USA.



# ICT initiatives in primary education: the case of Plan Ceibal in Uruguay

**Paula Cardellino**

Facultad de Arquitectura, Universidad ORT  
11300 Montevideo, Uruguay  
[cardellino@ort.edu.uy](mailto:cardellino@ort.edu.uy)

**Roine Leiringer**

Construction Management, Chalmers University of Technology  
SE- 412 96, Gothenburg, Sweden  
[r.leiringer@reading.ac.uk](mailto:r.leiringer@reading.ac.uk)

## Abstract

'Plan Ceibal' is a deliberate attempt to promote digital inclusion in public primary schools in Uruguay. The aim of the programme is to enable a higher and better access to education through the provision of laptops to all pupils and teachers in primary education. The implementation and roll out of the initiative puts existing educational approaches and infrastructure to the test. Plan Ceibal has the potential to change traditional teaching methods and behavioural patterns, which will in turn have an impact on how facilities and spaces are used. The paper highlights the interface between the appropriation and distribution of individual laptops within the education system and the existing school facilities. The aim is to illuminate the impact that the implementation of the Plan Ceibal imposes on the existing school infrastructure and how the use and upkeep of available facilities might need to be altered and changed to accommodate the new technology. Questions are raised regarding the ultimate effectiveness of the programme and if the aspired to improvements might be curtailed by a lack of investment in other areas of the school infrastructure.

**Keywords:** ICT, digital inclusion, educational facilities, FM

## 1. Introduction

Developments in digital technologies over the last two decades have generated a period of significant social and cultural change. In the developed world digital technologies impact on almost every aspect of modern society and more and more these technologies, and the opportunities that come with them, are being taken for granted. But these benefits are not enjoyed by all. Inequality in the use and application of digital technologies has become a driver of exclusion, which risks accelerating existing social divides and creating new ones (Warschauer, 2003; Selwyn, 2004; Finqueliévich, 2006). In simple terms, digital exclusion is a symptom of wider exclusion within and between countries, but it is also a cause. Developing countries are, for example, due to a relatively lesser exposure to Information and Communication Technology (ICT) within the workforce finding it difficult to compete in a dynamic global economy that regards information as an essential asset in designing, producing and delivering goods and services (Hepp *et al.*, 2004; Dutta and Mia, 2010). It follows that one area in which the issue of inequality and digital exclusion is particularly important is education (cf. Warschauer *et al.*, 2004; Gulati, 2008). In Uruguay ‘Conectividad Educativa de Informática Básica para el Aprendizaje en Línea’ [Basic Educational Connectivity for Online Learning], or ‘Plan Ceibal’ as it is commonly known, is a deliberate attempt to promote digital inclusion in the Uruguayan educational system. Through the programme, which is a part of the national educational plan, Internet-connected laptops are to be distributed to all public primary school children in Uruguay at no charge for pupils’ families or schools. The aim is to decrease the digital gap that exists with respect to other countries and between the regions and people in Uruguay (Balaguer, 2010).

The aim of this paper is to illuminate and bring into context how increased access to, and appropriation of, a certain form of ICT tool (individual laptops) affect existing pedagogical practices and unravel some of the many implications that this will have for the operation and maintenance of existing school facilities. It takes as its point of departure the strong commitment to social inclusion in Plan Ceibal. An initial touchstone is the increasing emphasis given to equality and social inclusion and how this relates to the facilitation of digital inclusion. The second part of the paper reviews the broader literature on ICT and education. The point is made that in the developed world the education sector is undergoing rapid changes and ICTs are becoming more and more prevalent (Balanskat *et al.*, 2006). In particular, attention is drawn to how ICT increasingly is considered to play a role in changing pedagogical practices and generating new approaches to education. The third part of the paper highlights and discusses the links between the introduction of new technology and the way that educational facilities are used. The discussion focuses on how the roll out of Plan Ceibal will put the existing equipment and facilities to the test. It is argued that the initiative brings with it significant potential for change in teaching and learning processes and that this will lead to new requirements for how school facilities are used. The paper concludes with reflections on the impact that the implementation of the Plan Ceibal imposes on the existing infrastructure. In particular, a case is made for the need for further research into whether or not the effectiveness, and ultimate

benefits of the programme, is limited due to insufficient attention being given to the operational context into which the changes are introduced.

## 2. Plan Ceibal

Uruguay has a predominately urban population of 3.3 million, almost half of whom are under 30 years of age (IDB, 2010). The education system is made up of six levels: early childhood (3-5 years); primary school (6-11 years); middle school (12-14 years); high school (15-17 years); and higher education and postgraduate studies (18 years and older). Fourteen years of education is required by law, beginning at the age four. The country has achieved complete coverage in primary education and close to complete (95.5%) access for five-year olds. 95% of 12-14 year olds and 78.5% of 15-17 year olds attend school (Morey *et al.*, 2009). Despite these relatively high attendance rates and despite social and income distribution indicators being among the highest in Latin America, Uruguay was in 2007 one of the countries in the region with the highest level of inequality in learning (OECD, 2007). Plan Ceibal was jointly developed by the Ministry of Education and Culture, the Technological Laboratory of Uruguay, the National Administration of Telecommunications and the National Administration of the Public Education as a means to address this inequality and to further strengthen social inclusion. The programme was launched by the Uruguayan government in April 2007, with the intention of providing, free of charge, one computer to each child and teacher in public primary education. At that point 43% of primary schools in Uruguay had no computer equipment available to pupils, 43% had between one and four computers, and only 14% had five or more (Grupo Radar, 2010). There were also substantive differences in the number of computers and the degree of availability to them depending on the locations of the schools; ranging from 37 to 78 pupils per computer. Even in the most favourable cases pupils were limited in their access to a computer to approximately three hours per month. Furthermore, across the country 36% of the available computers were more than six years old and 74% had no Internet connection (*ibid.*). At the time, this reflected the situation in society in general. In March 2005, only 29% of Uruguayan households had a computer and only half of these had Internet access (Vazquez, 2009).

The roll out of Plan Ceibal commenced in May 2007 in the form of a pilot project in Villa Cardal; a small town in the department of Florida. By the end of the year laptops had been provided to pupils in the majority of the urban schools in this department. This was followed by an expansion to other departments, with the exception of the capital (Montevideo) and the metropolitan area. By the end of 2008, laptops had been handed out to 167 349 children and 6 863 teachers. In 2009, a further 141 714 laptops were distributed in 514 schools in Montevideo and the metropolitan area (Baez and Rabajoli, 2010). In addition, servers are being installed in the schools to provide the necessary network connectivity (Brechtner, 2010).

Plan Ceibal is commonly depicted as being constituted by three pillars: equity, all children and teachers in public schools receive a laptop; learning, new tools for learning, new contents, new forms of education; and technology, wireless Internet, connection in schools, public places and

homes (Cyranek, 2009). It is important to note, though, that Plan Ceibal is not solely oriented towards increasing the use of ICT in the school environment. A key aspiration, and the long-term objective, is to achieve digital inclusion across society. As an integral part of the Plan pupils are expected, and actively encouraged, to take their laptop home, so that it can be shared among family members. The aspiration is that this will promote increased usage of, and exposure to, ICT in households, especially amongst the most excluded social strata (Vazquez, 2009). This dual purpose is important and sets Plan Ceibal apart from previous efforts to bridge the digital divide in Uruguay, as well as in other countries. However, identifying and evaluating potential impacts on society at large represents a significant challenge and is clearly out with the scope and remit of a conference paper. Thus, whilst it is recognised that digital and social inclusion are crucial to the success of Plan Ceibal the rest of the paper will be confined to digital inclusion in schools.

### 3. Plan Ceibal and improving the level of education

The following general pedagogical objectives have been set for Plan Ceibal (Acosta *et al.*, 2008): (i) to contribute to improving educational quality through the integration of technology in the classroom, the school and the family; (ii) to promote equal opportunities for all primary school pupils by providing each pupil and teacher with a portable computer; (iii) to develop a collaborative culture along four lines: child-child; child-teacher; teacher-teacher, and child-family-school; and (iv) to promote digital 'literacy' and more critical perspectives within the education community, while adhering to ethical principles.

A number of more specific objectives have also been set (Comisión de Educación, 2007):

- Promote the integrated use of the laptop computers to support the pedagogical approaches in the classroom and the school.
- Provide teachers with training and updates in technical and pedagogical areas, in order to ensure the best possible educational use of the new resources.
- Produce educational resources based on available technologies.
- Bring about the teachers' involvement and appropriation of the innovation.
- Generate support systems and specific pedagogical technical assistance to ensure the adequate development of the educational experience.
- Involve parents in the achievement of adequate and responsible use of the new technology to benefit the pupil and the family.
- Promote the participation of all the parties involved in the production of relevant information for decision making.

It is clear from these objectives that there is a heavy emphasis on the provision and use of the technology. Yet, it should be noted that it is also clearly recognised that the introduction of ICT tools in schools is not enough to ensure the aspired to transformation in education. Hence, the emphasis given to the need of accompanying the distribution of laptops with appropriate training programmes for those involved and the push for the introduction of teaching and learning approaches that are in line with the new requirements (cf. Grandy, 2009). Accordingly the distribution of laptops is complemented through multiple government agencies and volunteers working together to provide teachers with the resources and training necessary to adapt.

So far the programme has, according to their own records, had a degree of success in incorporating the equipment into the day-to-day practices in the schools (cf. Cyranek, 2009). The impact the Plan Ceibal is starting to have on primary education, in particular the potential for changes in approaches to teaching and learning, has not surprisingly, generated considerable interest from abroad (Acosta *et al.*, 2008). However, experiences from elsewhere show that several conflicts arise when new technologies are introduced into the educational system and there are host of considerations that need to be made (Hinostroza *et al.*, 2004). Not least amongst these is how the introduction of new technologies and changes in pedagogical approaches conflict with existing school facilities.

#### 4. ICT and education

The last ten years have produced a vast array of research in the field of ICT in education (e.g. Pelgrum, 2001; Fonseca, 2001; Angrist and Lavy, 2002; Warschauer, 2008; Tolani-Brown *et al.*, 2009; Pena-Lopez, 2010). Not surprisingly, the findings from these studies vary immensely (cf. Condie *et al.*, 2007). Some claim that new technologies have the potential to fundamentally transform how and what people learn. This part of the literature is replete with claims about the revolutionary potential of ICT to impact on enhanced student learning and increased quality of education (*ibid.*) Others are more sceptical and note that, although many positive results have been reported on a small scale, there are considerably fewer improvements in attainment that can be linked directly to ICT on a large and replicable scale (e.g. Hepp *et al.*, 2004, Balanskat *et al.*, 2006). Whilst consensus is yet to be reached, it is nonetheless hard to refute that the increased use of ICT has impacted on teaching and learning approaches. Not least in the emergence of new pedagogical approaches that focus on tailoring education towards individual pupil's needs, changing the dynamics of grouping within schools and opening up schools to the wider community (e.g. Clark, 2002; Day & Midbjer, 2007; Durán-Narucki, 2008). However, whilst new digital technologies might have the potential to revolutionise learning, they certainly do not guarantee it. Instead, experience shows that change initiatives imposed on the schools and teachers all too often are used to reinforce existing approaches to learning rather than bringing about change (Rivlin & Rothenberg, 1976; Higgins *et al.*, 2005). This has also been found to be the case with the introduction of ICT tools. Most teachers tend to use these mainly to complement rather than change existing pedagogical practice (cf. Smeets, 2005). It follows, therefore, that to take full advantage of new ICTs there is a need to rethink traditional

approaches to teaching and, perhaps more importantly, what constitutes an effective learning environment.

The necessary precursory changes for this to happen are arguably already taking place. A gradual change in emphasis has been clearly discernible in the education literature for quite some time now. The traditional discipline based agenda for learning is gradually giving way to one based on creativity, innovation, critical reflection, teamwork and the collective construction of knowledge (e.g. Gardner and Hatch, 1989; Woods and Jeffrey, 1996). The latter agenda is built around concepts such as dialogue, ownership, innovation, flexibility, equality, democracy, individuality and freedom. Some commentators take these concepts one step further and go as far as to argue that the availability of ICT means that education is just as effectively delivered outside schools and, thus, rendering school buildings unnecessary (cf. Hepp *et al.*, 2004). Such a position might seem radical, but it becomes much more viable if the school is conceptualised as an organisational unit rather than a physical entity. However, not surprisingly, this disregard of the link between the physical environment and teaching and learning has been heavily criticised (e.g. Jamieson *et al.*, 2000; McGregor, 2004). Rather than abandoning the school building it is argued that the rather abstract concepts mentioned above can be translated into concrete objectives for the schools and be embedded in the physical design of the learning environments. This line of reasoning finds support in a plethora of studies that have shown that changes in pedagogical approaches accompanied with the use of the appropriate technology can be successfully supported by altering the way in which spaces and buildings are used (cf. Cardellino and Leiringer, 2009).

#### **4.1 Facilities and educational attainment**

There is a long tradition of studies targeting the impact of the built environment on performance in general (e.g. Herzberg, 1966). Building on these it is commonly argued that the physical environment plays an important role in shaping behaviour in schools (e.g. Day & Midbjer, 2007; Durán-Narucki, 2008). How the school building is designed and maintained is understood to play a central role in the creation of environments that improve educational attainment. There is a long-established international trend of promoting educational facilities that address changing curriculums (cf. Woolner *et al.*, 2005; OECD, 2006; Hertzberger, 2008). In the UK, for example, the £52 billion Building Schools for the Future initiative comes on the back of an increasingly widely held belief that older schools, as well as those built or refurbished in recent years, are inadequate in their ability to cope with anticipated changes such as shifting pedagogy, curriculum and learning expectations (cf. Audit Commission, 2003; Cardellino *et al.*, 2009). The ultimate goal of the programme is to achieve 'educational transformation' and significant investment is put into the design, construction and operation of the school facilities in order to achieve this. The belief that the building can be effectively used to support attempts to transform educational practices is also easily discernible in other parts of Europe, for example Scandinavia (Cardellino and Leiringer, 2009).



School buildings provide for a variety of social groups within their premises. Spaces govern and support interactions between these groups and individuals. Ultimately, spatial design and how the facilities are maintained and used, both facilitates and inhibits behaviour and relationships between different actors (cf. Penn *et al.*, 1999; Heerwagen *et al.*, 2004). Significant attention has been given to the impact that aspects of the physical environment, such as classroom and school size, and the degree of openness of the spaces have on educational outcomes (e.g. Bennett and Hyland, 1979; Horne-Martin, 2002). The social interaction within these spaces is commonly put forward as a critical factor in establishing the relative success of the learning environments (e.g. Tanner, 2000). Wireless ICT, as provided by the laptops in Plan Ceibal, have an impact on the physical environment as it allows for transformations in the notions of space and place. In theory, it could make physical distances less of an issue and enable the creation of personalised spaces that are ‘moveable’.

## 5. Rethinking the use and operation of school facilities

Plan Ceibal attempts to affect Uruguayan society at a variety of levels. The provision of laptops to all primary and secondary school pupils is an ambitious initiative that so far is unrivalled in the world. As previously stated, the programme is aimed at both decreasing the digital divide and improving the quality of the education that is delivered in schools across the country. Obviously, the impact of ICT in schools goes beyond the pedagogical to also affect other areas such as the cultural, social, professional and administrative. As such, ICT has the potential to affect many aspects of school life, from altering present teaching practices and providing the opportunity for teacher development to improvements of the quality, scope and depth of the learning environment. It follows from the discussion in the previous section that such changes are more likely if they are compliant with the context into which they are introduced. It therefore seems highly pertinent to further explore the relationship between the articulation of the educational vision, the introduction of ICT and the accomplishment of compatible learning environments. And, how the physical environment can support or impede the introduction of laptops and associated pedagogical ideas in forming effective learning environments.

### 5.1 New settings, new requirements

International experience in evaluating the use of ICT in education shows that they have had a positive but moderate impact on learning outcomes (Balanskat *et al.*, 2006; Tolani-Brown *et al.*, 2009). More evident is the change they produce in the short term on pupil and teacher attitudes and expectations (Balanskat *et al.*, 2006; Condie *et al.*, 2007). A major challenge in this context is to match these expectations with necessary changes and improvements of the school environment that will support and enable teacher and pupil use of ICTs. This means successfully managing the link between the physical and ‘psychosocial’ classroom environment. The provision and maintenance of an adequate physical learning environment is very much an educational issue.

As previously noted, the impact of ICT is mitigated by the belief that systems of teachers change far more slowly than does the technology. Thus, even after receiving basic and pedagogical training in ICT, some teachers will still not be able to make use of that training since they are hampered by a range of school level factors. Several studies have sought to establish the extent to which teachers make use of available spaces and the degree to which the physical environment dictates how they teach (e.g. Moore & Lackney, 1993), and there is relatively strong agreement on the existence of a link between the style of teaching and classroom organisation (cf. Horne-Martin, 2002; McGregor, 2004). The tendency simply to cope with the given environment rather than actively attempting to manage it should not be underestimated (Higgins *et al.*, 2005). It follows that unless some of these structural impediments to change are tackled, technology will be used to support existing practices and cultural values rather than encourage new ones.

Failing to provide an adequate physical learning environment may also detract pupils from their learning (Higgins *et al.*, 2005). At the most basic level deficiencies in physical considerations, such as the quality of the furnished environment, adequate ventilation and the suitability of lighting may distract groups of pupils from their primary learning tasks and thereby diminish the quality of the learning environment (cf. Zandvliet and Straker, 2001). At a more general level, the social interaction within classrooms and other school spaces is commonly put forward as a critical factor in establishing the relative success of the learning environments (e.g. Tanner, 2000). The possession and use of laptops impacts on how such social interaction can take place. What previously might have been an adequate learning environment may no longer be so. Individual work spaces and classroom layouts that were designed for conventional 'teaching from the front' may in the new laptop inspired teaching scenario be a cause of distraction and, thus, detrimental to learning. Redesigning or reconfiguring existing school facilities so that they become more flexible could enable the creation of spaces that accommodate a variety of individual and group activities, and allow the media to become the new centre of the school.

In summary, an ICT policy should preferably not be designed in isolation. In order to have a longer lasting effect and to be effectively infused into the school's culture it should be part of a more comprehensive effort towards improving the equality and quality of the educational environment as a whole. This, in turn, is supported through the provision of facilities that are suited for the new technology in terms of fulfilling basic physical variables such as adequate ventilation, temperature, light and colour etc.; and also are adaptable and flexible enough to support potential changes in teaching and learning that the use of ICT might inspire.

## 6. Concluding remarks and a way forward

It is generally believed that ICTs can empower teachers and pupils, thus providing potentially significant contributions to learning and educational attainment. However, as described above, current research on the impacts of ICTs on pupil achievement has yielded few conclusive findings regarding the directly attributable positive outcomes of the introduction of ICT tools in education. Undoubtedly, Plan Ceibal, through its wide distribution of laptops, has the potential

to affect substantial change in society in general, as well as in education. However, its success is reliant on the establishment of an educational model that is relevant and aligned to the individual particularities of the school population. This represents a major challenge for the Uruguayan school system.

So we ask ourselves: is facilities and asset management the missing ingredient in Plan Ceibal? Well, if we are to believe Baez and Rabajoli (2010) and their claim that introducing a laptop for every child in the classroom will potentially bring unforeseen changes to every aspect of the school – then the answer is clearly yes. Whether or not the changes will be radical remains to be seen, but a clear case can be made for the importance of adapting not only the pedagogical approaches but also the physical environments in which they are delivered. The broader institutional context in which the change is to take place and the structural characteristics of the educational sector combine to form unique localised challenges for all involved and also form the process and content of academic work. To date there is only sporadic non-systematic evidence of the positive impacts of Plan Ceibal and its effects on enrolment, attendance, motivation and graduation rates. This is hardly surprising given that the programme has only been in operation for three years. More importantly, however, there is no readily available research that has investigated implementation processes and impacts. It is worth remembering that the use of ICTs in the classroom does not diminish the role of the teacher; nor does it automatically change teaching practices. Successful incorporation of ICTs in day-to-day practices is dependant on the implementation of a variety of support and enabling mechanisms. Yet, there is little current knowledge about what an integrated approach to operating, maintaining, improving and adapting the school buildings and infrastructure in order to create a supporting environment might look like. The research challenge, therefore, is to unravel the myriad of practices, as realised in schools, situated in complex, yet specific environments. And to explore the tensions that the introduction of laptops pose and establish the different ways in which these can be alleviated. The current research agenda therefore needs to be expanded to incorporate learning environments. More empirical research is needed in order to further our understanding of how the introduction of laptops changes behaviour in classrooms and the wider school environment; how individual behaviour is shaped by existing facilities; and how the use and upkeep of the facilities can be altered to respond to changes in teaching and learning approaches.

## References

Acosta K, Albornoz R, Argenti M, Baez M, Brener M, Caro A, da Rosa F, Elissalde R, Garay R, Gonzalez M, Morales A, Rabajoli G, Rios M and Siri S (2008) *Ceibal. En la Sociedad del Siglo XXI* [Ceibal. In the Society of the XXI Century], Montevideo, UNESCO.

Angrist J and Lavy V (2002) “New Evidence on Classroom Computers and Pupil Learning.” *The Economic Journal*, **112**(October): 735-765.

Audit Commission (2003) *PFI in schools*, London, Audit Commission.

Baez M and Rabajoli G (2010) “La Escuela Extendida. Impacto del Modelo Ceibal” [The Extended School. The Impact of the Ceibal Model]. In R Balaguer (ed.) *Plan Ceibal. Los Ojos del Mundo en el Primer Modelo OLPC a Escala Nacional*, Montevideo, Prentice Hall, pp.75-94.

Balaguer R (2010) *Plan Ceibal. Los Ojos del Mundo en el Primer Modelo OLPC a Escala Nacional* [Plan Ceibal. The Eyes of the World on the First OLPC Model at a National Scale], Montevideo, Prentice Hall.

Balanskat A, Blamire R and Kefala S (2006) *The ICT Impact Report A review of studies of ICT Impact on Schools in Europe*, Brussels, European Schoolnet, European Communities.

Bennett N and Hyland T (1979) “Open Plan – Open Education?” *British Educational Research Journal*, 5(2): 159-166.

Brechner M (2010) “Los Tres Sí” [The Three Yes]. In R Balaguer (ed.) *Plan Ceibal. Los Ojos del Mundo en el Primer Modelo OLPC a Escala Nacional*, Montevideo, Prentice Hall, pp.163-169.

Cardellino P, Leiringer R and Clements-Croome D (2009) “Understandings of Design Quality in the Building Schools for the Future Programme.” *Architectural Engineering and Design Management*, 5(4): 249-262.

Cardellino P and Leiringer R (2009) “Design of 21st Schools: Lessons from Scandinavia”, *Proceedings of the 5th Nordic Conference on Construction Economics and Organisation*, 1, 10-12 June 2009, Reykjavík, Iceland.

Clark H (2002) *Building Education: The Role of the Physical Environment in Enhancing Teaching and Learning - Issues in Practice*, London, Institute of Education.

Comisión de Educación (2007) *Ceibal. Proyecto Pedagógico* [Ceibal. Pedagogical Project], Montevideo, Ministerio de Educación y Cultura.

Condie R, Munro B, Seagraves L and Kenesson S (2007) *The Impact of ICT in Schools – A Landscape Review*, Coventry, Becta Research, Becta.

Cyranek, G (ed.) (2009) *En el Camino del Plan Ceibal. Referencia para Padres y Educadores* [On the Path to Plan Ceibal. Reference to Parents and Educators], Montevideo, UNESCO

Day C and Midbjer A (2007) *Environment and Children. Passive Lessons from the Everyday Environment*, Oxford, Architectural Press.

Durán-Narucki V (2008) “School Building Condition, School Attendance and Academic Achievement in New York City Public Schools: A Mediation Model.” *Journal of Environmental Psychology*, **28**(3): 278-286.

Dutta S and Mia I (2010) *The Global Information Technology Report 2009 – 2010. ICT for Sustainability*, Geneva, World Economic Forum and INSEAD.

Finkelievich S (2006) “Innovación, Información y Prácticas Sociales” [Innovation, Information and Social Practices]. In *Primer Congreso Internacional de Investigación en Ciencias de la Información*, 8-10 Nov. 2006, Escuela Interamericana de Bibliotecología, Universidad de Antioquia, Medellín, Colombia.

Fonseca C (2001) “Mitos y Metas Sobre los Usos de las Nuevas Tecnologías en la Educación.” [Fallacies and Objectives Regarding the Uses of New Technologies in Education] *Prospects*, **31**(3): 399-413.

Gardner H and Hatch T (1989) “Multiple Intelligences Go to School: Educational Implications of the Theory of Multiple Intelligences.” *Educational Researcher*, **18**(8): 4-10.

Grandy J (2009) “Prólogo” [Prologue]. In G Cyranek (ed.) *En el Camino del Plan Ceibal. Referencia para Padres y Educadores*, Montevideo, UNESCO.

Grupo Radar (2010) *El Perfil del Internauta Uruguayo - 7ma Edición* [The Uruguayan Surfer Profile – 7<sup>th</sup> Edition], Montevideo, Investigación de Mercado y Opinion, Plan Ceibal and Antel.

Gulati S (2008) “Technology-Enhanced Learning in Developing Nations: A Review.” *International Review of Research in Open and Distance Learning*, **9**(1): 1-16.

Hepp P, Hinostroza E, Laval E and Rehbein L (2004) *Technologies in Schools: Education, ICT and the Knowledge Society*, Washington DC, World Bank.

Heerwagen J, Kampschroer K, Powell K and Loftness V (2004) “Collaborative Knowledge Work Environments.” *Building Research and Information*, **32**(6): 510-528.

Herzberg F (1966) *Work and the Nature of Man*, Cleveland, World Publishing Company.

Hertzberger H (2008) *Space and learning*, Rotterdam, 010 Publishers.

Higgins S, Hall E, Wall K, Woolner P and McCaughey C (2005) *The Impact of School Environments: A Literature Review*, London, Design Council.

Horne-Martin S (2002) “The Classroom Environment and its Effects on the Practice of Teachers.” *Journal of Environmental Psychology*, **22**(1-2): 139-156.

Hinostroza E, Hepp P and Laval E (2004) *Enlaces: The Chilean ICT Experience in Education*, Santiago de Chile, Instituto de Informática Educativa, Universidad de La Frontera, Ministerio de Educación de Chile.

Jamieson P, Fisher K, Gilding T, Taylor P and Trevitt C (2000) "Place and Space in the Design of New Learning Environments." *Higher Education Research and Development*, **19**(2): 221-237.

IDB (2010) *Technical Note on the Education Sector for IDB Country Strategy with Uruguay 2010 – 2014*, Education Division, Washington DC, Inter-American Development Bank.

McGregor J (2004) "Space, power and the classroom", *Forum*, **46**(1): 13-18.

Moore G and Lackney J (1993) "School design: crisis, educational performance and design applications", *Children's Environments*, **10**(2): 1-22.

Morey X, Cabrol M, Casburi G, Demaestri E, Duarte J, Fernandez R, Garcia J, Giordano P, Giro A, Malarin H, Medina L, Lozano C, Mejia F, Quevedo F, Salazar H and Santo M (2009) *IDB Country Strategy with Uruguay (2005 – 2009)*, Washington DC, Inter-American Development Bank.

OECD (2006) *PEB Compendium of Exemplary Educational Facilities*, 3rd edition, Paris, Organisation for Economic Co-operation and Development Publishing.

OECD (2007). *PISA 2006: Science Competencies for Tomorrow's World. Executive Summary*, Paris, Organisation for Economic Co-operation and Development.

Pelgrum W (2001) "Obstacles to the Integration of ICT in Education: Results from a Worldwide Educational Assessment." *Computer & Education*, **37**(2): 163-178.

Penn A, Desyllas J and Vaughan L (1999) "The Space of Innovation: Interaction and Communication in the Work Environment." *Environment and Planning B*, **26**(2): 193-218.

Pena-Lopez I (2010) "From Laptops to Competences: Bridging the Digital Divide in Education." *Revista de Universidad y Sociedad del Conocimiento*, **7**(1): 21- 32.

Rivlin L and Rothenberg M (1976) "The Use of Space in Open Classrooms." In H Proshansky, W Ittelson and L Rivlin (eds.) *Environmental Psychology: People and their Physical Settings*, New York, Holt, Rinehart and Wiston.

Selwyn N (2004) "Reconsidering Political and Popular Understandings of the Digital Divide." *New Media and Society*, **6**(3): 341-362.

Smeets E (2005) "Does ICT contribute to Powerful Learning Environments in Primary Education?" *Computers and Education*, **44**(3): 343-355.

Tanner C (2000) "The Influence of School Architecture on Academic Achievement." *Journal of Educational Administration*, **38**(4): 309-330.

Tolani-Brown N, McCormac M and Zimmermann R (2009) "An Analysis of the Research and Impact of ICT in Education in Developing Country Contexts." *Journal of Education for International Development*, **4**(2): 1-12.

Vazquez T (2009) "Digital Democracy." In *Connectivity and the Digital Divide, Americas Quarterly*, (Winter 2009).

Warschauer M (2003) *Technology and Social Inclusion: Rethinking the Digital Divide*, London, MIT.

Warschauer M, Knobel M and Stone L (2004) "Technology and Equity in Schooling: Deconstructing the Digital Divide." *Educational Policy*, **18**(4): 562-588.

Warschauer M (2008) "Laptops and Literacy: A Multi-site Case Study." *Pedagogies: An International Journal*, **3**(1): 52-67

Woods P and Jeffrey B (1996) *Teachable Moments: The Art of Creative Teaching in Primary Schools*, Buckingham, Open University Press.

Woolner P, Hall E, Wall K, Higgins S, Blake A and McCaughey C (2005) *School Building Programmes: Motivations, Consequences and Implications*, Reading, The Centre for British Teachers.

Zandvliet D and Straker L (2001) "Physical and Psychosocial Aspects of the Learning Environment in Information Technology Rich Classrooms." *Ergonomics*, **44**(9), 838-857.





# A survey of Information Technology Applications in Palestine

**Adnan Enshassi & Karem Abed**

School of Civil Engineering, IUG, Palestine

Email: enshassi@gmail.com

## Abstract

Information technology (IT) is very important to the global economy, as it opens new visions in the businesses and industries of the world. The construction industry is considered as one of the key beneficiaries of IT. This paper presents the findings of a research project, which explores the current application of IT in the Palestinian construction industry. Data was gathered through questionnaire surveys, which were distributed to construction companies in the Gaza Strip. The survey investigated issues such as the IT environment and management, use of software, hardware, as well as internet application. The study considered the benefits gained and problems associated with IT implementation, together with an assessment of the exploitation of IT for business strategic purposes. The findings reveal that the level of IT applications among contractors in the industry is acceptable with regards to the use of PCs in different applications such as design, scheduling, word log and accounting. Use of the Internet for online bidding and e-meetings was almost negligible. From the strategic point of view, the Palestinian construction industry is still in a reactive mode in managing IT, and the industry has a limited understanding of the value and potential of IT. The study recommends that top management in construction companies should have strong commitment to develop the strategic management of IT in their business at all levels, thus making this industry sector more competitive. Appropriate and sufficient training education for staff is required.

**Keywords:** IT environment, construction, management, contractors.

## 1. Introduction

Until 2000, contractors enjoyed very good business and achieved satisfactory profits. However since then, uptight tense political climate affected in winding down of many plans for development which in turn created what was perceived to be a recession in the construction industry in Gaza Strip. The shrinkage of budgets has forced the clients to find different competitive tendering. As a result, the contractors' profits margins as well as the demand for construction have been in the decline. This situation affected the local contractors to become more competitive in order to survive and remain in the market. After 2000, new features of the construction market in Gaza Strip forced many contractors to look for other alternatives or to improve their abilities by using proper managerial tools to keep inside the circle of competitiveness.

Among these tools, IT applications became an effective way to improve the contractor's abilities and to facilitate the performance of their projects (Dawood et al 2005). Computers have revolutionized the way documents are generated. Similarly, IT is bound to revolutionize the way people exchange information and documents (Hue 2005). IT is defined as “the use of electronic machines and programs for the processing, storage, transfer and presentation of information” (Rivard, 2000). IT encompasses many technologies such as computers, software, networks and even telephones and fax machines.

IT and information and communication technology (ICT) have been identified as essential tools for improving communication in construction processes and for creating new construction business opportunities (Peansupap, 2005). IT is now widely used in the construction sector; however, companies are still failing to gain full advantage from implementing and using emerging IT because of organizational issues (Whyte, 2002). The purpose of IT is to facilitate the exchange and management of information and has a lot of potentials for the information process component of the construction industry. These recent technologies will undoubtedly have a profound impact on how organizations operate on a daily basis (Rivard, 2000).

The objectives of this study are to identify the construction industry access to computer systems and services, the purposes for which the industry uses computers and the extent of such use, the barriers that prevent the industry from better using existing computer technology, the advantages of the information technology in achieving the strategic goals required to improve the construction industry, the future effects of information technology on construction industry.

## 2. Literature Review

A number of surveys on the use of IT in construction have been carried out in different countries. There have been both quantitative and qualitative surveys that complement each other in the way they express the use of IT in the industry. Egbu and Botterill (2002) identified the technologies that are used to manage knowledge in the construction industry in UK. Their research revealed that conventional technologies, such as the telephone, are used more frequently to manage knowledge, than more radical IT, such as groupware or video-conferencing. In construction organizations, the potential benefits of IT for knowledge management are not fully exploited and many have expressed a need for greater implementation of IT, appropriated by sufficient training and education of staff. Turk (2006) stated that Construction informatics is a relatively young and immature field of applied science. Collaboration between all role players during construction is not only important but also necessary for the successful completion of a construction project (Perreira and Soares 2007).

Barriers hindering the flow of information include the organizational structures, behavior of individuals involved with information management and the technical characteristics of the information in this industry (Zeng et al 2007). Information must be able to flow seamlessly between all parts of the organization (Hicks 2007). CAD software has become ubiquitous and was used in most of the drawing work. Even though most firms have adopted e-mail and the Internet, most processes were still not computerized and most documents were still exchanged in a traditional fashion (Rivard, 2000). The study done by Arif and Karam in 2003 covered the areas of general use of IT, use of CAD and the use of networks in South Africa. The results showed that areas of main use of IT were not dramatically different and so was the area of the CAD packages used.

In a recent comparative report between USA and Korea in the field of using Wi-Fi (Wireless Fidelity) networks on construction sites, the results indicated that construction managers in the U.S.A seem to be more hesitant to embrace IT to improve their information logistics widely recognized as a key inhibitor to improving productivity. Compared to Korea, the participating U.S.A companies see fewer opportunities for Wi-Fi to bridge the many communication chasms that inhibit the automation of data collection and dissemination. The Korean respondents assessed benefits of Wi-Fi positively at double the rate than their American counterparts. On the other hand, the same U.S. respondents consider the barriers to the implementation of modern IT to be much lower (Williams, 2006). Recent benchmarking reviews of IT use, in Europe, in briefing and design have identified serious shortcomings in the construction industry. This lack of technological uptake is compounded, in Europe, by the fact that research expenditure does not reflect its economic importance. Investment is limited to 0.3% of the sector's turnover, compared with the situation in Japan where investment is of the order of 2.0-3.0% (cited by Aspin, 2001). The comparison between Sweden, Denmark and Finland showed that Finland and Denmark had a greater use of model based CAD and more employers had their own computer at the workplace. Companies in Sweden think they get better financial control with IT and also prioritize costing/cost control and accounting systems to a greater extent (Samuelson, 2002).

Based on the survey done by Mui in 2002 that discussed the Internet applications in the Malaysian construction industry, it was found that the respondents had accessibility to the Internet; comparable to countries such as the United States. However, the main use of the Internet was only for emails and information search. On the other hand, the survey found that the main disadvantages experienced were slowness in downloading, virus problem and frequency of being cut-off from Internet connection (Mui, 2002). For the Indonesian case, results of the survey investigated by Pamulu and Bhuta (2004) revealed that the level of IT applications among contractors in the industry was relatively low in their core activity; also there was growing gap in managing IT, where high investment and expenditure on hardware and software on one hand with poor human resources development on other hand.

Many construction organizations are under financed (Andresen, 2000). However construction organizations are often slow to formulate strategies that recognize the role of IT and result in corresponding IT strategies. With many surveys being carried out on the use of IT, it is important to ensure that their results can be compared and that they can be repeated to gain a picture of the growth of IT use and of particular successes. The IT barometer survey done by Howard and Samuelson (1998) compared results from Denmark, Finland and Sweden on the use of computer hardware, software and communications. It is complementary to other surveys looking at the strategic use of IT within companies. The study indicated that Microsoft products dominate both operating systems and office applications in all these countries but there was greater use of Windows NT and UNIX in Finland. CAD was used in almost all design offices in Sweden, with AutoCAD as the dominant product, but Micro station is now more widely used by architects in Denmark. CAD data structures are becoming more advanced with objects being

used by more firms in Finland and Sweden, but structured 2D data dominates in Denmark. Communications networks are used in about 90% of Swedish firms but only in about 60% in Denmark (Howard and Samuelson 1998).

Shash and Al-Amir (1997) conducted a survey on the extent of computer use and their applications in construction contractor firms in Saudi Arabia. The findings indicate that computers were not widely used by construction contractors, especially in relation to those who are classified as small and medium-sized contractors. The use of computers was directly proportional to the size of the contractor firm. While, all large contractors used computers, only 41% and 62% of small and medium-sized contractors used them. When computers were used, they were limited to administrative operations such as accounting and databases. On the other hand O'Brien and Al-Biqami in 1999 found that Saudi Arabian construction companies were reasonably well advanced with regards to the use of PCs on their construction sites. In order to develop a successful IT implementation in any construction firm it is suggested that (1) user-developer Communications are critical for the successful implementation of non-diffused innovations in the construction industry; and (2) successful uptake of IT requires both strategic decision-making by top management and decision-making by technical managers (Whyte, 2002).

### 3. Methodology

A questionnaire survey was used in this study. The questionnaire was structured to encourage the relevant organizations to participate in the study; to help them to provide the necessary information easily. The questionnaires were distributed to 45 contractors in the Gaza Strip. The overall response rate to the survey was 67% (30/45). The questionnaire was sent by two ways:

- By e-mail to fifteen contractors while the return of this type was only five respondents (The return rate by e-mail was around 34%).
- Delivery by hand to the contractor while the telephone was used for follow-up and explanation. Twenty five questionnaires were collected out of thirty ones were distributed among different type of contractors with a return rate of around 83%.

The following three conditions were maintained for ensuring the selection of a representative sample from all the classified contractors:

- Equal opportunity. Each firm has the same opportunity of being selected.
- Appropriateness. The sample must precisely reflect the characteristics of the population.
- Independence. Each firm is selected independently of any other firm.

The scope of the survey included all types of local contractor involved in the industry since the communication technology will affect them all together. There was no geographical restriction on the selection of participating contractor, as Gaza Strip is divided into four regions: South, North, Gaza city and Central. The survey was sent to top management as well as key persons to assess current use of information and communication technology in their organizations.

The questionnaire was designed based on previous studies (Shash and Al-Amir, 1997; Whyte, 2000; Arif and Karam, 2001; Egbu and Botterill, 2002; Pamulu and Bhuta 2004; Dawood et al, 2005). The questionnaire was divided into four sections. The first section contained questions seeking information on the characteristics of the firm, such as size, capacity, personnel in the firm, machinery belongs to the company and type of work performed. The second section

contained questions seeking information regarding hardware and software platforms used by the company, functions performed by computers and methods of training. In the third section, the survey covered the most important factors affecting the computer use and its applications in the construction industry and how they are rated. The fourth section clarified the other uses of information technology; particularly the Internet and web site belong to the company. Also this section covered the multiple applications of information technology within the construction industry in Gaza Strip and reasons obstruct the use of information technology. The last part of the questionnaire was included to encourage respondents to participate in the survey by allowing them to put their comments or any other additions in this regard.

The mean value method is used here to determine the ranks of all factors that affecting the use of computer in the construction industry. The mean value was computed as:

$$Mean \quad value = \frac{\sum_{i=1}^5 W_i X_i}{\sum_{i=1}^5 X_i}$$

Where:

- $i$  = response category mean value 1, 2, 3, 4, and 5 for not, slightly, moderately, very, and extremely important respectively.
- $W_i$  = the weight assigned to the  $i$ th response = 1, 2, 3, 4,5 respectively
- $X_i$  = frequency of the  $i$ th response given as percentage of the total responses for each factor.

## 4. Results

### 4.1 Characteristics of survey respondents

The survey indicated that the majority (80%) of the entire participating contractor are corporation contractor whereas 13% are partnership type and only two contractors are family-owned companies as it is shown in table (1).

Table 1: Classification of contractors vs. their companies' type

Company type	Number of contractor	Percentage of all
Partnership	4	13.33%
Family owned	2	6.67%
Corporation	24	80%

Figure (1) shows that, approximately 33.3% of the participating contractors can be classified as small. Medium-sized contractors accounted for 33.3% while large constitute of 30 % (only one respondent was unwilling to provide its annual or overall turnover). Also the results indicated that about 67% of the participating firms, mostly small and medium sized contractors, started business during the last decade while the establishment of large construction companies became a less attractive investment option. This fact might be attributed to the drop in demand for large construction projects due to the unstable political circumstances and shortage of funds given to

the Palestinian authority.

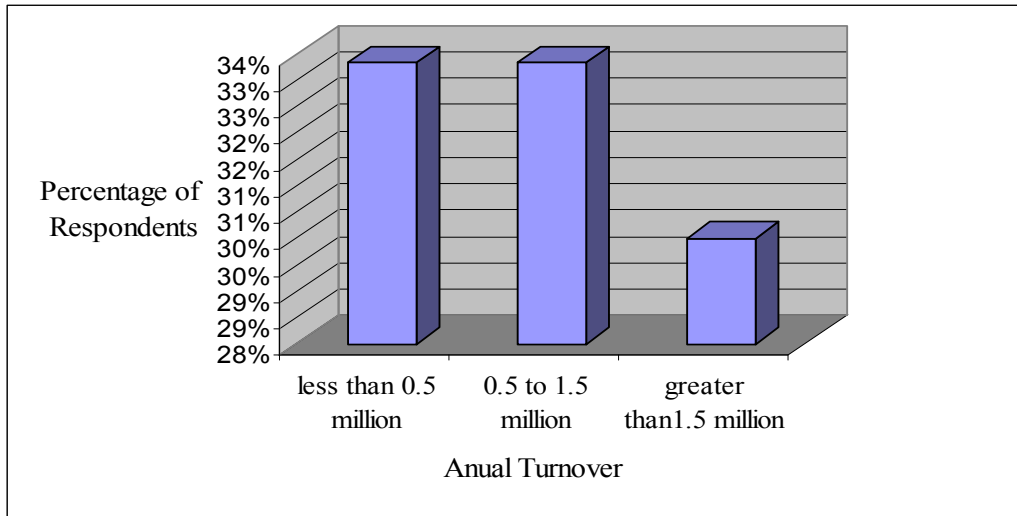


Figure 1: Classification of contractors vs. their annual turnover

### 4.2 Computer availability and types

All the respondents included in the survey have computers in their organizations. Most the participants have the type of PCs (around 76.6% of respondents), whereas a percentage of 20% of respondents operate using the system of minicomputers and only one large company is dealing with mainframe computer. Table 2 clarifies the computer systems used by the participating contractors.

Table 2: Computer systems used by different contractors

Type of computer system	Mainframe	Minicomputer	Microcomputer
No. of contractors	1	6	23
% of all	3.33%	20.00%	76.67%

The results indicated that the use of microcomputers is far ahead of other systems as the majority of the respondents are small and medium sized contractors who most often use the microcomputer systems in their operations. The heavy use of microcomputer systems might be a result of the fact that the micros are of lower cost compared of other systems as well as such systems offer the necessary needs required to run the business of small and medium contractors. Also the survey revealed that six companies out of thirty (around 20%) applied the minicomputer systems. Such systems offer all the functions of mainframes but with a slower processing speed, smaller memories, and less input-out-put and data communication capabilities. Only one large contractor (around 3%) reported having mainframe computers which is predictable because such companies have more recourses than smaller firms, many users may operate at the system and different types of complex software and programs are included in these systems.

### 4.3 Computer usage and applications

Microsoft-Windows XP is the dominant brand of operating systems used in the construction industry in Gaza Strip since the majority of the contractors (around 90%) are applying the XP version of operating systems. Only three contractors (around 10%) were found using other versions of operating systems like windows 2000 or windows 98. On the other side, office software consists of general-purpose applications such as word processors, data base and spreadsheets. The surveys also investigated types of office software applications and to which extent have been used in the construction industry. Figure 2 show that the majority of respondents use word processors, graphics, cash flow, accounting soft ware and scheduling programs. On the other hand, other computer applications like costing, estimating and project planning packages are not as prevalent but their use is increasing. No results have been registered by any contractor regarding the use of either risk analysis or fields communications applications and that is due to the unavailability of software or qualified experts in these fields.

### 4.4 Accounting

The results indicated that 93% of the surveyed contractors use accounting functions when compared with other functions that the computer systems may be used for. That may be one of the major reasons for introducing computer systems by the contractors to their firms. In the field of accounting, most used software programs are locally designed to meet the necessary requirements of the contractors business like accounts receivable, accounts payable, accounts of taxes, salaries sheet and producing balance sheets and income statements. The results indicated that speed, minimal error, and quality of presentations are the basic advantages gained when dealing with computerized accounting. Updating accounts, and providing immediate reports of the up-to-date financial position, are of the most important applications of computer in the field of accounting. The use of accounting software contributed in keeping accurate records that could be used as basic information in similar future projects.

### 4.5 Word Log

It's predictable that the use of word processing applications is very high, with a percentage of 93% among all the participants, comparing with other computer functions, as most of the contractors reported purchasing the computers mainly for using word log. Computerized editing, updating, inserting, and printing of documents and records are the most widely appreciated applications among word processing applications. The computer systems have great ability to store all documents, letters, personnel information, photos and any required data. Such information is of great importance for managing and running the projects that executed by the company. Even at sites, usage of word log applications became most common in editing letters, reports and payments. The computer ability to record and retake the information facilitated the performance in the construction firms as well as improved the quality of paper work.

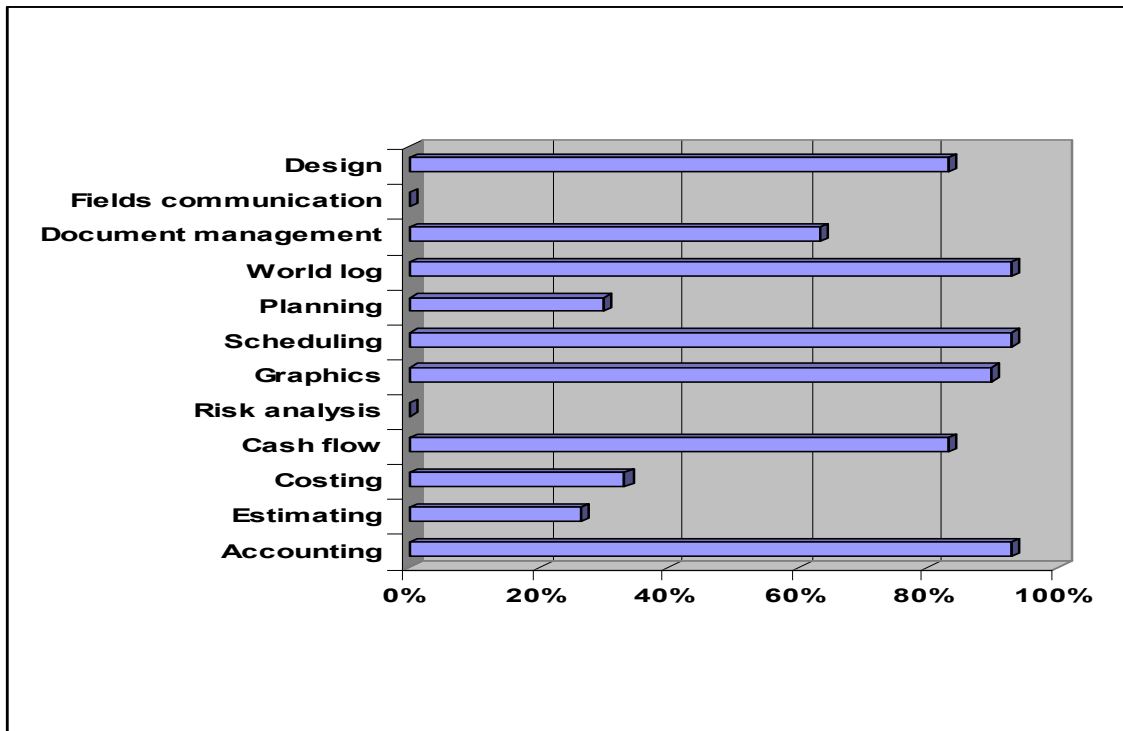


Figure 2: The computer applications within the contracting companies

### 4.6 Scheduling and graphics

The study indicated that around 93% of all participants use computerized scheduling and the majority of the contractors prepare time schedules for their projects using different versions of the Microsoft office project program. This program maintains detailed project schedule data and generates the required schedules and reports. The results revealed that large companies generally use the Microsoft office project software in a professional manner with more details in comparison with small and medium sized companies. A precedence diagrams, network formats and different reports are not very common with small and medium sized firms. Working with different alternatives, and hence achieving better decisions-making, was the main advantage of using computers in scheduling. Any change to the schedule can be reported more easily and updated schedule will be generated quickly. Quick results in time, cost, cash flows are also of the most important applications of Microsoft office project soft ware.

### 4.7 Estimating and costing

The study indicated that the applications of estimating and costing programs are used by only one-third of all participating in the survey. Only eight firms (26.5%) were found using some applications of estimating whereas ten contractors (33.3%) were using costing applications. The low percentage of using these types of programs is attributed to the expensive cost of such software, different considerations accounted for in the estimating process from one contractor to another and the availability of much easier and less expensive alternative methods such as excel applications. Also the absence of both qualified experts and training courses might be added to the reasons of the above results.



## 4.8 Design and Cad applications

### *CAD Users*

The influence of CAD on design and construction is growing tremendously and the varied levels of application of CAD are evident by all contractors of all sizes. Hence, higher levels of CAD proficiency were expected from the staff. In surveying the current literacy of staff in CAD, around 84% of all respondents indicated a high level of staff literacy, which is a good indication of the development in the field of design and its applications in the construction industry. At the other end of the spectrum lies 16% of the contractor's practices with "No" staff conversant with CAD. The high percentage of Cad users between the participating contractors is attributed to the increased abilities of fresh graduated engineers in this field and to continuous quick diffusion of Cad software within the construction industry in Gaza.

### *CAD packages*

In a query about the CAD package of choice, respondents indicate that AutoCAD is the most popular package used in contracting firms. This practice is also shared with New Zealand and Sweden, where AutoCAD represents the most common software in use. Second choice software packages, however, that are being used locally are different from those used internationally. In Gaza Strip other design packages are in the next rank particularly in architectural offices such as 3D studio whereas, Caddie and ArchiCAD rank second and third in South Africa, and ArchiCAD and MicroStation in Scandinavia are next in popularity. In Canada MicroStation and VisioTechnical are the next popular packages as stated by Arif in 2003. Such variance is probably related to external marketing, distribution factors and the particular requirements of the construction industry in each country.

### **Risks analysis**

The construction contracts are described as along term contracts and require much time for implementation on ground. Therefore, risks should be taken into account in the planning phase and during execution. Accordingly the analysis of risks incurred the construction projects are considered of an extreme importance reducing the troubles that might be arisen during the construction phase. Although, no case of any contractor have been reported for using the risk analysis applications through the survey of the construction industry in Gaza Strip. The reasons behind this result might be attributed to the fact that no proper planning is performed in construction projects, the unavailability of both risks analysis specialists and computer applications and finally to the lack of awareness in this issue.

### **Fields communications**

An area with a great advantage is the rapid communication between the firm's head office and construction fields using computer link. The study revealed that construction companies don't place any value on computerization several functions, such as linking with field offices and risk analysis. The study showed that none, even from the firms that are classified large, use the feature of computerized linking with jobsites. That might be attributed to many reasons such as the limited area in Gaza Strip, using other communications facilities like phones, faxes, mobiles and transports and to the limited volume of projects within Gaza Strip.

## 4.9 Factors affecting computer use

According to the mean value method, factors had been analyzed and ranked as shown in table (3). According to ranks of all factors affecting the extent of the computer use in contracting firms it is obtained that the majority of the participants agreed that the computer is an essential

component in their firms and it will be extremely difficult to ignore the importance of its applications in running their business. Lack of both computer experts and training programs occupied the first and second ranks with mean values of 3.80 and 3.77 respectively. These results revealed that there is an obvious shortage in computer usage in the Palestinian construction industry, and that's due to the insufficient skills of computer users and also to the unavailability of training programs in the construction sector, to recover, it is important to work with more efforts to enhance the use of computer in construction field by asking for the assistance of specialized experts.

*Table 3: Factors affecting computer use*

<i>Factors</i>	<i>Mean Value</i>	<i>Rank</i>
<i>Lack of computer experts</i>	<i>3.80</i>	<i>1</i>
<i>Lack of training programs</i>	<i>3.77</i>	<i>2</i>
<i>Cost effectiveness (return on investment )</i>	<i>3.40</i>	<i>3</i>
<i>Difficulty in selecting a software program</i>	<i>3.10</i>	<i>4</i>
<i>Difficulty in selecting the right system</i>	<i>3.07</i>	<i>5</i>
<i>Unsophisticated management methods</i>	<i>3.07</i>	<i>5</i>
<i>Lack of computer standards</i>	<i>2.97</i>	<i>7</i>
<i>Restrictive forms of output</i>	<i>2.90</i>	<i>8</i>
<i>Hardware and software incompatibility</i>	<i>2.70</i>	<i>9</i>
<i>Cost of software</i>	<i>2.43</i>	<i>10</i>
<i>Cost of hardware</i>	<i>2.00</i>	<i>11</i>

The third significant factor is cost effectiveness (return on investment) with mean value of 3.40. In order to explain this result, it's known that the local market of construction in Gaza Strip is still relatively small and that could be one of the reasons behind low investments by the contractors in the computer field. In general, contractors think that purchasing two or three computers could be sufficient to run their important functions such as accounting, word processing and scheduling. On the other side, they believed that other communication functions could be performed by different instruments like mobiles, telephones and faxes. Difficulty in selecting software programs as well as the right system came at the fourth and fifth ranks with approximately same mean values 3.10 and 3.07 respectively. These factors are among the significant factors that affecting badly the proper use of computer in the field of construction industry in Gaza Strip. On the other side the contractors still believed that the available computer programs such as excel, word, auto cad and accounting software are sufficient to facilitate their business.

#### **4.10 Areas of information technology advantages**

Also the questionnaire covered the advantages of the information technology in achieving the strategic goals required to improve the construction industry as it is ranked in Table (4).

Table 4: Areas of information technology advantages

<i>Factors</i>	<i>Mean Value</i>	<i>Rank</i>
<i>Communication</i>	4.77	1
<i>Time management</i>	4.23	2
<i>Business development</i>	4.03	3
<i>Quality</i>	3.33	5
<i>Profit</i>	3.37	4
<i>Safety</i>	2.73	6
<i>Environmental needs</i>	2.03	7

According to ranks of the information technology advantages in the construction industry, it is obtained that the information technology applications affected heavily in improving the communications either within the contracting firm itself or between the contractor and others like suppliers, subcontractors and clients. The most common tools that have been used in the construction industry are mobile, telephone, fax and internet facilities. Contractors and engineers most often use mobiles in running their daily programs of work whereas telephones and faxes are used mainly to link head office with jobsites, receive quotations and other routine work.

Time management and business development are among the top three significant fields that have been improved by using the information technology applications in the construction industry. The respondents stated that information technology contributed in time saving, faster implementation of projects and easier coordination between the different parties. Moreover, using planning and scheduling programs developed the performance of managerial and control abilities in the construction industry. On the other hand the information technology has minor effects in improving either quality or safety of work due to the unavailability of its applications in the local construction industry. Also the environmental needs occupied the last rank among all the other fields and that means that the information technology has the lowest effect in achieving the environmental goals.

#### 4.11 Future effects of information technology

The information technology will have a significant role in improving the communication, which ranked first, either with jobsites or with others like subcontractors, consultants, clients and suppliers (Table 5). Also it's expected by the respondents to start using the internet facility to facilitate the information exchange between the management at head office and jobsites. Also the information technology applications will help achieving better projects control which ranked second with a mean value of 4.23 and that should be done together with applying more training programs.

The majority of the respondents agreed that in order to obtain the maximum benefits of information technology in construction, engineers as well as management should improve their skills in different topics such as planning, project control, scheduling and communication skills. The need for more training, which ranked third with mean value of 4.20, became very urgent in

order to enhance the information technology in the construction industry. On the other hand increasing profits margins occupied the fourth rank with mean value of 4.07. This means that the IT will have the lowest effect in achieving better incomes to the contractors due to the fact that profits margins in construction industry are heavily related to the high competitions between the contractors.

*Table 5: Future effects of information technology*

<i>Factors</i>	<i>Mean Value</i>	<i>Rank</i>
<i>Improve communication</i>	<i>4.57</i>	<i>1</i>
<i>Develop projects control</i>	<i>4.23</i>	<i>2</i>
<i>Need more Training</i>	<i>4.20</i>	<i>3</i>
<i>Increasing profits margins</i>	<i>4.07</i>	<i>4</i>
<i>Improvement of scientific researches</i>	<i>3.57</i>	<i>5</i>

#### **4.12 Internet and electronic mail**

In a question about the availability of a particular home page used by the contracting firm, only seven contracting firms (around 23%) were found using the facility of web site in addition to the electronic e-mail; whereas around 74% of the participating contractors answered that they are using only the electronic e-mail in their business. Areas of main use behind having a home page in any contracting company are to provide more general information about the company itself as well as the projects implemented by the company. The main barriers to the widespread digital exchange of information are: the lack of common standards and training programs, the high speed of improvement in the field of information technology and the fact that this new mode of communication has still not been integrated in the business culture of the construction industry and ensuring the receiving of information still not guaranteed. These proportions are bound to augment as more companies are switching to better connections and as more players in the construction industry get accustomed to this mode of information exchange. Use of the Internet for online bidding and e-meetings was almost negligible.

### **5. Conclusion**

The aim of this paper was to presents the findings of a research project, which explores the current application of information technology (IT) in the Palestinian construction Industry. Research into such area is still in its early stages and there is an apparent need for further studies, especially at a national level. This paper has provided a description of the current state of IT and communications in the construction industry in the Gaza Strip. The paper first considered the overall and general knowledge that exists; where as the later part has presented some preliminary results from the survey. Palestinian construction companies are reasonably acceptable with regards to the use of PCs in different applications such as design, scheduling, word log and accounting.

The advent of IT has been both beneficial and detrimental. According to the respondents, IT has raised productivity in some business processes and particularly in general administration, design and project management. The main benefits achieved by the use of IT is an increase in the quality of documents, an increase in the speed of work, a better financial control, simpler and

faster access to common data as well as a decrease in the number of mistakes in documentation. The study revealed that construction companies don't place any value on computerization the function of linking with field offices. Lack of both computer experience and training programs are among the significant factors that affecting the use of computer in that field. The paper also covered the advantages of the information technology in achieving the strategic goals required to improve the construction industry as well as the future effects of information technology on construction field, it was found that communication, time management and projects control are the main areas of development.

It is recommended that top management in construction companies should have strong commitment to develop strategic management of IT in their business at all levels. They also are required to give greater attention to IT support and training by making sure that there is sufficient trained staff for the implementation of IT. The government and the public agencies should facilitate policies that encourage the use of IT in construction industry, thus pushing the industry in the right way.

## References

- Andersen, J. (2000) " A framework for Measuring IT Innovation benefits" *ITcon*, Vol. 5 pp. 57-72.
- Arif, A. and Karam, A. (2003) A comparative study: with insight into the use of IT in local architectural practices, (available online [http://itc.scix.net/paper\\_W78-8](http://itc.scix.net/paper_W78-8) [accessed on 20/11/2009])
- Aspin, R. (2001) "A Conceptual Framework for Multi-Modal Interactive Virtual Workspaces", *ITcon*, Vol. 7 pp. 149-162.
- Dawood N, Scott D, Sriprasert E and Mallasi Z, (2005) "The Virtual Construction Site (VIRCON) Tools: an Industrial Evaluation", *ITcon* Vol. 10, pp. 43 – 54.
- Egbu, C and Botterill , K (2002) " Information Technologies for Knowledge Management: Their Usage and Effectiveness", *ITcon*, Vol. 7 pp. 125-137
- Hicks, B.J. (2007) "Lean Information Management: Understanding and Eliminating Waste", *International Journal of Information Management*, 27(4), pp.233-249.
- Howard, R and Samuelson (1998)" Surveys of IT In the Construction Industry And Experience Of The IT Barometer in Scandinavia", *ITcon*, Vol. 3 pp. 45-56.
- Hue, G (2005) "IT Barometer 2003: Survey of the Singapore Construction Industry and Comparison of Results", *ITcon* Vol. 10, pp. 1-13.
- Mui, L (2002) "A survey of Internet Usage in the Malaysian Construction Industry", *ITcon*, Vol. 7 pp. 259-269.

O'Brien, M. and AL-Bbiqami, N. (1999) Survey of information technology and the structure of the Saudi Arabian construction industry, (available online [http://itc.scix.net/paper\\_W78-8](http://itc.scix.net/paper_W78-8) [accessed on 20/11/2009])

Pamulu, M and Bhuta, C (2004) "Managing Information Technology in Construction Industry: the Indonesian Experience" CIB World Building Congress, Toronto, Ontario, Canada.

Peansupap, V (2005) "Factors Enabling Information and Communication Technology Diffusion and Actual Implementation in Construction Organisations", *ITcon*, Vol. 10, pp. 193-218

Perreira, C.S. and Soares, A. L. (2007) "Improving the Quality of Collaboration Requirements for Information Management through Social Networks Analysis", *International Journal of Information Management*, 27, pp.86-103.

Rivard, H. (2000) "A survey on the Impact of Information Technology on the Canadian Architecture, Engineering and Construction industry" *ITcon*, Vol. 5 pp. 37-56

Samuelson, O. (2002) "IT-Barometer 2000, the Use of IT in the Nordic Construction industry" *ITcon*, Vol. 7 pp. 1-26.

Shash, A. and Al-Amir, M. (1997)" Information Technology in Contractors Firms in Saudi Arabia" *Construction Managements and Economics*, 15, pp.187-200.

Turk, Z. (2006) "Construction Informatics: Definition and Ontology", *Advanced Engineering Informatics*, 20 (2), pp.187-199.

Whyte, J. (2002) "IT implementation in the Construction Organization" *Engineering, Construction and Architectural Management*, 9 5/6, pp.371–377.

Williams, T. (2006) "The State-Of-Practice and the Future of Information Technology in Construction 2005" ASCE-CI Committee on Wireless Construction.

Zeng, S.X, Lou, G.X. and Tam, V.W.Y. (2007) "Managing Information Flow for Quality Improvement of Projects". *Measuring business excellence*, 11(3), pp.30-40.

## Quality Management System applied to architecture offices: report on a Brazilian experience in the city of Rio de Janeiro

**Mônica Santos Salgado**

Federal University of Rio de Janeiro, Architecture Post Graduation Course  
monicassalgado@ufrj.br

### Abstract

The improve of quality on Brazilian's civil construction industry have been stimulated after 1998 through the Federal Government with implementation of PBQPh – Brazilian Program for Quality and Productivity in the habitat. This program proposes the progressively comply with the requirements of ISO 9001/2000. The encouraging results obtained with this program can be testified by the construction enterprises which had incorporated the routines and improved their quality management systems. The reduction of constructive material waste, the improvement of buildings quality, the increase of productivity on construction site and the improvement of the qualification of hand-to-workman are some of the results obtained during the past ten years. The design sector was the last to join this initiative with the establishment, on 2008, of a quality management system program created specifically for design offices. The delay on the establishment of a quality management system for the design sector is related with the great resistance of professionals involved (architects and engineers) that couldn't comprehend the value of a quality program that could not assure the quality of the building itself. However, the experience of some architecture offices had proved that the establishment of a quality management system could also collaborate for the quality of the product. The purpose of this paper is to present the partial results obtained through a pilot-experience with a collaborative project among the researchers of Federal University of Rio de Janeiro (Universidade Federal do Rio de Janeiro - Brasil) and architecture offices. The firms have been selected considering their interest on quality management systems. Among the partial results obtained, it is important to emphasize the impact of knowledge management for the implementation of a quality management system.

**Keywords:** design management, quality management, quality control

## 1. Brazilian effort to improve quality on construction sites

Quality management can be defined as an adjustment to certain requirements. In Brazilian civil construction industry, this concept gained its biggest impulse into the 90's, when companies initiated their search for new methodologies for the management of buildings site. At the beginning, the proposals had considered:

- the use of certified buildings materials;
- the establishment of procedures to be used on construction sites;
- the qualification of man-work on standardized processes.

Considering the importance of the construction industry in Brazilian's economy, the Federal Government instituted in 1998 the Brazilian Program for Quality and Productivity in the Habitat (PBQP-H). This program's overall objective is to provide support to the Brazilian effort of modernizing the construction industry by promoting quality and productivity in residential construction.

PBQP-H was structured in projects, based on a matrix model. Each Project corresponds to a set of actions that contributes directly towards the Program's development and seeks to solve a specific problem in the construction industry.

Every project is developed by the Federal Government in conjunction with specialists, sector associations, consultants and the private sector, and has the support of a technician of the General Coordination and of the Technical Assistance Group (*Grupo de Assessoramento Técnico – GAT*), which acts as process facilitator and is responsible for ensuring that actions of all Program projects are compatible.

One of PBQP-H's triggering projects is the **System of Conformity Assessment for Construction Companies** (*Sistema de Avaliação da Conformidade de Empresas de Serviços e Obras – SiAC-Obras*). The objective of SiAC-Obras is to evaluate the compliance of quality management system of Brazilian construction companies based on ISO 9001 quality management system standards..

The evaluation of construction companies' compliance according to SiAC-Obras is divided into four levels: D, C, B and A. Each level has standard guidelines that have to be met by the companies that are interested in being certified. Each standard guideline includes which ISO 9001 requirements have to be met. This way, companies gradually develop their quality management systems until eventually reaching the "SiAC-Obras level A" qualification.



## 2. Characterization of the design development sector for the construction industry and concern with quality

The concern for quality during the development of the designs (architecture, structure, etc) initiated when the researchers proved that most of the problems identified during the construction were due to failures in the conception. By the end of the 20th century, Helene (1992) said that, based on studies, approximately 40% of the pathologies that occur in buildings start in their planning and design phases. Thanks to this observation, professionals of the sector became interested in discussing design management process.

Tzortzopoulos (1999) highlighted the importance of developing a model that would help in the design management process: a development plan where the main activities and their priorities - as well as roles and responsibilities of the main participants of the process and information flow - would be defined. In her research, the author observed that, in general, designers have a process approach that is restricted to their specific area of expertise which proves their lack of knowledge of the process as a whole.

Melhado (1994) introduced the “production design” concept. This new type of design must defines the organization and sequence of construction activities and working fronts; the equipment use; the arrangement and evolution of the construction site, among other items.

This proposal gave birth to the following discussion, conducted by Fabrício (2002), who suggested the simultaneous engineering logic be applied to the building design process. However, he mentioned the lack of models capable of globally treating the integration between the design and the client, the production process and undertakings’ entire life cycle.

### **It became necessary to map the design process and organize companies to ensure proper production flow in design management.**

Ferreida (2006) concludes with her research into architecture offices certified by ISO 9001 that the certification itself does not represent a market issue, and that the high financial cost constituted an obstacle for maintaining a certified management system. However, all surveyed companies acknowledged the importance of a QMS (Quality Management Sytem) to organize their production processes. The companies investigated had confessed that one of the difficulties in regards to the organization of the management system is to reconcile the development of each employee’s everyday tasks with the production of the documents the system requires, as well as implement a culture change in the company.

What one can see is that companies that try to implement the quality system very often make mistakes, such as (SALGADO, 2004):

- in the procedures, they describe the *ideal* and not the *real* process;

- they describe details that do not affect quality, but stiffen the process;
- they plan for inspections at the beginning, during or at the end of the process, but do not detail the parameters that should be observed;
- they plan to use reference documents for the application of procedures/work instructions, but do not consider them fully when carrying out the processes.

It should be emphasized that the quality management system created for the building design offices is supposed to help the management of the information, thus making work easier and contributing indirectly to the quality of the designed building.

### **3. The current moment: quality management systems models for building design's offices**

The design management process has sparked the interest not only in researchers, but also in professionals of the field, who see a possibility to improve their productivity with quality and efficiency.

Among the architects who has manifested on the topic, Mahfuz (2003) has criticized severely management models pointing out the importance of drawing the distinction between design management process certification and certified architecture.

According with this author, some architecture offices use the "ISO 9001 quality seal" as misleading advertisement, since the simple certification of a company's quality management systems does not ensure the quality of the architecture produced by this same company.

This discussion confronts the two meanings of a design:

- design as product – refers to the building itself;
- design as process – refers to the sequence of activities that are required to turn the original construction idea (concept) into guidelines that have to be followed by the construction company in order to create the product, i.e. to build the building.

Another aspect that compromises the implementation of a quality management system in design companies is their resistance to complying with ISO 9001 requirements. The professionals of the area say that the model proposed by the norm is not applicable at small companies. Based on the need of creating a management system that is consistent with the reality of designs offices, researchers in the field developed some management models, incorporating this production sector's particularities.

### 3.1 Different proposals for design management models

Of all presented proposals, we would like to highlight the one the Brazilian Architecture Office Association (AsBEA - *Associação Brasileira dos Escritórios de Arquitetura*) prepared in 1992, which offered a basic routine for the development of architecture designs with the objective of establishing information, subsidies, requirements, procedures and “end products” for each phase or step of the work.

In 1997, the CTE (*Centro de Tecnologia de Edificações*), in partnership with the Union of Construction Industry of São Paulo (*Sindicato da Indústria da Construção Civil de São Paulo SINDUSCON-SP*), prepared a “Quality Management Program in Design Development for the Construction Industry” that intended to gradually self-implement improvements to the design process, by understanding the flow of design process activities, mainly the need to develop the strategic planning of design companies (Tzoropoulos, 1999).

In the search of a model that was geared towards small design companies, Oliveira (2005) prepared a proposal, including guidelines for the management of the main processes and functions of the small building design offices such as: organizational structure, strategic planning, design process planning and control, cost management, commercial management, information system, H/R management, project-aggregated services and performance evaluation. Oliveira tried to establish a model that is different from those offered by ISO standard, because – according to him – the implementation and maintenance of ISO 9001-based quality management systems are very costly, requires a great deal of bureaucracy, requires a staff exclusively dedicated to issues related to the specific quality management system, among other issues. According to his opinion, this aspects make the ISO quality management system unfeasible for small companies.

The Brazilian Architecture Office Association (AsBEA) focused again on the topic of the design management process and published, in 2006, a series of manuals whose main objective was to establish the scope of the services related to the development and coordination of design. AsBEA does not suggested any specific management model, but pointed out the issues that the companies must consider when organizing their management systems.

### 3.2 Management model proposed by PBQP-H

The Brazilian Federal Government addressed the concerns of the Brazilian construction industry, specifically the design sector by creating, in 2008, the Compliance Evaluation System for Design Offices (SiAC-Projetos). This system was created within the Brazilian Program for Quality and Productivity in the Habitat (PBQP-H) and has the following main properties:

- Four implementation stages;
- Four standard guidelines – one for each stage;
- **STAGE 1** – Statement of Adhesion to Standard Guideline of Stage 1;

- **STAGES 2, 3 and 4** – Certification by Certification Bodies (CO) or Authorized Certification Bodies (CCO) with *in loco* audits.

**Table 1 – Compliance Evaluation System for Companies that are specialized in preparing projects stages**

<b>STAGE</b>	<b>PHASES</b>
<b>Stage 1</b>	<p><i>PHASE 1 – Characterization of the company and of its planning and management processes</i></p> <p><i>PHASE 2 – Contractor relations management</i></p> <p><i>PHASE 3 – Document management</i></p> <p><i>PHASE 4 – Communication management</i></p>
<b>Stage 2</b>	<p><i>PHASE 1 - Characterization of the company and of its quality planning and management processes (complement)</i></p> <p><i>PHASE 3 – Document management (Quality Manual)</i></p> <p><i>PHASE 5 – Design process management</i></p> <p><i>PHASE 6 – Customer satisfaction management</i></p> <p><i>PHASE 7 – Evaluation and Improvement</i></p>

Source: (PBQP-H, 2008).

Design offices will be certified according to the qualification stage they have reached. For example, in this proposal, design offices could obtain the “stage 2” certification permanently, without necessarily meeting all management system requirements set forth by standard ISO 9001; this will make it easier for small and medium-sized design companies. Qualification stages 3 and 4 include ISO 9001 requirements. Offices wishing to implement the system up to stage 4 receive a standard-equivalent ISO 9001 certification.

## **4. Report on an experience with design companies in the city of Rio de Janeiro**

### **4.1 Characterization of the Project and of the involved companies**

In order to conduct the experience of following up on SiAC-Projetos implementation in design offices, a work proposal had been presented to three design companies located in the city of Rio de Janeiro.

The objective of this proposal was to prepare the design companies to be qualified in “stage 2” of SiAC-Projetos (PBQP-H). After this phase, depending on how work progresses, companies may remain at stage 2 or upgrade the implemented management system, expanding the documents and registration so to meet the requirements of the following levels until they reach ISO 9001 certification.

Table 2 lists the characterization of the design companies that agreed in participating of this pilot project.

**Table 2 – Characterization of companies that participated in the project.**

<i>Companies</i>	<i>A</i>	<i>B</i>	<i>C</i>
<i>Foundation year</i>	1987	2006	1986
<i>Number of employees</i>	6	33	39
<i>Activity niche</i>	<i>Architecture projects, including all phases, and coordination of residential and business projects.</i>	<i>Real estate, schools, special projects (dealers, stands, squares, etc)</i>	<i>. Architecture projects: coordination and development of executive projects . Engineering projects: infrastructure for developments and groups (implementation, earthwork, drainage, sewage system, drink water, power supply, lightening, etc).</i>
<i>What do you expect from implementing a quality management program at your company?</i>	<i>To improve the company's performance; record the adopted operation and organization; improve the workflow and information management.</i>	<i>To organize the company's management system by establishing routines in order to comply with contracts, reduce errors and rework.</i>	<i>To standardize the procedures used by the company (from internal administrative processes to the services rendered to clients) in order to ensure the quality (deadlines, costs and technical quality) of the services we render to our clients.</i>

NOTE: Data obtained in December 2008.

The selected companies had also the following common characteristics:

- Interest in participating in a cooperation project;
- Operate professionally in the development, coordination and compatibilization of design;
- Not to have an implemented quality management system.

The suggested work dynamics considered holding bi-weekly meetings, which would take place alternatively at the University's or at the involved companies' location. At the request of the companies, the work initially took place in monthly meetings. However, six months later the group realized that it was necessary to intensify the periodicity of the meetings and went back to the original proposal of holding bi-weekly meetings.

## 4.2 Company diagnosis and work routine

Before starting the project, it was necessary to **diagnose** each company as for the existing management system and the tasks to be introduced for the implementation of the management system as suggested in SiAC-Projetos (PBQP-H).

**Table 3 – Design company diagnosis as for stage 1 requirements**

<b>REQUIREMENTS</b>	<b>A</b>	<b>B</b>	<b>C</b>
<b>Phase 1 requirements (Company characterization)</b>	<i>Fully met.</i>		
<b>Phase 2 requirements (Management of contractor relations)</b>	<i>Some procedures had already been implemented for the process, but they had not been documented.</i>		
<b>Phase 3 requirements (Document management)</b>	<i>Some of the procedures had already been implemented, but lacked formal registration.</i>	<i>Some of the necessary procedures had not been defined yet.</i>	<i>Some of the procedures had already been implemented, but lacked formal registration.</i>
<b>Phase 4 requirements ([internal and external] Communication management)</b>	<i>Communication management procedures were in place, but were only partially documented.</i>	<i>Communication management procedures were in place, but were only partially documented.</i>	<i>Communication management procedures were in place and were entirely documented and implemented, undergoing continuous feedback and improvement. In his opinion, this issue was solved at the company.</i>

NOTE: Data obtained in December 2008.

Based on the companies' diagnosis, the management system implementation process started, discussing document management procedures. The three companies understood that this requirement was partially met; it was therefore chosen as the priority to initiate the establishment of a new quality management system.

### 4.3 Role of information management at design companies

By discussing document and data control, some doubts came up regarding document creation. Routines have to be established for the following situations:

- a. Control of technical documents and data (designs);
- b. Control of administrative documents and data (payroll, issued invoices, delivery receipts, etc);
- c. Control of Quality Management System documents and data;
- d. Backup of documents and data;
- e. Registration of system users (access to the network);
- f. Control and safety of digital data.

The first step for the implementation of a design quality management system into design offices was the knowledge management. Information and communication technologies meet this need by offering possibilities of organizing information over cooperation networks. These networks can help professionals of different companies to make contact and also they facilitate the record of design data and the accompanying of design development.

#### 4.4 Difficulties in implementing a quality management system

Although the three companies involved acknowledge the importance of establishing a quality management system and the advantages of its implementation, in the middle of the year (2009), one of the involved companies decided to abandon the project. We believe that the causes of such decision reflect the main challenges these companies have to face when defining their management models. According to the director these were the reasons that led them to interrupt the process (SALGADO, 2009):

- little **TIME** dedicated to organizing the company's management system: the director believes that the implementation of a quality management system cannot be done in your spare time. The company should allocate some time to perform this task;
- the implementation of the system has to become a **PRIORITY**: if it is not perceived as a priority, it ends up ranking second and being forgotten. Considering that the implementation of a quality management system initially generates costs and no revenue for the company, executing the company's daily tasks is the priority;
- a professional of the company has to be assigned to be **EXCLUSIVELY** dedicated to the organization of the quality management system. This aspect is closely linked to the others. Smaller companies also have more limited resources, and it is therefore not always possible to assign a person that will exclusively perform this task.
- The **OVER-OPTIMISTIC MARKET** increases the demand for services at the companies and, consequently, the time to perform the tasks for the implementation of a quality management system is reduced. In addition, on a heated market, companies have problems keeping professionals and hiring new ones. Therefore, they work hard to meet the deadlines defined in the contracts.

The director of the company that has chosen to abandon the implementation of the quality management system added that, in his opinion, for **FAMILY** business companies the process is even more complicated. According to him, it is common in this type of companies not to have a formalized organizational structure – especially in regards to its management. When directors in this type of companies have conflicting opinions the system implementation does not go ahead.

## 5. Final considerations

Based on the reported experience, we can conclude that knowledge management is the first step for the organization of a quality management system in design offices. We can also establish some guidelines as follows:

**Establish unique codes for each file** – there can be no duplicity when identifying files, even if they are filed in different directories or subdirectories;

**Organize the file directory and subdirectories on the server** – this should allow all coworkers to quickly identify the used path when searching for a specific work document. The company should establish its own rules on how to open new folders on the server (mentioning the professional within the company that has that responsibility), and to migrate these folders to the permanent file, after the work is concluded.

**Verify the safety and control the access to the documents** – not everybody working at the design company has to access all company folders. Even small companies should take this preventive measure. Unfortunately, that does not always happen. Our suggestion would be to establish safety protocols for access documents with registered passwords.

**Ensure the integrity of the office's information and data backup** – A routine has to be in place – preferably an automated mechanism – that ensures that a safety backup of all the design company's files is done at different times of the day.

Both companies that stayed on the project acknowledged that the problems pointed out by the one that have abandoned the project are true; they are aware that they will have to overcome these problems if they really wish to conclude the implementation of their quality management systems. The goal for 2010 is to conclude the project, meeting all requirements up to Stage 2, and to conduct the first audit of the implemented system in order to obtain the official certification.

Finally, it has to be emphasized that the first phase of the discussion on design management process at Brazilian companies has relativized the importance of aspects, such as the quality in the design conception of the building, user satisfaction, among others. This happened due to the urgency in reducing design errors, such as incompatibilities between the different specialties, the discrepancies between the last reviewed version of the design and the one that is actually being executed on the construction site, and the problems in tracking design tem decisions.

## Acknowledgements

The author thanks all directors of the companies: *ART5 Planejamento e Projeto*; *FEU Arquitetura* and *SEICOR Projetos e Obras*.



## References

ASSOCIAÇÃO Brasileira dos Escritórios de Arquitetura, *Manual de Contratação dos Serviços de Arquitetura e Urbanismo*, Ed. PINI, São Paulo, 1992

FABRÍCIO, Márcio Minto *Projeto Simultâneo na Construção de Edifícios* Tese de Doutorado. Departamento de Engenharia de Construção Civil, Escola Politécnica/USP, 2002

FERREIRA, C. *Contribuição aos Estudos para a Implantação de um Sistema de Gestão da Qualidade em escritórios de Arquitetura*. 2006. 122 f. Dissertação (Mestrado em Arquitetura) – PROARQ/FAU/UFRJ, Rio de Janeiro, 2006.

MELHADO, S. B. *Qualidade do projeto na construção de edifícios: aplicação ao caso das empresas de incorporação e construção*. 1994. Tese (Doutorado) - Escola Politécnica, Universidade de São Paulo, São Paulo.

OLIVEIRA, Otávio José. *Modelo de Gestão para pequenas empresas de projeto de edifícios*. Tese de Doutorado. Departamento de Engenharia de Construção Civil, Escola Politécnica/USP, 2005

PROGRAMA BRASILEIRO DA QUALIDADE E PRODUTIVIDADE NO HABITAT *Sistema de Avaliação de Conformidade de Empresas de Serviços e Obras da Construção Civil – SiAC, Especialidade Técnica Execução de Obras*, Ministério das Cidades, Brasília, 2005

PROGRAMA BRASILEIRO DA QUALIDADE E PRODUTIVIDADE NO HABITAT *Sistema de Avaliação de Conformidade de Empresas de Serviços e Obras da Construção Civil – SiAC, Regulamentação da Especialidade Técnica Elaboração de Projetos*, Ministério das Cidades, Brasília, 2008

SALGADO, M. S. *Apostila para a disciplina Gestão da Qualidade e Administração de Equipes*. PROARQ/FAU/UFRJ, 2001.

\_\_\_\_\_. *Produção Arquitetônica e Interdisciplinaridade: uma discussão sobre o processo do projeto e a ISO 9001/2000*. In: Anais da I Conferência Latino-Americana de Construção Sustentável e 10º. Encontro Nacional de Tecnologia do Ambiente Construído. São Paulo: ENTAC, 2004

\_\_\_\_\_. *Estratégias para a gestão de projetos nas empresas*. Palestra apresentada no evento Soluções para Empresas de Projeto. João Pessoa, Paraíba, 2009.

TZORZOPOULOS, Patrícia *Contribuições para o desenvolvimento de um modelo do processo do projeto de edificações de empresas construtoras incorporadoras de pequeno porte* Dissertação de Mestrado apresentada ao Curso de Pós-Graduação em Engenharia Civil, UFRGS, 1999



## Session 5 - Sustainable Facilities Management

Dr. Paul Detwiller<sup>1</sup> & Prof. Dr. Francisco Ferreira Cardoso<sup>2</sup>

<sup>1</sup>Zurich Institute of Applied Sciences - Institute of Facility Management - Waedenswill/Switzerland

<sup>2</sup>EPUSP Escola Politécnica, University of São Paulo - MBA/USP TGP - São Paulo/Brazil

<b>Green Buildings and FM - A Case Study on How FM Influences the Environmental Performance of Office Buildings</b>	<b>309</b>
KYRÖ, Riikka <sup>1</sup> ; MÄÄTTÄNEN, Eeva <sup>1</sup> ; ANTTILA, Anna <sup>2</sup> ; LINDHOLM, Anna-Liisa <sup>1</sup> ; JUNNILA, Seppo <sup>1</sup>	
<sup>1</sup> Aalto University, Finland	
<sup>2</sup> ISS Palvelut Ltd., Finland	
<b>The role and effectiveness of a formal sustainability policy in facilities management</b>	<b>321</b>
PRICE, Samantha Jayne <sup>1</sup> ; PITT, Michael <sup>2</sup> ; MARMOT, Alexi <sup>2</sup> ; TUCKER, Matthew <sup>2</sup> ; MCLENNAN, Peter <sup>2</sup> ; UCCI, Marcella <sup>2</sup>	
<sup>1</sup> Liverpool John Moores University	
<sup>2</sup> University College London	
<b>Sustainable Asset Management of Heritage Buildings</b>	<b>333</b>
JONES, Keith; LIAO, Hanwen	
School of Architecture & Construction, the University of Greenwich	
<b>Improvement Suggestions for Sustainability Certification – Standardization and FM</b>	<b>347</b>
SCHNEIDER, Daniela; LENNERTS, Kunibert	
Karlsruhe Institute of Technology (KIT), Germany	
<b>Facilities management and building's environmental performance</b>	<b>359</b>
DEGANI, Clarice Menezes; CARDOSO, Francisco Ferreira	
University of São Paulo	
<b>Facilities Management and Certification of Sustainability of the Built Environment: A Comparative Analysis for the real estate operation of hydraulic systems in commercial buildings</b>	<b>371</b>
SANTOVITO, Carla Cristina; GONÇALVES, Orestes Marraccini	
Escola Politécnica, University of São Paulo, Brazil	



# Green Buildings and FM - A Case Study on How FM Influences the Environmental Performance of Office Buildings

Riikka Kyrö<sup>1</sup>; Eeva Määttä<sup>1</sup>; Anna Anttila<sup>2</sup>; Anna-Liisa Lindholm<sup>1</sup>; Seppo Junnila<sup>1</sup>

(1) Aalto University, Finland

(2) ISS Palvelut Ltd, Finland

contact author: riikka.kyro@tkk.fi

## Abstract

Over the past decade it has become well-known that the built environment is a major contributor to climate change. It is further known that the majority of carbon dioxide emissions caused by buildings are created during the operating phase of existing buildings. In other words, the way a building is managed and maintained has a major impact on the environmental performance of the building. Notwithstanding, research and discussion have to date mainly focused on green design and the construction of new buildings. Particularly in Europe, the role of facility management (FM) in the green building market has not been adequately addressed. Facility services typically include, but are not limited to, maintenance of air conditioning, electric power, plumbing and lighting systems; and cleaning. Several of these services may have a significant impact on the environmental performance of a building. The aim of this study is to identify and understand the role of FM in the environmental performance of existing office buildings. The study is conducted using case study methodology. The green building indicator system used as a reference is the United States Green Building Council's LEED for Existing Buildings: Operations and Maintenance Rating System (hereinafter "LEED EB"). The rating system is specifically tailored for existing, operational buildings and was chosen due to its wide international recognition. The case facility represents a rather typical Finnish office building dating from the 1980's, where all major facility services are provided by a single FM provider. In the study, facility service processes of the FM provider are compared and analyzed against the chosen green building indicator. The study reveals the surprisingly central role the FM service processes play in the environmental performance of an office building. The FM service processes have both direct and indirect influence on environmental indicators and performance metrics. Based on the study, FM providers readily hold a great portion of the data required for green management.

**Keywords:** green building, LEED, facility management (FM), operating phase, office building

## 1. Introduction

Over the past decade it has become well-known that the built environment is a major contributor to climate change. The built environment (i.e., residential and commercial buildings) accounts for roughly 40% of both the total energy consumption and the carbon dioxide emissions in Europe (COD/2008/0223) and the U.S. (USGBC, 2010a). Furthermore, research (Rosenblum et al, 2000) has shown that, even when compared with the industrial sector, the service industry (including the use of commercial buildings) accounts for a surprisingly large portion of all environmental impacts in areas such as energy consumption. Consequently, reducing the environmental impacts of commercial buildings represents significant potential.

An estimated 80% (Junnila and Hovarth, 2003; Junnila et al, 2006) of climate change impacts caused by commercial buildings are created during the operating phase of existing buildings. Moreover, existing commercial buildings will continue to represent the majority of the building stock far into the future. Notwithstanding, research and discussion associated with environmental performance of commercial buildings has to date mainly focused on building technologies and the construction of new buildings. Particularly in Europe, less attention has been paid to the role of FM in the green building market. However, based on previous research, FM could potentially support user organizations in their effort to become more environmentally sound (Hodges, 2005; Roper and Beard, 2006; Nousiainen and Junnila, 2008). Furthermore, as Hodges (2005) suggests, facility managers are unique in bearing knowledge of historical, current, and future operations, i.e., the entire life-cycle of a building. Appropriate FM practices can, consequently, improve an organization's sustainability. This study suggests that the focus of green building research be shifted from new buildings to the operation and maintenance of existing buildings. The lack of new developments, resulting from the current economic downturn, could accelerate the shift.

The purpose of this research is to identify and understand the role of FM service processes in the environmental performance of office buildings. More specifically, this study aims to determine which areas of environmental performance would be most efficiently managed through FM. It is hypothesized that FM service processes play a central role in an office building's environmental performance. The working hypothesis has been that FM organizations can significantly support client organizations in their efforts to minimize their total environmental impact. FM organizations can for instance provide information and knowledge of the building operation systems and, particularly in long-term service agreements, produce reference data from previous years as along with information on potential trends.

Following this introduction, Section 2 briefly defines the concepts of facility management and green building. Section 3 describes the research approach and methodology, while Section 4 presents and analyses the major findings. Finally, the Section 5 discusses the findings further, draws conclusions, and provides recommendations for the application of the results and future research.

## 2. FM and Green Buildings Overview

### 2.1 Facility Management

Facility management (FM) can be described as the integration of an organization's non-core services, primarily related to the maintenance and care of buildings. The aim of facility management is to support the organization in their core business. The potential scope of facility management is very broad and can vary greatly. The European Committee for Standardization (CEN 2007) divides the scope of facilities management in two categories based on client demand: Space & Infrastructure and People & Organization. The former includes client demands for space, working environment, utilities, hygiene and cleanliness. The latter category comprises client demands for a safe environment, a hospitable working environment, information and communication (ICT) services, and logistics, i.e. transport and storage of goods. The categories are not intended as exhaustive and other client specific demands and related services potentially exist as well.

Several of the aforementioned services may have a significant impact on the environmental performance of a building. Consequently, as previous research (Nousiainen and Junnila, 2008) has demonstrated, end-user companies already expect facility managers to be able to provide environment and energy related services. End-user companies wish to receive comprehensive reporting and recommendations on improving their environmental performance. Energy system commissioning and green cleaning policies are examples of such improvements.

### 2.2 Green Buildings

Green buildings are buildings or structures that have less impact on the environment than conventional buildings. The environmental aspects to be considered in estimating the impact include, at a minimum, energy and resource use, waste generation, pollution, and indoor air quality (US EPA, 1995). The green building practice ideally considers all of the environmental aspects listed above, and therefore does not equal building energy-efficiency, as sometimes falsely perceived. Furthermore, green building is a practice that extends throughout the entire life-cycle of a building, not just the design and construction phase.

It is worth noting that the term sustainable building is sometimes used synonymous to green building. However, generally only the environmental dimension of the triple bottom line of sustainable development (environmental, social, and economical) is considered when evaluating green buildings. This paper refrains from using the term "sustainable" to avoid confusion.

Many green building indicator systems are available globally, the most well-known being the British BREEAM and the U.S. based LEED. Others include HK-BEAM (Hong Kong), DGNB (Germany), Green Star (Australia), as well as CASBEE (Japan). While all mentioned indicator systems have similar scopes, the criteria differ, making benchmarking difficult (Reed et al., 2009). However, Lee and Brunett (2007) found that LEED, BREEAM, and HK-BEAM do not show significant differences when estimating building energy efficiency.

### 3. Research Approach and Methodology

The study was conducted using case study methodology. A single-case design is used in order to retrieve detailed empirical data on the studied phenomenon (Yin 1994). As the study hypothesizes that an FM organization can play a significant role in the environmental performance of an office building, it was of importance to find a plausible critical case for the testing of the hypothesis. The three different elements of this case study and their respective selection criteria are described in the following chapters.

#### 3.1 Case Facility

The subject of this case study is a 16,300 square meter office facility housing the Finnish headquarters of the information technology corporation Hewlett-Packard (HP), employing ca. 800 staff. The building was first developed in 1984. An extension was built and major renovation carried out in 1991. The building parameters are presented in Table 1 below.

*Table 1: Building Parameters*

<b><i>Building Parameters</i></b>	<b><i>Value</i></b>
<i>Location</i>	<i>Espoo, Southern Finland (Northern Europe)</i>
<i>Current service life</i>	<i>24 years (1984)</i>
<i>Gross floor area</i>	<i>16,300 m<sup>2</sup> (~175,451 ft<sup>2</sup>)</i>
<i>Gross Volume</i>	<i>70,000 m<sup>3</sup> (~2,471 000 ft<sup>3</sup>)</i>
<i>Structure</i>	<i>3-storey with basement</i>
<i>Employees</i>	<i>800</i>
<i>Operating energy (2008):</i>	
<i>Heat</i>	<i>124 kWh/m<sup>2</sup>/year</i>
<i>Electricity</i>	<i>146 kWh/m<sup>2</sup>/year</i>

The HP facility is considered to represent a rather typical Finnish commercial facility. According to Statistics Finland (2010), a significant portion (22%) of existing commercial buildings in Finland date from the 1980's. Additionally, the facility is located in the Helsinki Metropolitan Area in Southern Finland, with the highest density of commercial buildings in the country (KTI Property Information Ltd, 2010).

#### 3.2 FM Organization

The partner FM organization in the research is ISS Palvelut Ltd (hereinafter referred to as "ISS"), which is part of the global ISS Group. ISS Group is one of the world's largest commercial providers of facility services. ISS operate in 53 countries and the service repertoire is individual for every country. For the purpose of the research, it was perceived important that



the studied FM organization provides a so called Total FM (TFM) service. Atkin and Brooks (2009) define TFM as follows:

*“Total facilities management is where a single entity takes responsibility for all facets of facilities management”.*

ISS use the term Integrated Facility Services (IFSs) as equivalent to TFM. ISS’s main services comprise cleaning, property, catering, and security services, with a number of supporting services; all provided using the IFS solution. ISS consider a service solution including three or more different services IFS.

Since September 2008, ISS has provided all major facility services for the HP facility using the IFS solution. Altogether 20 ISS staff, including a service manager work on site. The provided services comprise cleaning services, waste management, catering services, indoor and outdoor property services (i.e., air conditioning maintenance, housing automation, plumbing and lighting systems), in-house mail delivery services, reception of goods, office services, pest services as well as energy control services.

### 3.3 Green Building Indicator

The green building indicator system chosen as a reference in this study is the United States Green Building Council’s LEED for Existing Buildings: Operations and Maintenance Rating System (LEED EB). USGBC’s LEED was chosen due to its wide international recognition and popularity: 19,926 registered projects and 5,166 certified projects worldwide in July 2010 (USGBC 2010b). Majority of the LEED projects are located in the US, but LEED is also gaining interest in Europe, including Finland. At the time of this study, there were 4 certified and 14 registered LEED projects in Finland. LEED EB is a rating system specifically tailored for existing, operational buildings. In addition, the facility subject to the case study was in the process of adopting the LEED EB rating system.

LEED rating systems have been criticized, e.g., for the systems’ poor consideration of building materials (Marsh, 2008; Bowyer, 2007) and energy-efficiency (Gifford, 2008). However, the LEED EB rating system does have a broad approach to different environmental aspects, which is essential in estimating the environmental impact of a building. The rating system comprises altogether seven (7) categories with which the environmental performance of operational buildings is measured. Of the seven categories, six are applicable internationally. The six internationally applicable categories have been outlined by the USGBC (2010c), as follows:

- ***Sustainable Sites (SS)***. *Discourages development on previously undeveloped land; minimizes a building's impact on ecosystems and waterways; encourages regionally appropriate landscaping; rewards smart transportation choices; controls storm water runoff; and reduces erosion, light pollution, heat island effect and construction-related pollution.*

- **Water Efficiency (WE).** Encourages smarter use of water, inside and out. Typically achieved through more efficient appliances, fixtures and fittings inside and water-wise landscaping outside.
- **Energy and Atmosphere (EA).** Encourages a wide variety of energy strategies: commissioning; energy use monitoring; efficient design and construction; efficient appliances, systems and lighting; the use of renewable and clean sources of energy, generated on-site or off-site; and other innovative strategies.
- **Materials and Resources (MR).** Encourages the selection of sustainably grown, harvested, produced and transported products and materials. Promotes the reduction of waste as well as reuse and recycling, and takes into account the reduction of waste at a product's source.
- **Indoor Environmental Quality (IEQ).** Promotes strategies that can improve indoor air as well as providing access to natural daylight and views and improving acoustics.
- **Innovation in Operations (IO).** Provides bonus points for new and innovative technologies and strategies beyond other LEED credit requirements or for considerations not addressed in LEED. Rewards projects for including a LEED Accredited Professional on the team.

The above categories comprise altogether 52 credits from which a maximum of 106 points can be obtained. The basic level certification requires the minimum of 40 points, silver level 50 points, gold level 60 points and the highest level, platinum, 80 points.

The research was conducted by analyzing existing ISS service processes and comparing them against the LEED EB criteria.

### 3.4 LEED EB Process

Despite the age (first developed in 1984) of the facility, no major structural or technical refurbishments were needed to achieve the green building certificate. The facility has been appropriately maintained, and many environmental aspects had already been taken into consideration. Most recently, remote real-time energy monitoring of the building was included in the facility services. However, some modifications were required to achieve desired results in the certification process. Most of the required changes involved adjusting various set point values and operating schedules in the building automation system. The most significant actions performed comprised the installation of a water pressure reduction valve to the main water line in order to control the fixture water flows, and replacing one chiller system with a system including a free-cooling exchanger.

The needed process or documentation changes were implemented prior to the beginning of the performance period of the LEED EB certification system. The performance period started 1

December 2009 and ended 31 March 2010, covering 4 months. The FM practitioners and researchers cooperated actively throughout the certification and research processes. The following Section presents the main findings of the case study.

## 4. Findings

As a result of a preliminary analysis by the FM, the case facility decided to attempt a Gold level certification. The required score for the Gold level is 60 points. In this case, 66 of the 106 available points were deemed feasible to attain without major upgrades or alterations. The pursued points fall quite evenly between the different LEED categories, as can be seen from Table 3.

The study focused on the role of FM services in the achievement of the green building points. Based on thorough analysis of the certification process, the following categories were developed, indicating the influence, or “impact potential” of the FM provider on the pursued points.

1. **Fully attainable with FM’s internal policies and processes.** *FM readily holds the information or documentation required to meet the criteria, or FM has full control over the processes included in the criteria. Meeting the criteria is independent of the site characteristics and occupant. Credit Example: Green Cleaning Program.*
2. **FM has operational impact and can influence the points achieved.** *FM plays a central role in meeting the criteria via operating the systems, equipment or processes in question and can produce the required documentation. However, meeting the criteria also depends on the site characteristics and occupant. Credit Example: Optimize Energy Efficiency Performance.*
3. **FM has operational impact, but cannot influence the points achieved.** *FM has no impact on whether the systems, equipment or processes in question are in place, but can implement the required changes and produce the necessary documentation. Meeting the criteria depends on the site characteristics and occupant. Credit Example: Protect and Restore Site Habitat*
4. **FM can act as an expert advisor.** *FM can perform tasks, such as occupant surveys, required by the green building system, or advice on the best practices. Meeting the criteria depends on the site characteristics and occupant. Credit Example: Alternative Commuting Transportation.*

LEED EB entails nine prerequisites that must always be met in order to achieve certification. The prerequisites are grouped according to the respective impact potential of the FM provider in Table 2.

Table 2: Impact Potential of FM - LEED EB Prerequisites

Impact Potential	Prerequisite
Fully attainable with FM's internal policies and processes	-EA P1 Energy Efficiency Best Management Practices - Planning, Documentation, and Opportunity Assessment - EA P3 Fundamental Refrigerant Management - MR P2 Solid Waste Management Policy - IEQ P3 Green Cleaning Policy
FM has operational impact and can influence the points achieved	- WE P1 Minimum Indoor Plumbing Fixture and Fitting Efficiency - EA P2 Minimum Energy Efficiency Performance - IEQ P1 Minimum Indoor Air Quality Performance
FM has operational impact, but cannot influence the points achieved	-
FM can act as an expert advisor	- IEQ P2 Environmental Tobacco Smoke (ETS) Control - MR P1 Sustainable Purchasing Policy

SS = Sustainable Sites, WE = Water Efficiency, EA = Energy and Atmosphere, MR = Materials and Resources, IEQ = Indoor Environmental Quality, IO = Innovation in Operations

Most notably, four out of nine prerequisites are fully attainable through the FM provider. Furthermore, another three can be influenced by the FM, even though dependant on the subject facility. Only two out of the nine prerequisites could not be influenced by the FM. However, with these two prerequisites, the FM was still able to advice on best practice.

Once the prerequisites have been met, the credits to be pursued can be chosen freely, as long as the certification minimum of 40 points is achieved. The 66 points pursued by the case facility are presented in Table 3, divided by both the LEED EB category (horizontally) and the impact potential of the FM provider (vertically).

Table 3: Impact Potential of FM – LEED EB Points

LEED Category \ Impact Potential	SS	WE	EA	MR	IEQ	IO	POINT TOTAL	of point total
Fully attainable with FM's internal policies and processes	2	-	6	1	5	1	15	23%
FM has operational impact and can influence the points received	-	10	13	3	9	4	39	59%
FM has operational impact, but cannot influence the points achieved	3	-	1	-	-	-	4	6%
FM can operate as an expert advisor	7	-	-	1	-	-	8	12%
POINT TOTAL	12	10	20	5	14	5	66	
of point total	18%	15%	30%	8%	21%	8%		100%

SS = Sustainable Sites, WE = Water Efficiency, EA = Energy and Atmosphere, MR = Materials and Resources, IEQ = Indoor Environmental Quality, IO = Innovation in Operations

The results show that the FM had either direct or indirect (operational) impact on 82% of the points achieved by the case facility. The vast majority of the points achieved were either readily available due to the FM's existing internal policies and practices (23%, 15 points) or indirectly influenced by operations conducted by the FM (59%, 39 points). Moreover, the categories with less FM impact potential represent the minority of the achieved points with the shares of 6% (4 points), and 12% (8 points), respectively.

## 5. Discussion

The built environment plays a major role in fighting climate change and delivering a sustainable economy as the built environment accounts for roughly 40 % of both the total energy consumption and the carbon dioxide emissions globally. Furthermore, it is estimated that approximately 80% of carbon emissions caused by buildings are created during the operating phase of existing buildings, making the topic of this research both relevant and current. The initial hypothesis was that that FM plays a significant role in supporting end-user organizations in their efforts to minimize their total environmental impact.

The study shows, that using LEED EB as indicator for green performance an office building dating from the 1980's, the FM organization had either direct or indirect (operational) influence on 82% of the LEED points achieved by the building. The vast majority of the points earned by the subject facility were either readily available due to the FM organization's existing internal policies and practices (23%, 15 points) or substantially but indirectly influenced by operations conducted by the FM organization (59%, 39 points). The latter category is of course dependent on both the characteristics of the existing building, and the willingness of the end-user to adopt the points.

It should be noted; however, that only one service provider was assessed against a single green building indicator system. Moreover, the case study represents a situation where all FM services are provided by one service provider using an integrated facility service (IFS) solution. Since the case study is conducted in Finland, the results may not be applicable for other countries. It is therefore not possible to make wide generalizations based on the results. However, the study exemplifies the impact potential of an active FM organization in a reliable manner.

As previous research (Nousiainen and Junnila, 2008) has demonstrated, end-user companies expect facility managers to be able to provide environment and energy related services. This research has shown that, at least in the case of a leading Finnish FM organization, these services partially already exist, as part of the FM organization's internal policies. Additionally, the study has demonstrated that for a FM organization providing a wide range of services it is possible to contribute to several of the green building criteria. It can be argued that FM organizations are well equipped to guide the end-user through a green building certification process, since the required information is already in-house and readily available. What is needed is an active, even proactive, approach to the building occupant's potential green building initiatives.

Future research on the role of FM could focus on other countries, such as the U.S., where the number of LEED certified buildings is immensely greater than anywhere else in the world. Furthermore, similar studies using different green building indicators (BREEAM, HK-BEAM), energy efficiency or carbon footprint calculation as the measure of environmental performance would be of interest.

## References

- Atkin, B and Brooks, A (2009) *Total Facilities Management*. 3<sup>rd</sup> ed. Oxford: Wiley-Blackwell.
- Bowyer, J L (2007) *Green Building Programs - Are They Really GREEN?* Forest Products Journal, **57**: 9; 6.
- COD/2008/0223 *Proposal for a Directive of the European Parliament and of the Council on the Energy performance of buildings* (available online <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0780:FIN:en:PDF> [accessed March 2010])
- Gifford, H (2008) *A better way to rate green buildings?* (available online [www.energysavingscience.com/articles/henrysarticles/BuildingRatingSystems.pdf](http://www.energysavingscience.com/articles/henrysarticles/BuildingRatingSystems.pdf) [accessed February 2010])
- Hodges, C P (2005) *A facility manager's approach to sustainability*, Journal of Facilities Management, **3**: 4; 312.
- Junnila, S and Horvarth, A (2003) *Life-Cycle Environmental Effects of an Office Building*, Journal of Infrastructure Systems, **9**: 4; 157-166.
- Junnila, S, Horvath, A, and Guggemos, A A (2006) *Life-Cycle Assessment of Office Buildings in Europe and the United States*, Journal of Infrastructure Systems, **12**: 1; 10-17.
- KTI Property Information Ltd (2010) *The Finnish Property Market 2010*, (available online [http://www.kti.fi/kti/doc/ajankohtaista/KTI\\_FMP\\_Final\\_net.pdf](http://www.kti.fi/kti/doc/ajankohtaista/KTI_FMP_Final_net.pdf) [accesses May 2010])
- Lee, W L and Burnett, J (2007) *Benchmarking energy use assessment of HK-BEAM, BREEAM and LEED*, Building and Environment, **43**: 1882-1891.
- Marsh, A (2008) *Is Green Really Green?* Commercial Property News, **22**: 2; 32-35.
- Nousiainen, M and Junnula, S (2008) *End-user requirements for green facility management*, Journal of Facilities Management, **6**: 4; 266.
- Roper, K O and Beard, J L (2006) *Justifying sustainable buildings - championing green operations*, Journal of Corporate Real Estate, **8**:2; 91.
- Rosenblum, J, Horvath, A; and Hendrickson, C (2000) *Environmental Implications of Service Industries*, Environmental Science & Technology, **34**: 22; 4669-4676.

Reed, R, Bilos, A, Wilkinson, S and Schulte, K-W (2009) *International Comparison of Sustainable Rating Tools*, Journal of Sustainable Real Estate, 1: 1; 1-22.

Statistics Finland (2010) *Statistical Databases*, (available online [http://www.stat.fi/tup/tilastotietokannat/index\\_en.html](http://www.stat.fi/tup/tilastotietokannat/index_en.html) [accessed May 2010])

The European Committee for Standardization (CEN) (2007) *Facility Management. Part 1: Terms and definitions*, SFS-EN 15221-1.

United States Green Building Council (USGBC) (2010a) *Green Building Facts*, (available online <http://www.usgbc.org/ShowFile.aspx?DocumentID=5961> [accessed March 2010])

United States Green Building Council (USGBC) (2010b) *LEED Projects & Case Studies Directory*, (available online <http://www.usgbc.org/LEED/Project/CertifiedProjectList.aspx> [accessed May 2010])

United States Green Building Council (USGBC) (2010c) *What LEED Measures?* (available online <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1989> [accessed February 2010])

US EPA (1995) *Green Buildings Vision and Policy Statement*, (available online <http://www.epa.gov/greeningepa/projects/policy.htm> [accessed April 2010])

Yin, R (1994) *Case study research, design and methods*, 2nd ed., Sage Publications, Thousand Oaks, CA.





## The role and effectiveness of a formal sustainability policy in Facilities Management

**Samantha Price<sup>1</sup>,**  
s.j.price@ljmu.ac.uk

**Michael Pitt<sup>2</sup>,**  
m.r.pitt@live.co.uk

**Alexi Marmot<sup>2</sup>,**  
a.marmot@ucl.ac.uk

**Matthew Tucker<sup>2</sup>,**  
matthew.tucker@ucl.ac.uk

**Peter Mclennan<sup>2</sup>**  
p.mclennan@ucl.ac.uk

**Marcella Ucci<sup>2</sup>**  
m.ucci@ucl.ac.uk

<sup>1</sup>Liverpool John Moores University

<sup>2</sup>University College London

### Abstract

The paper develops the level of understanding of the current position of FM providers surrounding sustainable FM. The research establishes, through looking at a sample of FM companies, the level of commitment the FM industry is dedicating to the sustainability movement through looking at the sustainable business practice which stems from their Sustainability Policy (SP).

A data analysis of 65 FM companies was carried out. The companies were all members of the BIFM and were a mix of small, medium and large companies (according to employee number) as well as a mix of FM only organisations or FM+ (an FM branch of a construction firm for example). The data analysis looked at each company's commitment to sustainable business practice and the affect organisational characteristics had on this. This was achieved by creating a predetermined list of self questions to complete for each company; covering organisational characteristics and indicators to sustainable practice.

The research found that companies which have a sustainability policy are more likely to implement sustainable business practice, resulting in gaining awards, reporting on sustainable issues and setting targets. Many companies that do not have a policy still participate in these areas but less effectively. Company size also has a significant effect on sustainable business practice, with large companies much more likely to behave in a sustainable way.

This paper does not look at the reasons for not having a sustainability policy or practising sustainable business management. The paper demonstrates the purpose and effectiveness of a formal Facilities Management sustainability policy. As such the paper is useful in the preparation of a sustainability strategy.

# 1. Sustainable Facilities Management

## 1.1 Introduction

It is becoming accepted that sustainable FM (Facilities Management) will need to take into account social, economic and environmental aspects of sustainability to deliver the increasingly demanded rounded service (Elmualim et al, 2009). To deliver environmental targets and to exist in a sustainable environment both technological and attitudinal changes are needed. The FM profession is able to affect the technological and behavioural change needed to deliver the environmental targets due to their position of influence over how the building is used (Elmualim et al, 2009). The regulations being agreed by Government are going to directly impact FM activities, through FM being made directly responsible for implementing change to reduce emissions in an increasing number of areas (Elmualim et al, 2010).

## 1.2 Forces for change

The common view of the FM function as being responsible for managing buildings or being a maintenance department often does not match the modern reality of FM. Fm is increasingly seen as being woven into the core and support services of a given company, supporting the primary objectives of that organisation (Nazali et al, 2009; Edum-Fotwe, 2003; Nutt, 2004). To produce effective FM there is a need to integrate a multidisciplinary of activities and skills to design the facilities to suit the end user, moving away from FM as solely managing a facility but to managing facilities incorporating HRM (human resource management), IT and wider business support (Nutt, 2004; Edum-Fotwe, 2001; Pitt and Hinks, 2001; Alexander, 1992; Price, 1999). FM is emerging as an important corporate discipline, reflecting the fact that FM related costs can represent the second largest operating costs after personnel and the cost of the asset (Edum-Fotwe, 2003; Brandt, 1994; Puddy, 2001). A competitive edge can be achieved for organisations through effective and efficient use of the facilities (Patheridge, 2008; RICS, 1999; Pitt and Hinks, 2001).

Corporate Social Responsibility or ethical fund management is forcing organisations to be more open with investment decisions (Walker et al, 2007; Hannagan, 1998), with 75% of large companies reported as being under pressure to develop non financial measures of performance (Hubbard, 2009). Following the focus on sustainable construction, Government policy is increasingly being designed to target emissions resulting from the existing building stock. All of these commitments, and others, require the input of FM in order for them to be achieved. Their role has the potential to be at the forefront of delivery of sustainability due to the impact FM has on the selection, operation and management of properties (DTI, 2009). The BIFM carried out a survey in 2007 which found that over 60% believe the scope of FM will expand within their organisations over the next five years (BIFM, 2007).

ISO 14001 can be used as a method to manage and implement environmental and legal requirements. To gain accreditation organisations must have in place a framework to prioritise and address their environmental impacts (Walker et al, 2007; Watson & Emery, 2004). Organisations currently find legislation a major driving force for environmental improvement (Williams et al, 1993; Kok and Saint

Bris, 1994, Hillary 1995, Edum et Fotwe, 2001; Baylis, 1998). However the pressure felt by organisations from legislation is not as widely reported, which is reflected in company reports (Walker et al, 2007; Napper, 2003).

### 1.3 Sustainability Policies and FM

Creating a sustainability policy (SP) and indeed living in a sustainable society is the balance of demands from economic, political, ecological and technological angles (Shin, 2008). It has been found that 31% of FM organisations report that they do not have a sustainability policy, with the main barriers to practising sustainable FM being time constraints, lack of knowledge and lack of senior management commitment (Elmualim et al, 2010; Baylis, 1998).

Within the educational sector, it has been found that a company having in place an environmental policy does not mean that environmental and sustainable policies are implemented any further down in the company structure (Elmualim et al, 2010; Carpenter, 2002; Baylis, 1998; Carpenter and Meehan, 2002). Carpenter and Meehan (2002) undertook a study of 10 educational institutions and found that all 10 had environmental policies; but there proved to be varying degrees of implementation of that policy (Carpenter and Meehan, 2002). Only one institution had a direct funding agreement in place for an environmental management plan, not all had management level involvement and in some cases the SP was as far as the environmental management plan had developed. However, the survey did indicate that the FM department played a strong role in implementing environmental management policies (Carpenter and Meehan, 2002).

There have been many reasons cited for why small to medium companies from all sectors do not have SP in place. Many of such companies do not feel that they need a SP due to the view that they have no environmental problems, do not feel pressure to target environmental issues or do not believe that environmental issues present a threat or opportunity to the organisation (Baylis, 1998). Companies with environmental policies are not necessarily motivated to act on them, and thus may not implement the ideas any further into business practice (Baylis (1998). This indicates a gap between the creation of a SP and what companies are capable of doing (Baylis, 1998; Shin, 2008). This could again link to the pressure that companies feel to appear to be acting in a sustainable and environmentally innovative way through the corporate social responsibility (CSR) arena (Hubbard, 2009). Organisations are motivated by different factors; however studies have shown that companies are motivated by the compulsory (legal) and financial factors (Shin, 2008; Baylis, 1998).

### 1.4 The value of a policy

A policy is not fixed; it consists of language resulting from discussion and argument and is developed through analysis (Massa, 1997). This could result in a SP not having the ability to directly lead to action on sustainable issues but rather lead to discussion of the subject in formulating opinions and ideas. In developing a SP the driving implications of possible solutions may deter the implementation, for example if a financial cost is associated with the commitment to a sustainable agenda then this policy may be diluted to prevent a firm commitment to an agenda (Massa, 1997). This may result in a weak attempt to develop policy ideas throughout the company, and the policy may be used as a

method to appease the CSR audience. The envisioned potential lack of solutions to accepted problems may also act as barrier to a commitment of a sustainable solution (Elmualim et al, 2010).

So far the practice of sustainability reporting has often involved publishing a separate sustainability report in addition to Annual Reports (Hubbard, 2009; O'Dwyer 2005). This has the drawback of keeping sustainability as a separate entity and separate from financial reporting. Current methods of reporting also result in biased results with organisations focusing on the positives (Hubbard, 2009).

## 2 Research Design

### 2.1 Methodology

This research is intended to capture the frequency of FM companies having in a place a SP and the commitment shown to this SP through established sustainable business practice. A data analysis was undertaken through looking at reports and data from 65 companies in order to capture information against predefined parameters (shown below); this was then linked to indicators of sustainable business practice evidenced. The data was gained from the internet and databases containing company information, this reduces bias and the potential for erroneous data provided through human input.

A sample size of 65 was chosen with a spread of characteristics to represent the wide ranging company structures that feature within the FM industry. The sample was taken from members of the British Institute of Facilities Management (BIFM). In the sample there are 26 large companies, 24 medium sized companies and 15 small companies (according to employee number). The sample also included a spread of companies which were classed as FM only, so a standalone FM company, or FM+, a FM branch of a construction firm for example.

Firstly basic business characteristics were captured, which were then linked to indicators of sustainable business practice.

Firstly the following organisational factors were captured:

- Turnover
- Employees number
- Size according to employee numbers (CEC, 1996)
- Whether the company was an FM provider only (FM) or a FM subsidiary department (FM+<sup>1</sup>)
- The existence of a SP or not

---

<sup>1</sup> Meaning FM+: covering either a FM department or subsidiary within a larger construction company or a FM company which provided additional services other than FM. In each case the data was collected for the FM arm only. Out of the sample there are 21 FM+ organisations.

The following factors, which were considered to reflect the implementation sustainable business practice, were captured:

- The prevalence of sustainability as topic of consideration throughout business operations,
- The existence of environmental targets,
- The achievement of environmental awards<sup>2</sup> or accreditation,
- The existence of a reporting structure for environmental factors.

This method of data capture was chosen to avoid human input and erroneous data capture. Previous studies have highlighted that the sustainable activities of organisations can be embellished due to their awareness of the modern need to appear environmentally conscious, and to appeal to the CSR audience. In previous cases it has been found that companies have answered affirmatively to having a SP in place, only for there to not be one when the company was visited for further research (Baylis, 1998). A data analysis removes the input from participants directly and carries out an analysis of the information which is published in the public domain.

## 2.2 Analysis

The following analysis procedure was carried out for the test areas:

- Frequency distribution tests: identifying initial trends in percentages
- Multiple Correspondence analysis: to graphical represent the correspondence between parameters
- Chi squared test: To test the statistical significance of the data

The data will be tested in two areas; to find whether the likelihood of a company having a SP is affected by any major organisational factors such as size, turnover, and company structure. The second area is to test the significance of the SP and whether the policy is devolved through business practice.

## 3 Findings

### 3.1 Area one: Size and company structure

#### 3.1.1 The impact of organisational size

The majority (55.4%) of FM companies tested did have a SP in place, the remaining 44.6% not having a SP in place. The size of the company is an important organisational factor that is likely to affect the position of a SP. The sample shows that out of the companies that have a SP, 73% are large, 54% are

---

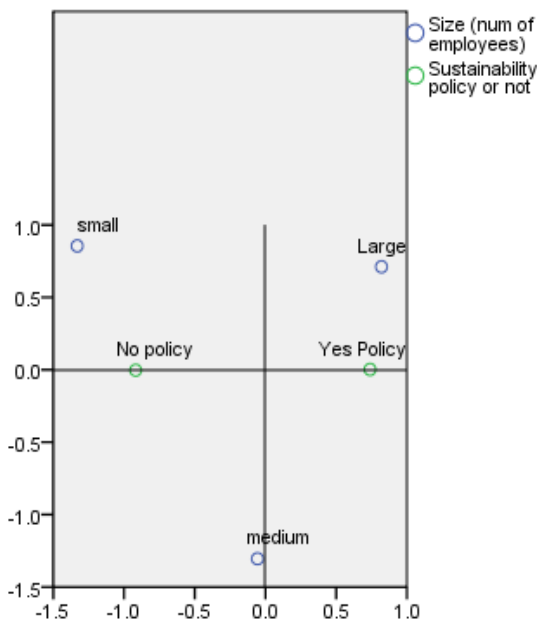
<sup>2</sup> Environmental awards, are awards which the organisation has gained specifically for environmental and sustainable achievements within the company direct.

medium and 27% are small organisations. This relationship is statistically significant with  $p < 0.05$  ( $p = 0.016$ ). It can be said with confidence that large companies are more likely to have a SP. Elmualim *et al* (2009) found that 69% of their total sample had an SP in place, this is higher than the findings here. However, this could support the idea that commitment to sustainability is often exaggerated, especially since the responses to the survey were self selected and voluntary. The data analysis removes this opportunity for human exaggeration in this fashionable topic.

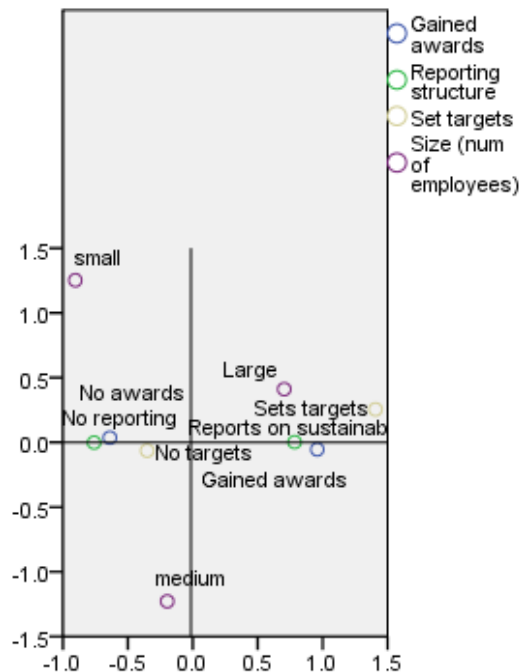
The size of the company may have an effect on the likelihood of the company implementing sustainable business practice; within the sample:

- 40% of companies had gained environmental awards or accreditation. Of these 65.4% were large companies, 31% were medium and, 3.8% were small companies. This relationship is significant with  $p < 0.05$ , ( $p = 0.001$ ). It can be said with confidence that large companies are more likely to have gained environmental Awards or accreditation.
- In the sample 53.8% of companies report on Sustainable issues: out of that sample 53.1% are large companies, 34.3% are medium sized companies and 12.5% are small companies. This relationship is significant with  $p < 0.05$ , ( $p = 0.053$ ). It can be said with confidence that large companies are more likely to report on sustainable issues.
- 20% of companies set environmental targets; of these 53.8% are large companies, 31% are medium sized and 15.4% are small companies.

The multiple correspondence analysis below indicates the correlation between the variables, the closer the variables are on the graph, the higher the correspondence or link between the two.



**Figure 1. Graph to show correspondence between Size and SP**



**Figure 2. Graph to show correspondence between Awards, Reporting structure, Targets and Size**

There is a strong correspondence between size of company and a SP, with a clear correspondence between large companies and having a SP, and between small companies and no SP.

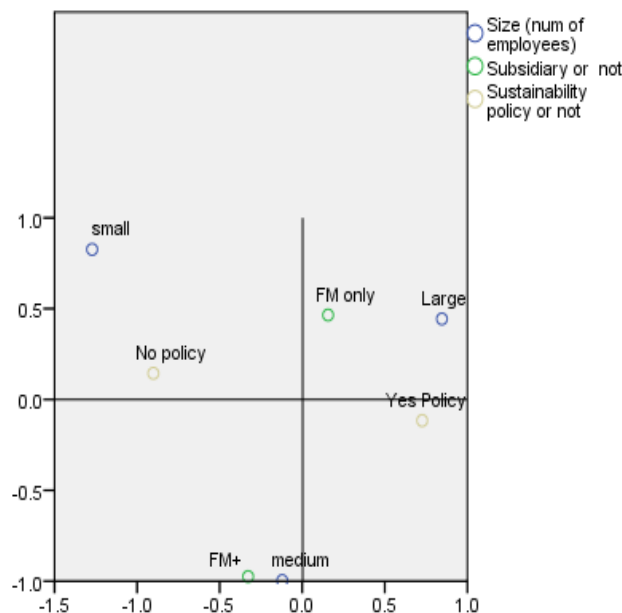
		Reports on sustainability		Sets targets		Achieved awards	
		Yes	No	Yes	No	Yes	No
Yes SP	Freq	26	10	12	24	19	17
	%	72.2	27.8	33.3	66.7	52.8	47.2
No SP	Freq	6	23	1	28	7	22
	%	20.7	79.3	3.4	96.6	24.1	75.9

Table 1. The influence of a SP

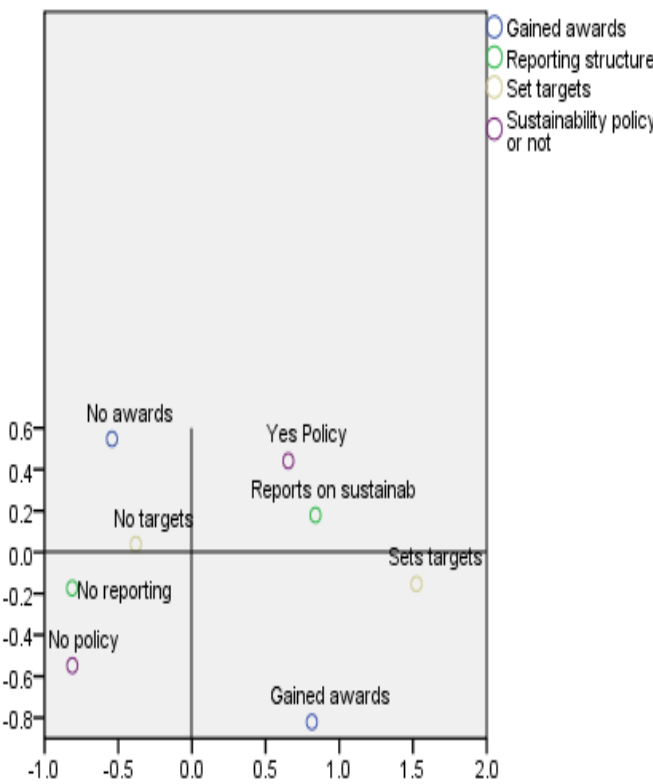
### 3.1.2 Company structure

Out of the sample a proportion of the companies were ‘stand alone FM companies’ and the remainder were subsidiary groups or an FM department within a wider company, for the purpose of this write up titled ‘FM+’. The nature of the structure of the company was captured to understand whether this affected the link between the type of company which create and implement a SP. In linking the nature of the provision of the service provided by the companies it can be seen that:

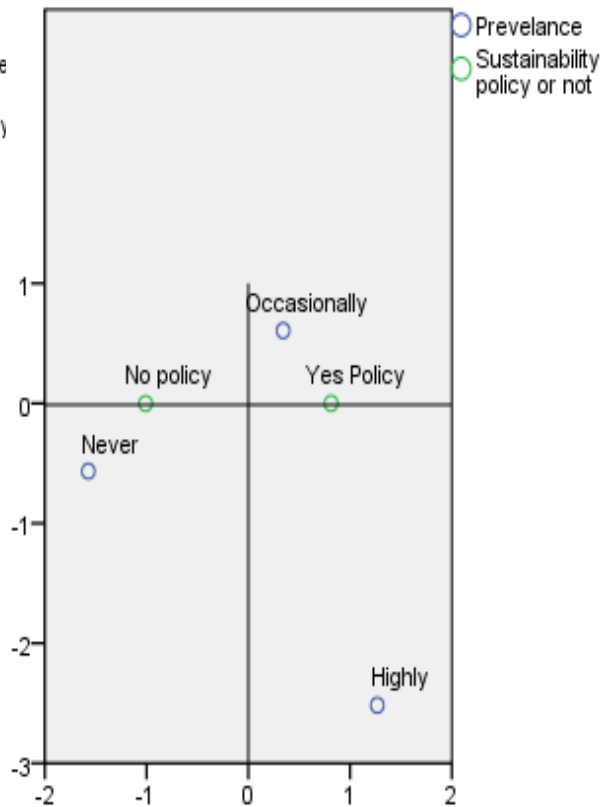
- 32% of large companies that are FM only companies have a SP.
- The provision of a SP for medium sized firms was less affected by being part of a wider company or being a standalone FM company.
- Large companies providing FM only were more likely to provide a SP than if they were part of a wider company, however, they were still more likely than not to provide a SP.
- 75% of small companies who have a SP are ‘FM only’.



on Sustainable issues, out of the companies which have a SP 72.2% report on sustainable issues. This is statistically significant at  $p < 0.05$  ( $p = 0.000$ ). The majority companies in the sample did not have environmental targets, at 80%, this is statistically significant at  $p < 0.05$  ( $p = 0.003$ ). Out of the companies that had a SP 33.3% had set environmental targets, out of the companies that do not have a SP only 3.4% have environmental targets. However, setting targets is still the least likely application of sustainable practice. The correspondence between not setting targets and not having an SP is the highest correlation



**Figure 4. Graph to show correspondence between Awards, Reporting structure, SP**



**Figure 5. Graph to show correspondence between SP and occurrence of sustainability**



Cross tab	$\chi^2$	df	Asymp. Sig.	
Size* SP	8.314	2	0.016	The size of a company is significant. Large companies are more likely to have an SP.
Size*gained awards	14.370	2	0.001	Large companies are statistically more likely to gain environmental awards.
Size* reporting	5.881	2	0.053	Large companies are statistically more likely to report on sustainable issues.
SP* Awards	5.489	1	0.019	The highest count is for no SP and No awards.
SP*Reporting structure	17.065	1	0.000	Highest count is for companies with an SP to Report on Sustainable issues.
SP* setting targets	8.966	1	0.003	The highest count is for companies with No SP to Not set targets.

Table 2. Influence of company size and SP (Chi-Squared)

#### 4. Successes and draw backs of the method of data collection

A data analysis was carried out to gain frank and factual answers to the above survey by looking at official company data and policy. There is a risk, due to the popularity of CSR that if companies and individuals are targeted directly to discuss their sustainable practices that answers may not be entirely correct. The data analysis by-passes this problem by looking only at official company data archives to eliminate human intervention and perception from the results as far as possible. The next stage is to develop an understanding of the motivations behind establishing sustainable business practice in FM organisations. This will involve the human factor, to explore the reasons further.

#### 5. Conclusion

When a SP is in place there is a much greater chance of further sustainable initiatives being woven into the company. This shows that the SP does have an influence on sustainable business practice; however, it could be limited as the relationship is not exclusive, not all companies which have awards, report on sustainable practice and set targets have a SP. This could be due to the nature of the industry as an FM company can gain an environmental award for one project due to a specific client request or culture but the FM company itself does not have to have a standard procedure for all contracts.

There is evidence to show that the size of the organisation has a high impact on the commitment made to sustainable business practice. It was found that size of the company (number of employees) was a stronger determinant for the presence of SP than type of company (i.e. whether a standalone FM company or FM subsidiary of a construction firm). However, FM only companies were more likely to have an SP than FM+ companies. Large companies are more likely to implement sustainable business

practice; through having achieved awards, report on sustainable issues and set environmental targets. This supports previous research indicating that large companies are more likely to have a SP in place (Baylis, 1998). However, the research shows that within the FM industry sustainable business practice is not yet embedded, but beginning to play more of an influential role, especially amongst the larger companies. As all companies do not report on sustainable practice as standard and do not have environmental targets.

This research adds to the information available on the commitment of FM organisations to the sustainable agenda. It would be of interest to repeat this process annually to see the developments in this area with the increased level of environmental legislation being developed. In addition further research into the underlying reasons for why company size and the creation of an SP have a strong affect. This could be carried out through structured interviews.

## References

- Alexander, K (1992) "Facilities Value Management" *Facilities* volume 10, number 3, page 8-13
- Alexander, K (1992) "The emergence of Facilities Management in the UK National Health Service" *Property Management*, Vol. 1, issue 1, page 31-41.
- Baylis R et al (1998) "Company size, environmental regulation and ecological modernisation: further analysis at the level of the firm" *Business Strategy and the Environment*. Issue 7, page 285-296.
- BIFM (2007) "Survey shows key role for FMs in business continuity and sustainability" 21-06-07 10:00 BIFM <http://www.bifm.org.uk/bifm/news/3899>
- Brandt R. M. (1994) "*A guide to strategic facilities planning*", Howarth, Mich.
- Carpenter, D and Meehan, B (2002) "Mainstreaming Environmental Management" *International journal of Sustainability in Higher Education* Volume 3, issue 1, page 19-37
- Commission of the European Communities. (1996) "Commission recommendation of 3 April 1996 concerning the definition of small and medium-sized enterprises "(96/280/EC), *Official Journal of the European Communities* L, 107, Page 4–9.
- DTI: Department for Trade and Industry (2009) "Strategy for Sustainable Construction: Facilities Management" DTI Consultation Events
- Elmualim et al (2010) "Barriers and commitment of Facilities Management profession to the sustainability agenda" *Building and Environment* . Vol. 45, No. 1, pp 58-64
- Edum-Fotwe et al (2003) "Designed needs into infrastructure projects: Case from a major hospital" *Journal of Performance of constructed Facilities*. Vol. 17, issue. 1, February 1, 2003
- Edum-Fotwe, F. T. (2001) "Review: Facility management: Risks & opportunities"
- by Bev Nutt and Peter McLennan, ed., Oxford: Blackwell Science, 2000." *ARCOM Newsletter*, 2, 6–7.
- Hillary, R. (1995) 'Small Firms and the Environment' A Groundwork Status Report, (Groundwork, Birmingham).
- Kok, E. and Saint Bris, H. (1994) 'Voluntary environmental initiatives in industry: what role for EMAS?' *European Environment*. Vol. 4, No 4, pp 14–17.
- Massa, L & Rydin, Y (1997) "Urban Sustainability: Discourses, policy, networks and policy tools" *Progress in Planning*. Volume 37, issue 1, June 1997, page 1-74.

- Nazali, M, Noor, M and Pitt, M (2009) "A critical review on innovation in Facilities Management service delivery" *Facilities*. Vol. 27, issue 5/6, page 211-228.
- Nutt B. (2004), "Infrastructure and facilities: forging alignments between supply and demand", Conference Proceeding of Future in Property and Facility Management II, A Two-day International Conference, University College London, London.
- O'Dwyer B, Owen D. (2005) "Assurance statement practice in environmental, social and sustainability reporting: a critical evaluation". *British Accounting Review Volume 37*, page 205–229.
- Pathirage, C (2008) "Knowledge management practices in facilities organisations: a case study" *Journal of Facilities Management* Vol. 6 No. 1, pp. 5-22
- Pitt, M and Hinks, J (2001) "Barriers to the operation of the Facilities Management: property management interface" *Facilities*. Volume 19 . Issue 7/8, page 304 -307.
- Price, I and Ahklagi, F (1999) "New patterns in Facilities Management industry best practice and new organisational theory", *Facilities*. Vol. 17, issue 5/6, page 159-66.
- Puddy, F.R., Price, I. and Smith, L. (2001), "FM policies and standards as a knowledge management system", *Facilities*, Vol. 19, issue 13/14, pp. 504-14.
- RICS (1999), *Facilities Management and the Chartered Surveyor*, Report.
- Saunders et al (2009) "Research Methods for Business Students" 5<sup>th</sup> edition (Pearson Education Limited; England)
- Shin, D (2008) "Development of a sustainability policy model for promoting cleaner production: a knowledge integration approach" *Journal of Cleaner Production* Volume 16, Issue 17, November 2008, Pages 1823-1837
- Watson, M. and Emery, R.T.A (2004) "Environmental management and auditing systems: the reality of environmental self-regulation", *Managerial Auditing Journal*, Vol. 19 No. 7, page 916-28
- Walker, D, Pitt, M and Thakur U (2007) "Environmental management systems Information management and corporate" *Journal of Facilities Management*. Vol. 5, issue 1, page 49-61.
- Williams, H.E., Medhurst, J. and Drew, K. (1993) 'Corporate strategies for a sustainable future'. *Environmental Strategies for Industry. International Perspectives on Research Needs and Policy Implications*. (Island, Washington, DC) pp 117–146.



# Sustainable Asset Management of Heritage Buildings

**Hanwen Liao**

School of Architecture & Construction, the University of Greenwich  
clothtiger@googlemail.com

**Keith G. Jones**

School of Architecture & Construction, the University of Greenwich  
k.g.jones@gre.ac.uk

## Abstract

The UK Government has identified the adaptation of existing buildings as a key driver in its attempt to move the UK to a more sustainable future. To date work has focussed on developing ‘technological fixes’ that address the environmental and quality of life issues associated with the built environment and, whilst these are beginning to have some impact, they are largely focussed on new or ‘easily modified’ buildings. The more complex buildings such as heritage buildings are largely ignored by the research community. This has resulted in inappropriate solutions being applied to many heritage buildings in a way that is not only detrimental to their physical performance but also their cultural, historical and tourism significance. This paper discusses a small scale study that explored the suitability of potential adaptation solutions to heritage buildings by using the Old Royal Naval College in Greenwich, UK as a study site. In examining various interventions the research team considered the changing impacts and demands that will be placed on the Naval College over the next 20-50 years and developed an approach to asset management that identified potential adaptation solutions to these changing demands. The paper also explores the practical problems faced by the Facilities Management Team as they sought to develop technical and workplace solutions to deliver a more sustainable campus. Computer simulation techniques were used to predict the building’s thermal performance over the coming decades based on the UKCIP projections. The paper concludes that, although heritage buildings are more complex to analyse from a sustainability perspective: the need to consider a much wider set of stakeholders; limitations placed on legal and technical interventions by planning authorities; the technical complexity of mixing new and traditional structures etc, the fundamental issues associated with developing a sustainable asset management strategy are none the less similar to those faced by all building owners/users. As such the paper will outline a generic approach to sustainable asset management of heritage buildings along with a set of practical guidelines that Facilities Managers can use to develop their own sustainable asset management strategy.

**Keywords:** Sustainability, Asset management, Heritage buildings, Climate change, Building adaptation

## 1. Introduction

Climate change has been firmly established as an issue of concern for all and particularly for those involved in the built environment sector. This is not only because buildings are responsible for more than 40% of global energy use and one third of global greenhouse gas emission (UNEP, 2009), but also because the built environment clearly represents a meaningful context of sustainable development within which social, economic and environmental pillars are fully integrated. Today many countries such as the UK have identified adaptations of existing buildings as a key driver in their attempts to move towards a more sustainable society. However standard or cost effective, building adaptation solutions are difficult to apply to those older, hard-to-treat buildings such as heritage buildings due to technical, legal and operation constraints. This has resulted in no or inappropriate adaptation solutions being applied to many heritage buildings in a way that is not only detrimental to their physical performance but also their cultural, historical and tourism significance.

This paper arises out of a small scale research project that sought to address this gap in knowledge. The project used the opportunity offered by the University of Greenwich's Old Royal Naval College, a UNESCO World Heritage site in London, to examine the suitability of potential interventions as the University sought to improve the sustainable performance of the campus as both a working place and an architectural heritage icon. This paper firstly overviews the current discourse of climate change and its potential effect on the historic built environment; secondly it discusses the environmental problems that the buildings of the Old Royal Naval College are facing at the current time; thirdly it considers the potential changing impacts and demands that will be placed on those buildings over the next 20-50 years. Based on these changing demands a number of feasible options as a part of sustainable asset management strategy are conceived to adapt heritage buildings to climate change. The study is built on the combination of in-situ survey and measurement of buildings' thermal properties, computer modelling and simulation, and open-ended interviews with users and the facility management team of the campus.

## 2. Climate change and its impact on the historic built environment

The increase of mean ambient air temperature is evident in many parts of the world. The UK Climate Impacts Programme (UKCIP) has recently reported that the whole British Isle is getting warmer by 0.4-0.9°C since 1914 (UKCIP, 2007). A separate study of London's climate trend indicates that summer temperatures in London have risen at an average rate of 0.73°C per decade over the last 30 years (GLA, 2009). In June 2009, the UK government published the latest version of climate projections, known as the UK Climate Projections 2009 (UKCP09) (UKCP09, 2009) which update the UKCIP02 (released in 2002) scenarios and represent the latest scientific measurement and computing simulations on climate change. Of relevance to this study are the UKCP09 summaries of the potential climate trend in London over the coming decades (till the 2080s) in terms of the changes to the key atmospheric variables under the

medium emission scenario compared to the 1961 to 1990 baseline period. According to these projections, London will have hotter and drier summers, with the average summer daily temperature being 2.7°C warmer and very hot days 5.2 °C warmer than the baseline, and warmer but wetter winters, with the average winter day being 2.2 °C warmer and a very warm winter day 3.5°C above the baseline. There will also be more intensive rainfall, particularly in winter, and a rise in sea level of between 96cms and 2 metres by the end of the century. On top of this general trend London is prone to experience more extreme events such as surface water flooding, heat waves, windstorms and water scarcity.

There will always be some uncertainty on climate projections, but it is important that the built environment, including the historic building stock, be fully prepared for the projected climate stimuli and their effects, and incorporate mitigation and adaptation strategies in their physical and social development. In the UK, heritage buildings refer to those listed buildings or buildings of special architectural, historical or cultural significance, or those situated within conservation areas, national parks or World Heritage Sites. There are around 50,000 listed properties and over 10,000 conservation areas in the UK, constituting nearly 8 percent of the total building stock. But the whole spectrum of historic building, including a significant number of Victorian and Edwardian dwellings, is much wider. Although many historic buildings have demonstrated considerable resilience in the face of past climate changes, many more are found potentially at risk from the direct effects of future, perhaps severer, climate change. According to current research literature, climate change may affect historic buildings on three major aspects: increasing users' thermal discomfort, exacerbating extreme weather incurred hazard, and accelerating building deterioration (Sabbioni *et al.*, 2004, 2006; Cassar, 2005; English Heritage, 2006).

The most obvious consequence of climate change is that many historic buildings in the UK are likely to become increasingly uncomfortable (thermally) in summer (Hacker *et al.*, 2005; Yu *et al.*, 2010). This overheating problem could be amplified by the heat island effect in more densely developed urban areas. Historic buildings display a wide range of materials and forms of construction, ranging from thick solid masonry walls to timber-framed wattle-and-daub infill panels. Most of these walls were constructed without cavity and insulation and do not comply with the current building code regarding thermal specification (English Heritage, 2002). Old original windows with single glazing and wooden framework also have poor air tightness and low thermal resistance causing excessive heat gain and loss. Summertime thermal discomfort may lead to heat stress on occupants, increased energy consumption (carbon emission) and eventually obsolescence due to thermal performance.

Another major threat to the historic built environment from climate change is the increased presence of extreme events such as flooding (Cassar & Hawkings, 2007; English Heritage, 2004). Although large European cities like London are well defended from the fluvial flooding of the Thames and tributaries, many cities still have high risks of surface water flooding due to large areas of urban impermeable surface and intensified heavy rainfall. Surveys suggest that roof and ground drainage system in many historic buildings are insufficient to cope with more frequent winter rainfall and storms (sometimes accompanied with landslides and fires).

Medieval gutters and gullies are easily blocked or distorted due to centuries' of corrosion. This makes historic buildings much more susceptible to fire, flood and storm hazards, and less insurable against potential damage.

Climate change is also predicted to have an impact on building deterioration on less visible scales (Inkpen, 2004; Grossi & Brimblecombe, 2005). The degradation of building material is usually a complex interplay of chemical, physical and biological parameters. Increasing atmospheric concentrations of Green House Gas and gaseous pollutants (SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>) alter air chemical composition and influence chemical reactions taking place on the surface of building materials. In general, a change in ambient temperature, seasonal and annual rainfall, relative humidity and intensity of solar radiation will alter the patterns of wetting, drying, heating and cooling of the building fabric. These in turn will influence factors such as the frequency of salt crystallization and ultimately, the rate at which materials weather (Smith et al., 2008). Many historic buildings were built with porous calcareous stone such as Portland limestone which is particularly vulnerable to accelerated corrosion when the environmental equilibrium is disturbed. On the other hand, an increase in wind velocity resulting from climate change will transport sea salt further inland, which can substantially enlarge the areas along sea coasts affected by marine aerosols. Furthermore, small alterations in microclimate such as surface temperature and moisture level may produce significant changes in the growth of micro-organisms on the surface of historic buildings. The biological particles colonizing building stones such as lichens and algae not only contribute to aesthetic deterioration of building façade but also cause degradation of structural material by production of acid metabolites and preventing the masonry drying out properly (Crispim et al., 2003).

The science of assessing impact of climate change on the historic built environment is at an early stage of development. As the UNESCO policy document adopted in 2007 has acknowledged that more research on climate change at World Heritage properties is needed to build deeper understanding of this topic and its implications (UNESCO, 2007).

### **3. Heritage buildings as a working place: demands and problems in a changing climate**

#### **3.1 The Old Royal Naval College in Greenwich**

The Old Royal Naval College in Greenwich, laid out to a master plan developed by Christopher Wren and built in four principle phases between 1696 and 1751, is arguably among the most outstanding ensembles of palatial Baroque architecture in England. Symmetrically arranged alongside the River Thames on the outskirts of London, the building complex represents English artistic and engineering endeavour in the 17th and 18th century, and more widely European architecture at an important stage of evolution.



The buildings were originally created as the Royal Hospital for Seaman on the instructions of Mary II in 1692 to house veterans of the Royal Navy, a function which it continued to fulfil until 1869. Between 1873 and 1998, the buildings were occupied by the Royal Naval College to provide training and research facilities for naval officers. Some parts of the buildings were damaged by bombing during the World War II, leading to substantial structural repairs in the 1940s. On the closure of the Royal Naval College, the property was passed to the Greenwich Foundation for the Royal Naval College and leased for 150 years by the University of Greenwich and Trinity College of Music, creating a unique new educational and cultural mix. Consequently, extensive regeneration work was undertaken to convert these buildings for use by the occupied institutes to fulfil more advanced educational needs. This includes certain alteration of the building's internal layout, installation of modern teaching facilities and renewal of electrical, heating and ventilation services while keeping the buildings' historic expression intact.



*Figure 1: The Old Royal Naval College in Greenwich with the Queen's House at the back.*

### **3.2 Problems of the Old Naval College in facing climate change**

Despite the late 1990s regeneration, recent surveys suggest that the Old Royal Naval College suffers from a number of environmental problems. Many rooms of the buildings are overheating in most seasons and lack sufficient ventilation. Queen Mary court, one of the four principle buildings constituting the college, experienced a number of surface water flooding events in the past decade. The building fabric has shown a sign of minor deterioration of the stonework.

Overheating problems have been reported since the early years of the University's occupation. One of the main reasons is that the University has to accommodate a large number of people and facilities into relatively a small space where little effective cooling mechanism is installed. It might be argued that there is little difference between the use made of these buildings by the University from that of the Naval College. However there are important distinctions in the usage pattern and nature of individual rooms and particularly in the number of occupants. In 1738 there were only 1,000 sea pensioners living in the buildings and during the Royal Naval College period never more than 3,000 naval officers on site. In comparison, today there are over 8,000 staff and students working in the buildings across various disciplines, almost certainly many more than at any time in the past. Many of the compartmental spaces have been merged and converted into densely-configured lecture theatres and computing laboratories which

generate a great amount of heat when in operation.

When the buildings were regenerated in the late 1990s, mechanical ventilation and cooling were introduced to large lecture theatres and some computing labs by locating new chiller units into roof voids. Almost every available existing aperture within the roof envelope was skilfully modified. Gregorian dormers were adapted to include louvers, and chimneys were reconstructed without internal divisions to form intakes and exhausts. Concealed open wells for the cooling condensers were formed at roof level behind the parapet. But most teaching rooms and offices, and some computing suites remain naturally ventilated. Despite of the hybrid cooling strategy, occupants have apparent perceptions of thermal discomfort and nasal stuffiness in many rooms, especially in the south and west facing wing of the buildings, in summer. This is reflected in the 2006 questionnaire survey among University staff and students on users' perceptions of the estate (University of Greenwich, 2006).

The buildings are 'heavy weight' in terms of their thermal mass with some parts of the external wall reaching 600mm in thickness. This helps maintain a steady indoor air temperature and store internal/external heat gains. However the effect of high-mass passive cooling is largely compromised due to the lack of nocturnal ventilation to diurnally flush out stored heat in the building fabric. This is because windows and doors of individual rooms are normally shut in the evening to address security concerns. Also in some research rooms computers and electrical appliances are running 24 hours a day which would not allow the room to be properly cooled down during the night. On the other hand, the buildings' envelopes are not even in terms of thermal resistance. The 18th century timber sliding sash windows with single glazing have high U-values and are not very efficient in draught-proofing and noise control. Air infiltration through distorted window frames was found to be excessive. In Queen Mary and King William building, the short walls below and above the windows are built in thinner brickwork of one brick thick for decoration purpose. This also causes thermal bridging on the external walls

In the daytime, those rooms without mechanical ventilation and cooling supply (which count as majority within the buildings) are short of efficient cooling methods when indoor temperature approaches the 'hot' threshold. Internal blinds, though known to be very useful to screen out direct solar radiation, are only installed on certain windows due to requirements of aesthetic planning, given the site as such a popular tourist attraction. At present, the most convenient solution is perhaps by implementing portable air conditioners in places where internal heat load is too high. Although these devices do not need physical installation to harm the historic masonry, they are used at the price of high energy consumption and carbon emissions, and affecting the buildings external appearance as they usually entail positioning a flexible hose by window.

Apart from the overheating issues, the Old Royal Naval College has experienced a number of floods in the past a few years. Greenwich riverfront has been prone to tidal flooding throughout history. While the likelihood of this risk has been greatly reduced by London Thames' Barrier four miles downstream, the buildings are growingly exposed to the threat of surface water flooding and storm leakage. Most of the soft ground around the buildings has been replaced by

hard or semi-impervious surfaces in order to avoid water seepages into the basement where all the plant is situated. This hard cover considerably increases surface water run-off and also contributes to surrounding air temperature rise. Due to legal requirements a ramp was built in the late 1990s to enable disabled access to the University Cafe in the lower ground level of Queen Mary Building. During the heavy rains in 2007, the ground drainage system could not cope with the intense rainfall on the site and the ramp acted as a ditch to direct water to the lower ground floor. As the result, the whole area had to be resurfaced.

Another problem faced by the estate is the minor deterioration of building fabric. Original walls of the buildings are in thick brickwork sometimes clad in Portland stone founded on chalk blocks over a dense gravel formation. The walls and structures are generally found in reasonable good condition. But the outside stone cladding needs attention as some of the stone was badly weathered and iron cramps tended to have corroded with the effect of loosening the areas of facings. Weathering patterns such as material loss and erosion of architectural details, stone sulphation, black encrustation and the growth of cyanobacterial biofilm are all identified on the surface of the buildings during the site survey. However at present none of these symptoms are severe enough to cause the degradation of the building's structure and envelope.

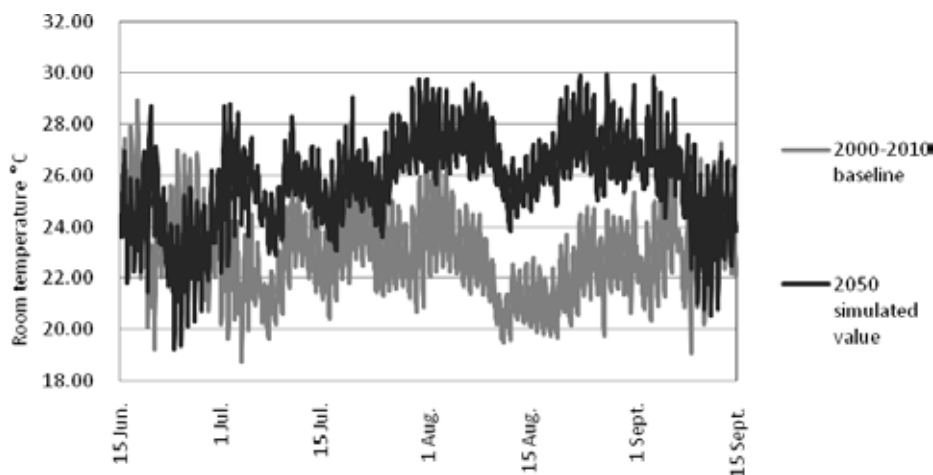
### **3.3 Demands posed by climate change in the future**

The problems discussed above could become more serious because of climate change over the next 20-50 years. Particularly, increased thermal discomfort is likely to be a major threat to the use of these heritage buildings as an educational facility unless they are properly adapted for the change. In order to make a quantitative assessment of how much the University will be impacted by the peak summer temperatures in the future, a computer model has been constructed to predict the thermal behaviour of the buildings in the 2050s. In this study, a simulation tool called DeST (Designer's Simulation Toolkit) has been used. Comparing to other contemporary simulation software such as ESPr, DOE-2, EnergyPlus, TRANSYS and EcoTect, DeST has its own advantages. The programme is built on a three-dimensional heat transfer model with consideration of multi-zone heat and mass balance so that it can be used to evaluate a building's thermal performance in a more systematic and accurate manner. Also DeST has a powerful architectural modelling function by integrating AutoCAD as the modelling platform and user's interface. The apparent weakness of this software is that it has been stopped in development since 2007 so that at present the software can only be used with dated operating systems such as Windows 2000 and XP.

In this study, a number of room groups in different sections of Queen Mary Building were modelled to assess overheating risk in the 2050s. Simulations were implemented over two sets of 'weather year' data (Known as Design Summer Year or DSY). The 2000-2010 baseline was used as a benchmark DSY and represents the current situation based on which simulated values for the year 2050 can be compared. The baseline data were collected from the MIDAS Land Surface Station Dataset provided by British Atmospheric Data Centre for 154 UK locations (<http://bdac.nerc.ac.uk/>) and Chartered Institution of Building Service Engineers (CIBSE)

Guide J (CIBSE, 2002). The 2050 DSY was built by using the UKCP09 climate change medium emissions scenario combined with the existing baseline DSY. To enable the simulation, future DSY at hourly resolution is required. Data at such time intervals can be generated from the Weather Generator provided by the UKCIP based on probabilistic projections.

Figure 2 shows the simulated room temperature ranges of a ground floor design studio in Queen Mary Building for the summer months in 2050. The 70m<sup>2</sup> sized studio has both northeast and southwest facing windows (facing the courtyard) with the overall heat-transfer coefficient (U-value) 1.58W/(m<sup>2</sup>K) for external walls, 5.23 W/(m<sup>2</sup>K) for external windows and 2.12 W/(m<sup>2</sup>K) for internal wall. Person density was set to 0.4person/m<sup>2</sup>. Lighting load and appliance (computers etc.) load is 40W/m<sup>2</sup> and 10W/m<sup>2</sup> respectively. The working time of the studio was between 9.30am and 18.00pm during the weekdays. From the diagram it can be seen that without any adaptation measures the indoor temperature of the studio will easily exceed 28°C during the summer months – the thermal discomfort threshold defined by the UKCIP for schools. According to Hacker et al. (2005) a building has ‘overheated’ if temperatures are above the ‘hot’ threshold for more than 1% of the time that it is occupied in any year. Based on this criteria the studio requires to be properly cooled down from late July to early September in the 2050s to enable a more pleasant environment.



**Figure 2: Simulation of the room temperature ranges of a ground floor studio in Queen Mary for the summer months in two weather years.**

In this study, the overall heat-transfer coefficient for the building components are tested in-situ rather than calculating from published thermal conductivity values of the involving materials. This is because the thermal property of historic building materials may have been altered after being exposed to the environment for centuries due to weathering process. Historic structures tend to be wetter hence lower thermal resistance as there is often some rising and penetrating damp accumulated over time. This study employed 12 Dallas 1-Wire iButtons temperature logger (DS1921G-F5 thermochrons) to measure the air temperature and humidity and surface temperature of external fabric at three minutes interval over a 72-hour period. Two heat flux

metres and a pyranometre were also used to test the heat flow through walls and solar radiation level. The heat-transfer coefficient values were calculated by using 'heat flux method' defined by ISO 9896: 1994.

## **4. Adaptation strategy options for the Old Naval College**

### **4.1 Problems to adapt heritage buildings in the UK**

Adapting heritage buildings brings with it problems beyond those encountered in ordinary adaptation scheme. The problems include legal restrictions, technical and operational constraints, conservation imperative, extra cost and is time consuming. In the UK, heritage buildings are protected by the Town and Country Planning Act 1990. Restrictions are imposed on the modifications allowed to a protected historic buildings' structure or its fittings. Any such initiative is subject to approval on a case-by-case basis by the local planning authority or English Heritage if it is a listed building in England. Many heritage buildings are sensitive to even slight alterations. Adapting heritage buildings should always provide that the work does not prejudice the character of the building, or increase the risk of long-term deterioration to the building fabric or fittings. This means standard adaptation solutions such as introducing solar shading devices, controllable mechanical ventilation or thermal upgrading could not be straightforwardly applied to heritage buildings. Research has shown that improvements in the thermal insulation of historic buildings may cause negative consequence to the fabric. Stirling (2002) specifies many risks that can arise when thermally insulating roof, walls, windows and floors. Thus it is essential to assess the feasibility of the work and seek the advice of the local planning authority's conservation officer before considering any alteration.

The Old Royal Naval College is grade I listed. Any works of alteration or extension are strictly regulated by English Heritage who has been closely involved in shaping the regeneration of the college since the late 1990s. What makes the situation more complicated is the limited jurisdiction of the University in estate management. As a tenant the University only has the users' control of the internal space whilst the Foundation oversees the operation of the whole site. That is, not much work could be done by the user side if no consent is granted both by the managing agency, the landlord and the planning authority.

### **4.2 Possible adaptation strategy for the Old Royal Naval College**

Following the discussion in the last section, it can be seen that it is both unfeasible and inappropriate to apply any major engineering work that may materially affect the unique architectural character of the Old Royal Naval College buildings. However demands for adaptation to climate change are also realistic and imperative. There is a need of flexible, practical and cost-effective approaches which both provide active response to the changing climatic stimuli and also avoid large alterations to the existing building fabric. A number of

such options are examined and summarised in below (due to page limit, here only to address the overheating issues). These approaches are conceived based on computer simulation analysis, extensive interviews with the users and the estate management team. Some of the methods will be tested by the University's estate management team in the coming summer.

1. Before any adaptation strategy is applied, map all the areas prone to thermal discomfort and identify the sources of heat. This will help to concentrate limited resources on remedying places with high or uneven heat load and control the chain of heat transfer from the outset.
2. Monitor the thermal variables of the buildings as a routine practice. This could be simple tests of indoor air temperature, humidity, solar radiation and air movement by using data loggers such as the iButtons and using thermographic techniques in estate check.
3. Rooms which are likely to generate high heat density such as computer labs and classrooms having low air circulation need special attention. In these rooms, seats and electronic appliance should be kept in low density and dispersedly arranged to reduce heat accumulation.
4. In most circumstances, portable fans may be used to assist ventilation. Furniture built with high thermal conductivity materials such as permeable wooden board can be selected to reduce heat sink from the body and ambient air. Large room plants, bright coloured wall paint and pleasant room decorations can be employed to give occupants a cooler perception.
5. Minimise heat generation from the appliance wherever possible. This includes, for instance, introducing low heat light bulb and sound controlled lighting system; switching all the computer monitors to LCD screens; changing outdated photocopier, printer and fridge etc.
6. Improving night time ventilation to flush out stored heat in the buildings' high thermal mass could be a useful method. This passive cooling strategy can be carried out by routinely opening up windows and doors of individual rooms during the off work time to allow cross ventilation throughout the buildings. Air flow route can be designed if opening up all the windows and doors are not possible. The task can be carried out by the University's security team. As all the buildings are enclosed in a curfewed campus covered by CCTV, security would not be a big problem. Alternatively, for security reasons the old hung sash window can be slid up only partially and locked up at the position to create an opening that no one is possible to creep through. Some windows in the Naval College are 'double hung windows' with both sashes moveable in the frame. In such a case upper rather than lower sash should be opened to lead evening breeze to the vaulted ceiling whilst remaining a higher level of security protection.
7. Turn the buildings LPHW (Low Pressure Hot Water) network and conventional radiators into 'water-chilled beams' by circulating cold water throughout the buildings in summer. Water can be drawn from the River Thames or urban water grid but preferably running

through underground loops (buried or using the basement of the buildings) such as those in a ground/water heat pump system. The underground loop may also help to reduce the heating bill in winter. A real chilled beam consists of a cooling coil suspended from the ceiling which cools the air around the beam and cause it to descend toward floor level. Because radiators are usually mounted at low position in each room, the 'LPHW converted chilled beams' may work better with the assistance of portable fans to transfer heat via convection.

8. Introduce internal blinds or curtains as much as possible to screen out most direct sunlight during the day. Blinds can be made from thin and semi-transparent fabric to minimise the effect on the buildings' aesthetic expression. Movable potted trees may be placed outside the buildings to provide shading for the ground floor windows which also help to change the emissivity and absorptivity of the ambient surface and visually 'soften' the environment. At present the courtyards of the buildings are all empty with no horticultural arrangement.
9. Adjust the usage patterns of the buildings by carefully scheduling the activities taking place in each room. For instance class may be arranged in the morning and early evening to avoid the hot peak period. Activities with higher thermal tolerance (e.g. workshop discussion) can be allocated to more heated rooms than those with lower thermal tolerance (e.g. lecture).
10. Changes and adaptation may be achieved majorly through the change of user's behaviour. Training and guidelines leaflet should be provided to educate people on how to use a historic building. Signs can be displayed to remind people to switch off lights and computers when leaving the rooms. This will reduce the energy use and keep the buildings cool.

## 5. Conclusions

Climate change over the next 20-50 years will inevitably affect the whole built environment including heritage buildings. Despite being bounded with various constraints, adaptation of historic buildings is possible and will play an increasing role in helping to obtain a more sustainable environment. Building adaptation solutions can be classified into technical, either permanent or temporary (such as the option 4, 5, 7 and 8 above), and operational based solutions (the rest of the list). For historic building adaptation, operational solutions will be easier and more practical to apply. This includes skilful asset management, monitoring and maintenance, and perhaps training to facilitate behaviour change rather than significant conversions, extension and modernization of building fabric. In practice, however, very often more integrated strategies need to be conceived and implemented to obtain a better output. Thus how to balance the two kinds of solution in building adaptation and the balance between building conservation and building performance are issues that those dealing with heritage buildings need to consider.

Despite heritage buildings are more complex to analyse from a sustainability perspective, the fundamental issues associated with developing a sustainable asset management strategy are none the less similar to those faced by all building owners/users. The issues include improving the physical performance of the building; strengthening buildings' resilience to extreme events; using green, indigenous or recycled materials and products in maintenance; minimising the use of non-renewable energy and water in operation; maximising access to the building for all users; preserving the bio-diversity on the site; Incorporating more responsive environmental monitoring and control; and finally making buildings more future-proof while retaining heritage features of them for conservation purposes. To help achieve better practice, a series of Key Performance Indicators (KPI's) can be developed to interpret sustainability criteria into asset management strategy for heritage buildings. This KPI's set may include the measurement of buildings' physical performance such as 'the percentage of occupied time that exceeds 28°C in the year', or 'energy consumption per square metre'. It may also include evaluation of different adaptation options against comparable variables such as cost, time, achievable effect, constraints and feasibility. To refine such a set of KPI's and make it more useful to guide the real practice, more research is needed to develop a deeper understanding of how climate change will impact on the use of historic buildings and how historic buildings can strengthen their adaptive capacity to cope with the changing demands and stimuli.

## References

- Cassar, M. & Hawkings, C. (eds) (2007) *Engineering Historic Futures: Stakeholders Dissmination and Scientific Research Report*. London: University College London, Centre for Sustainable Heritage
- Crispim, C., Gaylarde, P. & Gaylarde, C. (2003) "Algal and Cyanobacterial Biofilms on Calcareous Historic Buildings". *Current Microbiology*, **46** (2003):79-82.
- Cassar, M. (2005) *Climate Change and Historic Environment*. Nottingham: The Russel Press.
- CIBSE (2002) *Weather, Solar and Illuminance data*. CIBSE Guide J. London: Chartered Institution of Building Services Engineers.
- English Heritage (2002) *Building Regulations and Heritage Buildings*. London: English Heritage
- English Heritage (2004) *Flooding and Historic Environment*. London: English Heritage
- English Heritage (2006) *Climate Change and the Historic Environment*. London: English Heritage
- Grossi, C. M. & Brimblcombe, P. (2005) "Urban pollution and climate impacts on soiling of stone historical buildings". *Geophysical Research Abstracts*, **7**: 01792.



GLA (2009) *Understanding London's Urban Climate – Climate change and the urban heat island*. London: Greater London Authority.

Hacker, JN., Belcher, SE & Connell, PK. (2005) *UKCIP Briefing Report. Beating the Heat: keeping UK building cool in a warming climate*. Oxford: UKCIP

Inkpen, R. (2004) *Atmospheric pollution climate change and historic buildings*. Available online [http:// http://www.buildingconservation.com/articles/atmospheric/atmospheric.htm](http://www.buildingconservation.com/articles/atmospheric/atmospheric.htm) [Accessed on 18/05/2010].

Stirling, C. (2002) *Thermal insulation: avoiding risks* (3edn), London: BRE

Smith, B., Gomez-Heras, M. & McCabe, S. (2008) "Understanding the decay of stone-built cultural heritage". *Progress in Physical Geography*, **32**(4):439-61.

Sabbioni, C., Cassar, M., Brimblecombe, P., Tidblad, J., Kozłowski, R., Drdacky, M., Saiz-Jimenez, C., Grontoft, T., Wainwright, I & Arino, X. (2004) *Global climate change impact on built heritage and cultural landscapes*. In 6th European Commission Conference on Sustaining Europe's Cultural Heritage: From Research to Policy. London, 1-3 September 2004.

Sabbioni, C., Cassar, M., Brimblecombe, P., Tidblad, J., Kozłowski, R., Drdacky, M., Saiz-Jimenez, C., Grontoft, T., Wainwright, I. & Arino, X. (2006) Global climate change impact on built heritage and cultural landscapes. In Gomez-Heras & Vazquez-Calvo (eds), *Heritage, Weathering and Conservation*: 395-401 London: Taylor & Francis Group

University of Greenwich (2006) *Estate Strategy*, London: University of Greenwich.

UKCP (2009). *UK Climate Projections Science Report: Climate Change projections*. Available online: <http://ukcp09.defra.gov.uk/> [Accessed on 12/05/2010].

UKCIP (2007) *warmest years in the UK and globally up to 2007*, UK Climate Impact Programme Information Sheet. Available online: [http://www.ukcip.org.uk/images/stories/Tols\\_pdfs/warmest\\_years\\_2007update.pdf](http://www.ukcip.org.uk/images/stories/Tols_pdfs/warmest_years_2007update.pdf) [Accessed on 02/05/2010].

UNESCO. 2007. Sixteenth Session of the General Assembly of States Parties to the Convention Concerning the Protection of the World Cultural and Natural Heritage, Policy document on the impact of Climate Change on World Heritage properties. Paris: United Nations Educational, Scientific and Cultural Organization.

UNEP. 2009. Buildings and Climate Change, Summary for Decision-Makers. Paris: United Nations Environment Programme

Yu, G., Liu, W., Gao G. & Liu J. 2010. Testing and Analysis on the Indoor Thermal Environment in a Historic Building. *Engineering Mechanics* 27(1): 129-133.



## Improvement Suggestions for Sustainability Certification – Standardization and FM

**Dipl.-Ing. Daniela Schneider**

Karlsruhe Institute of Technology (KIT), Germany.  
daniela.schneider@kit.edu

**Prof. Dr.-Ing. Dipl.-Wi.-Ing. Kunibert Lennerts**

Karlsruhe Institute of Technology (KIT), Germany.  
kunibert.lennerts@kit.edu

### Abstract

Sustainability is a topic of growing importance and interest. The property sector and hence Facility Management (FM) has an increasing influence on sustainability. Keywords like “energy efficiency” and “life cycle costs” can be crucial factors for the successful marketing of a building. Especially investors demand certificates that supply evidence of the sustainability of real estate. Within the past few years, numerous efforts have been made to describe and assess sustainable buildings. However, they use different approaches, methods and data bases. In the interest of quality, transparency and comparability, rating systems and standardizations have to undergo harmonization and cover the whole life cycle of a building.

The following paper is based on a literature research as well as on experiences the authors made during the participation in the development works of the German Sustainable Building Council (DGNB) and CEN. It gives an overview of the current approaches in certification of sustainable building and points out improvement suggestions for an enhanced comparability of sustainability certificates. Furthermore, the paper intends to clarify why and how to add FM to the characteristics of sustainable building rating systems. Due to its holistic approach FM plays an important role in sustainability. It covers a broad spectrum of activities concerning economical, environmental and social aspects.

To accomplish the foregoing objectives, the deficits and need for action of rating systems are shown by using the example of DGNB. In many cases, the German Sustainable Building Certification, like other rating systems, refers to standards and guidelines in order to assess real estate. For the purpose of achieving international applicability und comparability, the authors advise the use of international standards like CEN and ISO as evaluation basis. The paper therefore gives an insight into the current approaches in CEN/ISO standardization and their resulting advantages for assessing sustainability.

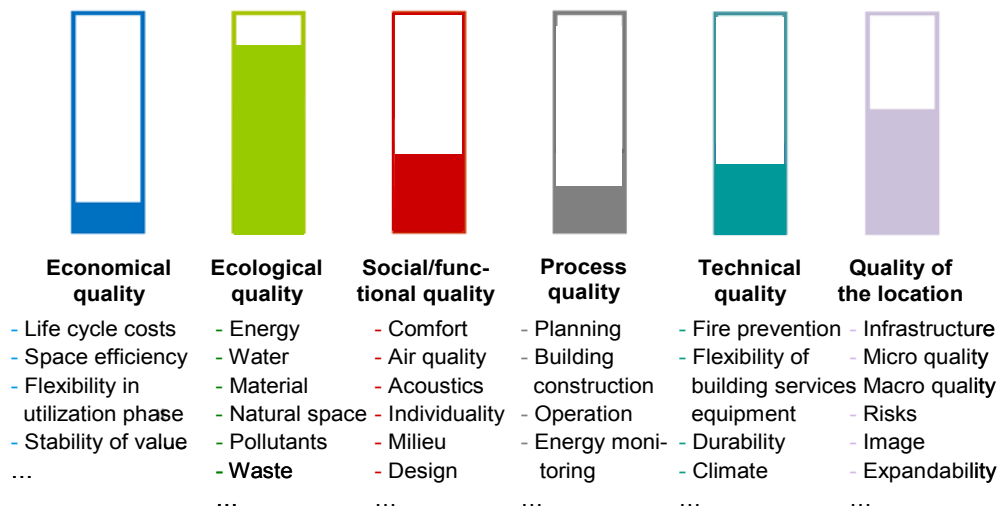
It is expected that internationally standardized sustainable building certificates will be soon a basic requirement for the marketing of a building. Consequently, Facility Managers need to assure that FM services will be sufficiently addressed in sustainable building rating systems and standards. In this way, they can emphasize the importance of their branch.

**Keywords:** Facility Management, Sustainability, CEN, ISO, DGNB

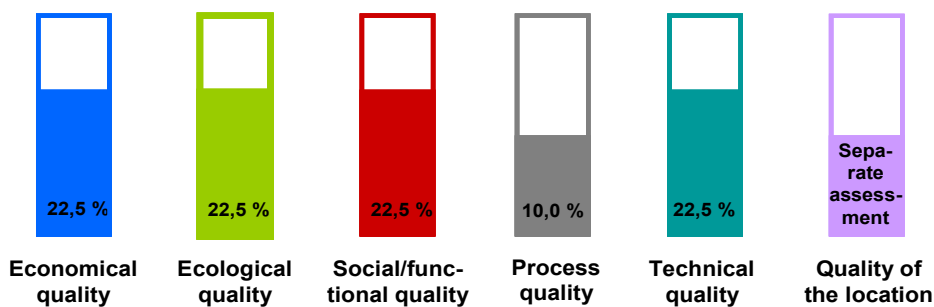
standards taken as a basis for these assessments are different. This also applies to the scope of the rating systems as described below:

The most commonly chosen certificates are the American “LEED” (Leadership in Energy and Environmental Design) and the British “BREEAM” (Building Research Establishment Environmental Assessment Method) which are classic Green Building labels. They are primarily concerned with eco-friendly building solutions, whereas economic or social aspects play a minor role. Although Green Buildings are commonly called sustainable as well, sustainability actually is beyond the scope of an energy- and resource-saving Green Building design. For this reason, the German Sustainable Building Council (DGNB) set itself the target to develop building type specific rating systems in order to assess real estate objectively and holistically. This is why the DGNB examines the “social”, “technical”, “process”, “site” and “economic” quality of a building (nearly) to the same extent as its eco-friendliness. The five additional topics are insufficiently regarded in LEED and BREEAM. Consequently, certified sustainable buildings are not necessarily comparable. Figure 1 indicates the divergences in substance using the example of LEED/BREEAM and DGNB.

**Systems like LEED and BREEAM don't address sustainability criteria comprehensively**



**DGNB system is better balanced and more comprehensive**



*Figure 1: Green/Sustainable Building according to LEED/BREEAM and Green/Sustainable Building according to DGNB (Sedlbauer, 2009)*

Not only does the substance of the rating systems diverge, but the standards that are underlying the assessment of criteria also differ. While LEED, for instance, refers to ASHRAE standards, DGNB is based upon German standards and guidelines. If a German building is intended to be assessed according to LEED, the certification often entails additional work and costs, because ASHRAE standards vary tremendously from German requirements.

As the preceding paragraphs reveal, rating systems internationally need to resemble each other with regard to their content so that the comparability of “Sustainable Buildings” can be achieved. Moreover, uniform standards have to be used as the basis of valuation. For this reason, efforts on the part of CEN and ISO are imperative. Several drafts have already been published or rather are about to be published and will be presented in chapter 4.

Besides the need for the revision of the valuation basis and of the framework of sustainable building certificates, the scope of sustainability criteria also has to be reviewed. There are important characteristics and services not assessed by Green/Sustainable Building rating systems. One kind of services decisive for the sustainability of a building and mostly disregarded are FM services. The results of research projects, like the „Zweiter Zwischenbericht: Orientierungswerte für die Bewertung von Hochbauten” by H. König (2008), prove that 70 to 80 % of a sustainable building’s quality are defined by the utilization phase. Besides, it shows that FM services are the main services within this phase of life of real estate. Apart from the final energy consumption, the performance within the utilization phase is the decisive factor for building sustainability. It would therefore be advisable to take FM services, just like energy issues, explicitly into account within the frame of an assessment tool for sustainability, and thus within the planning phase already.

In conclusion, valuation methods and standards need to undergo harmonization so that cost reductions, transparency and comparability can be gained. Moreover, FM and other services need to be integrated into Green/Sustainable building rating systems so that all characteristics and services essential for a building’s sustainability are covered.

### **3. Methodology**

#### **3.1 Method of resolution**

The contents of the present paper base upon a non-empirical research work consisting of a literature research and the participation in the development works of CEN and DGNB. These approaches enable the authors to review and analyze the status quo in certification and standardization of green/sustainable buildings and to make suggestions for improvement.

## **3.2 Analysis**

The analysis can be subdivided into four steps. First of all, the DGNB system and its assessment methods are described. In a second step, the authors present the status quo in international standardization. In order to explain how sustainable building rating systems can be made easy to apply internationally, the paper shows in the third step how CEN/ISO standards might be linked with the German rating system and how they might be used as a basis of assessment. Afterwards, in the fourth and last step, the authors explain why Facility Management is the ideal partner of sustainability. They give examples which FM services should be integrated into the DGNB system and how they might be assessed.

## **4. Results**

### **4.1 The DGNB rating system**

#### **4.1.1 The German Sustainable Building Certificate**

The German Sustainable Building Certificate (GSBC) is based on the concept of integral planning. It is aimed at defining, at an early stage, the targets of sustainable construction in order to be able to reveal and solve potential problems as long as there is still the possibility for action. In addition, integrating sustainability criteria into the planning phase provides the opportunity to design on the current state of technology. As mentioned before, the GSBC covers all six of the relevant aspects of sustainable construction: ecology, economy, socio-cultural and functional quality, technical quality, processes and location. Outstanding buildings, satisfying the criteria of these topics exceptionally well, can achieve bronze, silver or gold status.

#### **4.1.2 Assessment methods**

The GSBC is a very flexible system. It consists of 63 criteria which are weighted differently within the single topics (e. g. ecology, economy, location), depending on the building type to be evaluated and on the relevance for the country the building is located in. Hence, the DGNB rating system can be adjusted, in a practicable way, to the individual requirements of different building types. Similarly, it can be adapted to regional requirements or social developments. This way, for instance, it can be taken account of the fact that the “thermal comfort in winter” of a building in the temperate zone (e. g. Germany) is of less importance than the thermal comfort of a building in the Arctic (e. g. Country X; see Figure 2).

**Relevance Factors (RF)**  
Fictional example: Thermal comfort

	Building Type Specific RF	Regionally Adapted RF (Germany)	Regionally Adapted RF (Country X)
Office Building:	2	2	3
Retail Building:	2	2	3
Industrial Building:	1	1	2

*Figure 2: Adaptability of GSBC through building type and region specific relevance factors*

One characteristic of the GSBC is its output-orientation which means that, whenever possible, it evaluates buildings with the aid of quantitative instead of qualitative parameters. German standards and guidelines serve as the basis for the evaluation of many of these parameters. By not defining the measures but only the target values, the GSBC leaves room for innovative technologies, and thus for improvement. If the standards and guidelines used were replaced by international requirements, certified buildings might become even easier to compare worldwide. Moreover, the Green/Sustainable Building certification would increase in transparency and quality. In order to establish a basic understanding of the benefits of using international standards, the following chapter offers a brief description of the current approaches of CEN and ISO.

## 4.2 Approaches of CEN/ISO

### 4.2.1 Status quo in international standardization

Sustainable construction has been part of international standardization activities since 2002 and aims at developing a general basis for sustainable building. New ISO and CEN standards shall facilitate the international knowledge and data exchange and the cooperation regarding sustainable building projects. In this way, ISO and CEN intend to:

- create a uniform basis for the construction and assessment of sustainable buildings by providing a common language and appropriate indicators as a basis of assessment.
- set general geometric and other requirements for buildings, building elements and components (including e. g. general rules for joints, tolerances and fits).
- enable international exchange and use of building- and building component–related information about sustainability (e. g. Environmental Product Declarations, EPDs).

#### 4.2.1.1 ISO TC59/SC17 – Sustainability in Building Construction

To achieve progress in sustainable building, ISO gave TC 59/SC17 the task to create a common framework. This framework should include a common terminology, general principles, indicators for sustainable building construction as well as assessment and monitoring methods for production, design, construction and maintenance processes (see Table 1):

Table 1: Working Groups (WG) of ISO TC59/SC17

<b>WG</b>	<b>Working Group</b>	<b>Description</b>	<b>Norm</b>
1	<i>General Principles and Terminology</i>	<i>Principles for sustainable construction, important terms and definitions</i>	<i>ISO 15392:2008</i>
2	<i>Sustainability Indicators</i>	<i>Criteria reflecting the sustainability of buildings and their surroundings</i>	<b><i>Under development (ISO/DIS 21929)</i></b>
3	<i>Environmental declaration of products</i>	<i>Methodical principles and specific suggestions for building product parameters to be declared → assessment of single building materials/ components and of the whole building structure</i>	<i>ISO 21930:2007</i>
4	<i>Environmental performance of buildings</i>	<i>Assessment methods for the environmental performance of buildings</i>	<b><i>Under development (ISO 21931-1)</i></b>
5	<i>Civil Engineering Works</i>	<i>Transfer of the results of WG 1 to 4 to engineering structures and, if necessary, revision</i>	<b><i>Under development (e. g. ISO/NP 21929-2)</i></b>

#### 4.2.1.2 ISO TC59/SC14 – Design Life of Buildings

In order to reach their anticipated average life, building products and buildings need to fulfil certain criteria over a period of time. For this reason, ISO TC59/SC14 "Design Life of Buildings" tried to make the service life and operation of a building and of building components plannable. The activities of the Technical Committee resulted in the standards series ISO 15686 Part 1 to 10. It describes, for example, general principles and terminologies regarding life cycle considerations and it deals with the prediction procedures for the service life of building components and buildings. Moreover ISO 15686 provides information about life cycle costing (LCC) and life cycle assessment (LCA). Part 9 of the standard intends to harmonize and facilitate the assessment of service life data. To sum up, ISO 15686 can be considered an essential basis for the LC analysis and, consequently, for the sustainability assessment.

### 4.2.2 Status quo in European standardization

#### 4.2.2.1 CEN TC350 – Sustainability of construction works

Since May 2005, CEN/TC 350 has been in charge of the development of voluntary standardized methods for the life cycle assessment of the sustainability aspects of new and existing construction works. In addition, CEN TC 350 is responsible for the provision of standards for the environmental product declaration of construction products. Upon completion, the standards will describe a harmonized methodology for the assessment of the environmental and economical performance of buildings as well as the quantifiable performance aspects of health and comfort of buildings; but they will not set benchmarks or levels of performance (see Table 2).



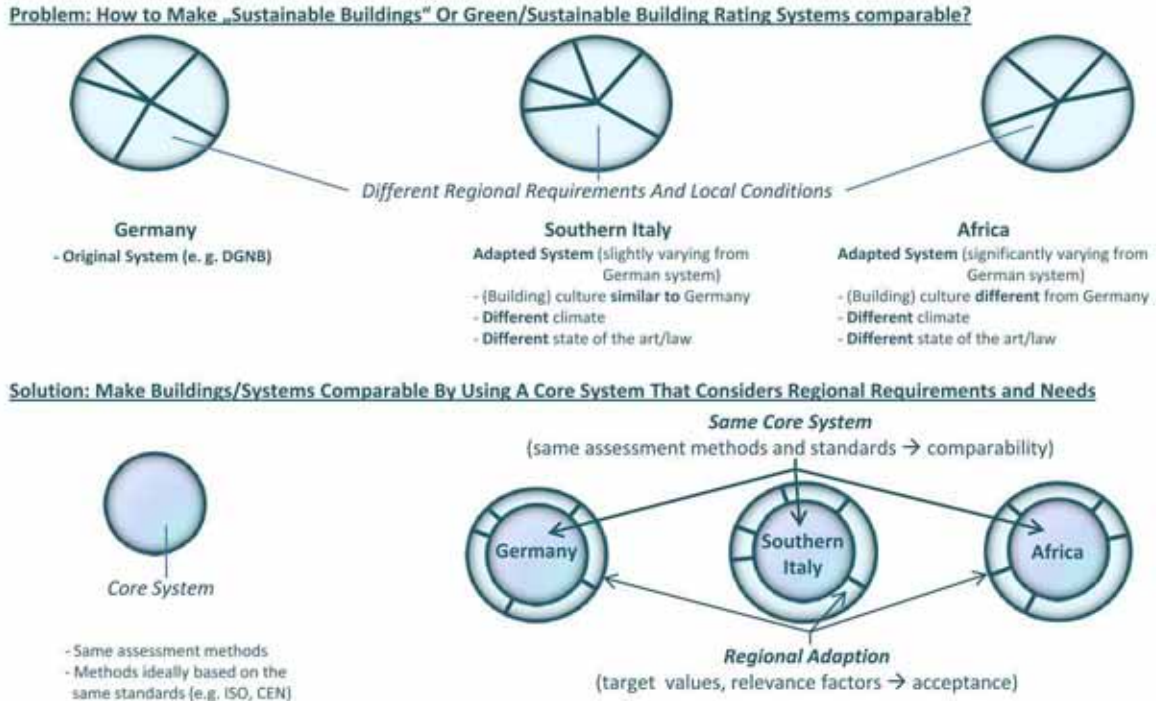
Table 2: Working Groups of CEN TC350

<i>WG</i>	<i>Working Group</i>	<i>Description</i>	<i>Norm</i>
<b>1</b>	<b>Environmental performance of buildings</b>	<i>Description of environmental quality of a building, use of environmental declarations for building products</i>	<b>Draft</b> <i>(prEN 15978)</i>
<b>2</b>	<b>Building life cycle description</b>	<i>Description of the building life cycle</i>	<b>Work abandoned</b>
<b>3</b>	<b>Products level</b>	<i>Description of the environmental quality of building products: product category rules, communication formats and generic data for Environmental Product Declarations (EPDs)</i>	<b>Drafts</b> <i>(prEN 15804, prEN 15942, Fpr CEN/TR 15941)</i>
<b>4</b>	<b>Economic performance of buildings</b>	<i>Framework for the description of the economic quality of buildings</i>	<b>Draft</b> <i>(prEN15643-4)</i>
<b>5</b>	<b>Social performance of buildings</b>	<i>Framework for the description of the social quality of buildings</i>	<b>Draft</b> <i>(prEN 15643-3)</i>  <b>Under development</b> <i>(Methods)</i>

Taking a closer look at the drafts and the existing standards on the subject of sustainability, it shows that the economic and social aspects have not yet been sufficiently elaborated. So far, the general principles and indicators have been regarded holistically. However, the product declarations and building assessment methods, for example, have only been developed from an environmental point of view. But in future, the existing standards are supposed to be completed.

### 4.3 Implementation of CEN/ISO in DGNB assessment methods

To achieve the international comparability, transparency and applicability of Green/Sustainable Building rating systems, it is useful to harmonize the different systems, at least to some extent. For this purpose, besides harmonization of the scope of the systems, the assessment methods and data bases need to be adapted. This might be acquired by using a core system which is adapted to the specific requirements and needs of the different regions it is used in. If the assessment methods of the rating system are based on uniform standards, the core system can gain comparability (see Figure 3).



**Figure 3: Adaptability of GSBC through building type and region specific relevance factors**

In the following paragraphs, using the example of GSBC, it will be explained, how uniform standards might be implemented in the existing rating systems. Therefore, the as-is situation of the LCC assessment and the target state will be presented.

According to DGNB (2009), LCC of a building are all costs that arise during the entire useful life of a building. The costs beginning with the project development up to construction and handover are defined as production costs. The costs from commissioning up to disposal are defined as follow-up costs. The LCC are divided into three cost categories: production costs, follow-up costs, and deconstruction and disposal costs. The lower the LCC, the better is the evaluation. Currently, the GSBC is making use of different data bases when assessing the criterion “life cycle costs”. The total costs are reckoned up with the aid of the cash-value method (in €/m<sup>2</sup>NFA) and for a period under consideration of 50 years which has been “chosen freely”. For the assessment of the LCC the production and follow-up costs are taken into account according to DIN 276 and DIN 18960, whereas the deconstruction and disposal costs are completely disregarded. Nevertheless, not all of the costs contained in DIN 276 and 18960 are part of the DGNB LCC assessment, but only a selection of costs. The definition of the cost types regarded, like maintenance and renewal, are based upon VDI directive 2067. Information about the repairs and maintenance expenses for building equipment [% of investment costs] during utilization phase are determined by VDI 2067 and AMEV, whereas performance values and hourly rates are taken from a research project of the Federal Ministry of Transport, Building and Housing (BMVBS). The assumptions needed for the calculation of the cash-value, like the required rate of return or the rate of price increase, are based on the results of a BMVBS research project, too. Moreover, the „Leitfaden Nachhaltiges Bauen“, also edited by BMVBS, contains data about the service life of building components.

The preceding paragraph shows how many different standards and data sources the DGNB is using for its life cycle costing. Furthermore, the cost types included are not complete. It is hard or even impossible to compare the benchmarks resulting from the assessment with values of other LCC analyses. The total DGNB LCC might differ from other LCC parameters, because the deconstruction and disposal costs are excluded. If the GSBC and other rating systems used uniform calculation methods on the basis of requirements like ISO 15686, the LCC assessment would result in harmonized and hence comparable LCC parameters. However, there is also need for action with respect to ISO 15686-5 whose requirements are not specific enough and give too much leeway. When estimating the LCC, the users of ISO 15686-5 can select if they want to take into account factors like the inflation rate or incomes. They also need to set the period of analysis on their own and decide if they consider the characteristics of a building over a period of, for example, 20, 50 or even 100 years. For this reason, an integration of ISO 15686-5 into international certification systems won't make sense until there are specific requirements with respect to:

- period under consideration [in years] and system boundaries (e. g. deconstruction, disposal)
- cost types (exact definition of scope and costs included: e. g. production, follow-up, deconstruction/disposal costs; costs for inspection/maintenance, cleaning costs, etc.)
- exact definition of reference service life and of addition to/reduction of service life
- rate of return [%], inflation etc.

Most of the ISO sustainability standards are still “under development”, but as soon as ISO exactly describes the valuation methods and defines the basic data, international systems will be comparable.

#### **4.4 Integration of FM into Green/Sustainable Building rating systems**

FM is a holistic approach. It invests for the long term and deals with all stages of a facility's life. In doing so, FM intends to optimize all phases of life regarding costs, benefits, ecology and value retention. Because of its integral thinking, FM strives for a total optimum of all sustainability categories instead of a multitude of sub-optima. That's why the FM branch supports a sustainable development ideally and plays a key role in sustainability.

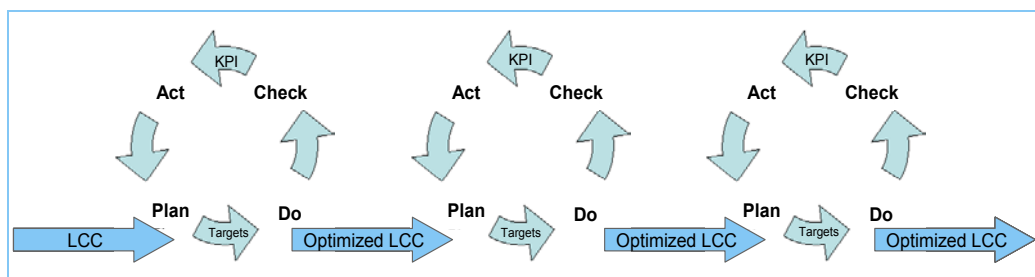
Despite its relevance for sustainable buildings, FM has not yet been sufficiently regarded by sustainability assessment tools. This fault is caused by the fact that the rating systems only evaluate the building and not the building-related services. In addition, FM services need to be regularly checked. In case of evaluating services, a one-time assessment would no longer be appropriate. That's why the validity of a certificate would have to expire after a certain time in case of not being renewed. The following paragraph exemplifies which services should be

integrated into Green/Sustainable Building rating systems and show what a continuous assessment might look like.

Criteria like fire protection, cleaning, life cycle assessments and the continuous improvement of the process quality (e. g. inspection-, maintenance-, repair processes) are essential FM services. However, at present, they are improperly, wrong or insufficiently evaluated. Life cycle costing, for example, is an important issue of a life cycle analysis. As described before, the LCC assessment method within the framework of building certification is not methodologically sound. It is not agreed either on the scope or on the valuation method and the assumptions to be made (e. g. interest rate, period under consideration). As for the criteria “cleaning” and “maintenance”, essential factors influencing the processes are not regarded. Above all, the cleaning and maintenance processes should be examined. So far, the rating systems don’t check whether a maintenance plan and the respective processes are coordinated well and whether the intervals are chosen correctly. The systems don’t regard if there are many different and/or expensive cleaning products and machines needed either. And they also don’t consider if the surfaces can be cleaned with eco-friendly detergents or if they have to be cleaned with the aid of aggressive cleaning products.

#### 4.5 Implementation of FM in DGNB assessment methods

In order to solve this problem, FM services need to be integrated into Green/Sustainable Building rating systems. For this purpose, an assessment model for sustainable FM processes needs to be developed. It is therefore necessary to set goals for a sustainable FM. These goals help to fix and operationalize the strategic FM targets. They can be broken down to tactical and operational level by defining sub-goals and Key Performance Indicators (KPIs) for the technical, commercial and infrastructural FM. In this way, FM processes can be continuously controlled and certified, as illustrated in Figure 4.



*Figure 4: FM controlling process using the example of life cycle costing (LCC)*

The (sub-) goals and KPIs mentioned above still need to be developed. They have to represent the different aspects of sustainability (ecology, economy, socio-culture, technical aspects, process quality, site quality) and can be derived from protection goals which are highlighted in Figure 5.

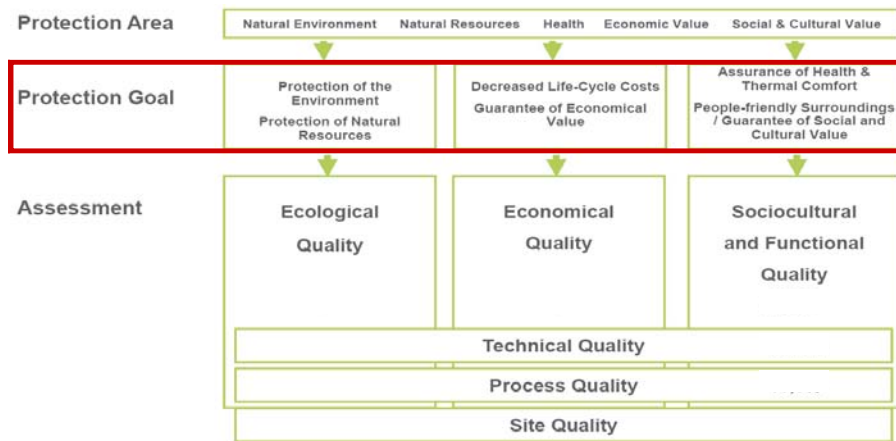


Figure 5: Protection goals as the basis of (sub-) goals and KPIs (DGNB, 2010)

## 5. Conclusion and outlook

The preceding chapters reveal that there is still a lot of need for action with respect to international standardization and the assessment of FM services within the framework of sustainable building certificates. However, at least the first step towards the assessment and comparability of sustainable construction is done. Apart from “research” activities, like those necessary for the revision of the sustainability assessment (ISO/CEN, FM), the FM branch also needs to take action to provide the convenient supply market for FM to find its way into sustainability for the long term. Different surveys among clients (Henzelmann and Büchele, 2010; Felix Meckmann, 2010) show that the supply of sustainable FM services and the availability of a specialized workforce in the field of sustainable construction is still insufficient (57,1 % and 58 %). FM providers have not yet been considered to be the ideal partner for sustainability as per a study by Lünendonk (2009).

It is expected that internationally standardized sustainable building certificates will be soon a basic requirement for the marketing of a building. Consequently, Facility Managers need to assure that FM services will be sufficiently addressed in sustainable building rating systems and standards. In addition, they have to provide research and education. In this way, they can extend the scope of services and increase the importance of their branch. There is a huge economic potential in the field of sustainability and the FM branch might play a key role. BUT Facility Managers need to seize this opportunity by strengthening their position as a partner of Green/Sustainable Building.

## References

Deutsche Gesellschaft für Nachhaltiges Bauen e V. (2009) *German Sustainable Building Certificate: Structure, Application, Criteria*, (available online [http://www.dgnb.de/fileadmin/downloads/DGNB\\_systemdescription\\_20091217\\_ohneblatt\\_en.pdf](http://www.dgnb.de/fileadmin/downloads/DGNB_systemdescription_20091217_ohneblatt_en.pdf) [accessed on 26/05/2010])

Deutsche Gesellschaft für Nachhaltiges Bauen e V. (2009) *DGNB International*, (available online [http://www.dgnb.de/fileadmin/downloads/DGNB\\_Presentation\\_wavequad\\_20100409\\_en.pdf](http://www.dgnb.de/fileadmin/downloads/DGNB_Presentation_wavequad_20100409_en.pdf) [accessed on 25/05/2010])

Eichholtz, P.; Kok, N.; Quigley, J. (2009) *RICS-study: Doing Well By Doing Good? Green Office Buildings*, UC Berkeley: Berkeley Program on Housing and Urban Policy. Berkeley, Maastricht, pp. 2.

Halweil, B.; Mastny, L.; Assadourian, E.; Starke, L.: Worldwatch Institute (2004) *State of the World 2004: A Worldwatch Institute Report on Progress Toward a Sustainable Society*. W. W. Norton & Company, pp. 167.

Hossenfelder, J.; Schultheiß, A.: Lünendonk GmbH, editor (2009) *Lünendonk-Studie 2009: Führende FM-Unternehmen für infrastrukturelles und technisches Gebäudemanagement in Deutschland*. Kaufbeuren.

König, H.: Bundesministerium für Bauwesen und Raumordnung, editor (2008) *BBR Forschungsprojekt: Zweiter Zwischenbericht: Orientierungswerte für die Bewertung von Hochbauten*.

Natural Marketing Institute and Porter Novelli (2007) *Neue Studie belegt: Europäer verhalten sich umweltbewusster als Amerikaner*, (available online [www.f-und-h.de/cms/upload/dokumente/LOHAS\\_Studie\\_FH\\_Porter\\_Novelli.pdf](http://www.f-und-h.de/cms/upload/dokumente/LOHAS_Studie_FH_Porter_Novelli.pdf) [accessed on 03/05/2010])

Pelzeter, A. (2008) *Lebenszykluskosten von Immobilien und mögliche Berechnungsansätze*, (available online [www.ilm-forum.com](http://www.ilm-forum.com) [accessed on 26/05/2010])

Henzelmann, T.; Büchele, R.; Engel, M.: Roland Berger, editor (2010) *Kurzzusammenfassung: Nachhaltigkeit im Immobilienmanagement*.

Sedlbauer, K. (2009) *Nachhaltigkeitsbewertung von Gebäuden: Fluch oder Segen für die Architektur?*, (available online [http://www.zellerporoton.de/pdf/MWT09\\_ProfDrSedlbauer.pdf](http://www.zellerporoton.de/pdf/MWT09_ProfDrSedlbauer.pdf) [accessed on 27/05/2010])

# Facilities management and buildings environmental performance

**Clarice Menezes Degani**

University of São Paulo  
claricedegani@gmail.com

**Francisco Ferreira Cardoso**

University of São Paulo  
francisco.cardoso@pcc.usp.br

## Abstract

This paper discusses some questions as: How to ensure existing buildings environmental performance and its evolution along time besides environmental, social and economic issues and also related to using, operating and maintaining activities? And how to recognize what are the new aspects of facilities management that have to be developed?

The management model for the sustainability of facilities presented on this paper was developed from the characterization of the activities that are usually performed by facilities managers by literature review, market observation and exploratory studies. It was also based on an intensive analysis of buildings environmental assessment and certification methods, aiming to identify relevant performance indicators and good sustainable practices.

The proposed model deals with facilities management issues such as the need for well defined responsibilities and scopes of work, professionalism, formal records and statistics related to building and its facilities environmental performance. It also helps on formalizing the planning and controlling facilities routines, which are essential on achieving better levels of buildings performance.

All of referred issues depend on the complexity and purpose of the building, so they can be handled either by a facilities employee or a specialized facilities management company. The presented management model for the sustainability of facilities applies to personnel responsible for managing facilities for housing, education, manufacturing, providing services, leisure, sports, health and trade in Brazil.

Resuming, the management model presented on this paper is based on “managing to perform” and can be easily applied to facilities managers as it presents a set of guidelines for managing the sustainability of existing buildings and suggests a set of performance parameters to be controlled. So, it may be a concrete way to insert issues of sustainability in the daily routine of facilities managers.

## 1. Introduction

A sustainable built environment must have its environmental impacts minimized, its social responsibilities and demands answered, its economics tasks known and improved, and also, its real estate concerns empowered by issues such as durability, flexibility and adequacy in use.

Some questions must be answered, as how to ensure existing buildings environmental performance and its evolution along time besides environmental, social and economic issues, and who is going to be in charge of those issues while using, operating and maintaining existing buildings.

Thus, the sustainability emerges as a big challenge and, concerning the built environment, facilities managers seem to play a crucial role to ensure an ongoing sustainable performance.

Based on environmental issues considered by some major building environmental performance assessment methods and also on facilities management usual practices, this paper identifies the prior environmental concerns that may guide facilities managers at their decision-making processes towards an improved environmental performance. Here, the objective is combining facilities management and sustainable practices, in order to improve buildings performance and minimize the environmental impacts from built environment and its operation.

The result was a management model that fits to personnel responsible for managing building facilities and more focused on key environmental performance parameters control.

## 2. Buildings environmental performance

The performance of buildings in terms of sustainability is extremely wide once it involves environmental, social and economic aspects that may be recognized in all stages of the life cycle of buildings: planning, designing, executing, using and operating, maintaining, renovating and finally “deconstructing”. So, make an assessment of this performance brings a lot of complexity.

There are several methodologies in the world aiming on assessing buildings environmental performance, this paper points the French *Démarche* HQE “*Haute Qualité Environnementale*”, the U.S. LEED “Leadership in Energy and Environmental Design”, the British BREEAM “Building Research Establishment Environmental Assessment Method” and the Japanese CASBEE “Comprehensive Assessment System for Building Environmental Efficiency”.

In Brazil, the national reference for assessment and certification of buildings environmental performance was launched in April 2008, by *Fundação Vanzolini*, in partnership with Certivéa (the French certifier organization responsible for the *Démarche HQE*<sup>®</sup>). It is named *processo AQUA* and presents some standards to evaluate buildings performance of many typologies in different phases such as new constructions, renovations and buildings in use.



Regarding buildings performance during their use and operation, this paper stresses the Brazilian, the French and the U.S. methodologies, respectively, *processo AQUA Edifícios em Operação* (FCAV, 2010), *Démarche HQE Exploitation* (Certivéa, 2008) and LEED for Existing Buildings LEED -EB (USGBC, 2008).

The assessment method proposed by the U.S. (LEED-EB) is accomplished by the sum of points awarded by attending many performance requirements that are proposed for six themes: (1) Sustainable sites, (2) Water use efficiency, (3) Energy and atmosphere, (4) Materials and Resources, (5) Indoor environmental quality, and (6) Innovation in operations. Besides the verification of these performance requirements, the LEED-EB also requires: a policy which identifies facilities management activities and operational procedures involved and related to some specific environmental issues; a formal allocation of responsibilities; the identification of key activities; the measurement and evaluation of a performance planning.

So, the U.S. method gives consideration to the presence of at least a simple management system, recognizing its importance on achieving and maintaining good levels of performance in buildings in use.

However, it is the French and Brazilian methodologies that further reinforce the relevance of the presence of a formal management system on achieving any performance goal. These certification standards are applied to different building typologies and their assessment method is capable to characterize both the existing performance and the management that are practiced.

These two assessment methods consist on evaluating the following topics.

- The management system of the existing building – There are requirements for establishing a formal management system including: organizational structure, contracts management, documentation and records controlling, other planning and controlling routines based on well known expected building performance, etc.
- The good practices – There are requirements for the evaluation of building practices beyond those directly related to the building itself. They are grouped into three areas: communication, management and supplies; they are related to minimizing energy consumption, water consumption, waste production, greenhouse gases emissions, and also to optimizing sanitary and comfort conditions.
- The environmental quality of existing building – There are performance requirements to be evaluated into fourteen categories of concern, both with regard to environmental quality of the building as intrinsic and to routines for monitoring, maintaining and improving these performances. Those 14 categories are (1) Relationship between building and surroundings, (2) Choice of materials and construction systems, (3) Low impact sites, (4) Energy management, (5) Water management, (6) Waste management, (7) Maintenance of performances, (8) Hygrothermal comfort, (9) Acoustic comfort, (10) Visual comfort, (11) Olfactory comfort, (12) Sanitary quality of the spaces, (13) Sanitary quality of the air and (14) Sanitary quality of water.

The management model presented on this paper was based on an intensive analysis of those mentioned assessment and certification methodologies and it identifies some relevant environmental issues of buildings environmental performance and also good sustainable practices that can enhance buildings performance. Considering the analyzed aspects of sustainability, the proposed model organizes its performance indicators into the following 'groups of aspects of sustainability'.

- Integration of the building to its surroundings - Performance indicators addressing issues related to buildings infrastructure, transportation and access, landscape quality and biodiversity, floods, disposal of polluted waters, comfortable and healthy external environment, outdoor lighting, noise and also natural, technological or sanitary hazards.
- Materials, systems and construction processes - Performance indicators related to the choice of materials, systems and construction processes to be retained and replaced during the lifetime of the building, covering aspects as adaptability, durability, recyclability, ease of storage and knowledge of their nature and chemical characteristics.
- Energy - Indicators addressing issues related to energy consumption reduction, envelope thermal transmittance, renewable energy use, greenhouse gases emissions and also the knowledge of total energy consumption and its disaggregated end use.
- Water - Indicators related to potable water consumption, non-potable water use, soil water infiltration, rainwater retention, recovery and wastewater treatment.
- Waste - Indicators related to the existing waste management system considering lower generation, sorting at source, flow optimization, quality and adequacy of local storage and collection, adequate disposals, maximized volume of waste recovered and reused on site.
- Technical devices - Indicators that represent the quality of existing devices to maintain the performance of various systems in the building in terms of accessibility of users and the technical areas, ease of operation of equipment and facilities, adequacy of devices and accessories, devices for measuring consumption, performance control and fault detection.
- Comfort and health - Indicators for hygrothermal comfort, acoustic comfort, visual comfort and olfactory comfort, and health-related quality of air, water and spaces.

In addition, it is important to consider that the methods of certification are not models of management, but environmental assessment tools that point some management routines and performance indicators, not addressing all relevant aspects of buildings sustainability and not covering all areas of facilities management activities. So, to deal with building operational phase, some issues must be stressed and others created and this is the intended improvement brought by the proposed model.

### 3. Facilities management – the new aspects that have to be developed

Facilities management (FM) is a somewhat recent activity comprising branches of engineering, architecture and management. Its purpose is to optimise the use of available resources and to raise buildings and its systems' performance, contributing on developing a productive environment. In fact, FM activities must link people demands, in terms of productivity and personal satisfaction, with existent building physical assets and technology. In other words, the FM can be a proactive management that enables buildings operation and maintenance planning, and that strategically supports organizations core business (Antonioli, 2003; IFMA<sup>1</sup>; Then, 1999).

According to Graça (2007), the FM is a professional activity whose purpose is to plan and operate efficient processes, integrating buildings, equipment and services to support people on achieving organizations purposes throughout buildings life cycle.

Then (1999) points that a sustainable FM role must be built upon an aspiration to keep adding value by providing appropriate and innovative 'facilities solutions' to business challenges through the skilful manipulation of all business resources – it is the optimum balance between people, physical assets and technology. It becomes clear that FM concepts are directly linked to organizations strategic management.

In Brazil, the facilities management began to be perceived, in the 80s, as a grouping of operational routines and activities for conservation and maintenance of buildings, initially in the form of self-management. At this time, professional associations began to emerge. It was the increasingly complexity of buildings that pushed the outsourcing of some services, so the professional of facilities has become an administrator hired by the end user.

In the 90s, the outsourcing market began to consolidate; there was an evolution in the infrastructure building management.

Nowadays, in Brazil, there are available various training courses for these professionals and they work as self-employees or as managers of facilities working for specialized management companies. However, the activities of use, operation and maintenance of the buildings are actually managed by different levels of professional expertise, which are also organized in different forms of organizational structures - some ineffectively, other informal and other very professional.

And also, the activities of the management of the facilities, once viewed as simple maintenance and operational routines, now has added other activities to support the core business hosted by the built environment. Recently, facilities managers begin to deal with social and environmental issues.

---

<sup>1</sup> International Facilities Management Association

Degani (2010) has grouped some usual practices, found on productive buildings operation, which are usually under facilities manager responsibility. This research was specially based on CSTB's internal records, on the extensive literature review made by Antonioli (2003), on the aspects listed by the Whole Building Design Guide (WBDG, 2002), on the eight case study reports presented by postgraduate students at the 6th Workshop on Facilities Management, promoted by a pos graduate programme of the University of São Paulo, and also on four exploratory studies detailed on this thesis.

So, according to Degani (2010), the activities that are usually performed by facilities managers may be:

- Operating and maintaining building physical assets – activities specifically related to building and technical aspects of building management such as: planning, operating and maintaining building systems and equipments; retrofitting; controlling consumptions and wastes; and other related.
- Operating infrastructure activities and core business supports – activities that were attributed to facilities managers over time as the buildings were becoming more complex and the outsourcing of services was becoming a common practice, and also, human resource management begun to cease to be an assignment of building owner or user. These are activities related to conservation and cleaning of spaces; managing services and benefits related to building users, such as bank agencies, gymnastic academy, parking lots, public restrooms, and other; providing supplies; managing suppliers contracts; and other related.
- Managing the workplace – these are the activities related to the core business and the building occupants. They are related to the layout of the workspaces and the workstations management in order to obtain productivity, flexibility, comfort, reliance, ergonomics and functionality; the workplace environment (nice and human); the indoor environment (healthy and comfortable); the communication flow support; the collective spaces and services management; the changing processes support personnel; and other related.
- Managing the building as a real estate – this group of activities deals with the commercial and economic aspects of the built environment considering the building itself, its core business and people. Their activities concerns: asset management and planning of development assets; contracts management; commercial and administrative activities; organizations inventory management; planning inventory evolution; controlling and evaluating available services in order to obtain a continual improvement concerning core business activities support; effective operational cost management; ensuring safety and security to people, the building and its components; organization image; and other related.

Despite there are some environmental issues considered by these activities, they are usually not formal considered as goals to be set, neither as indicators to be periodically monitored.

#### 4. The management model for the sustainability of facilities

The analysis of major building environmental performance assessment methods and the identification of usual facilities management practices, they all are brought to this paper in order to enhance the prior environmental concerns related to built environment and its operation and, also, to provide the basis of the proposed management model for the sustainability of facilities.

The proposed model assumes the "managing for performance" concept, seen as a way to structure management routines that could identify and promote the analysis, planning, implementation and controlling specific actions, all of them aiming to achieve buildings better performance. Thus, this management model is proposed to be held by personnel responsible for managing facilities for housing, education, manufacturing, providing services, leisure, sports, health and trade in Brazil.

Here, the term "facilities manager" is used to represent all the personnel responsible for the use, operation and maintenance of buildings and its services, among several other functions found in existing building facilities. The facilities manager may be a management organization, an employee of the condominium, a user, the owner himself or an agent nominated by the owner. So, this management model for the sustainability of facilities applies to facilities manager.

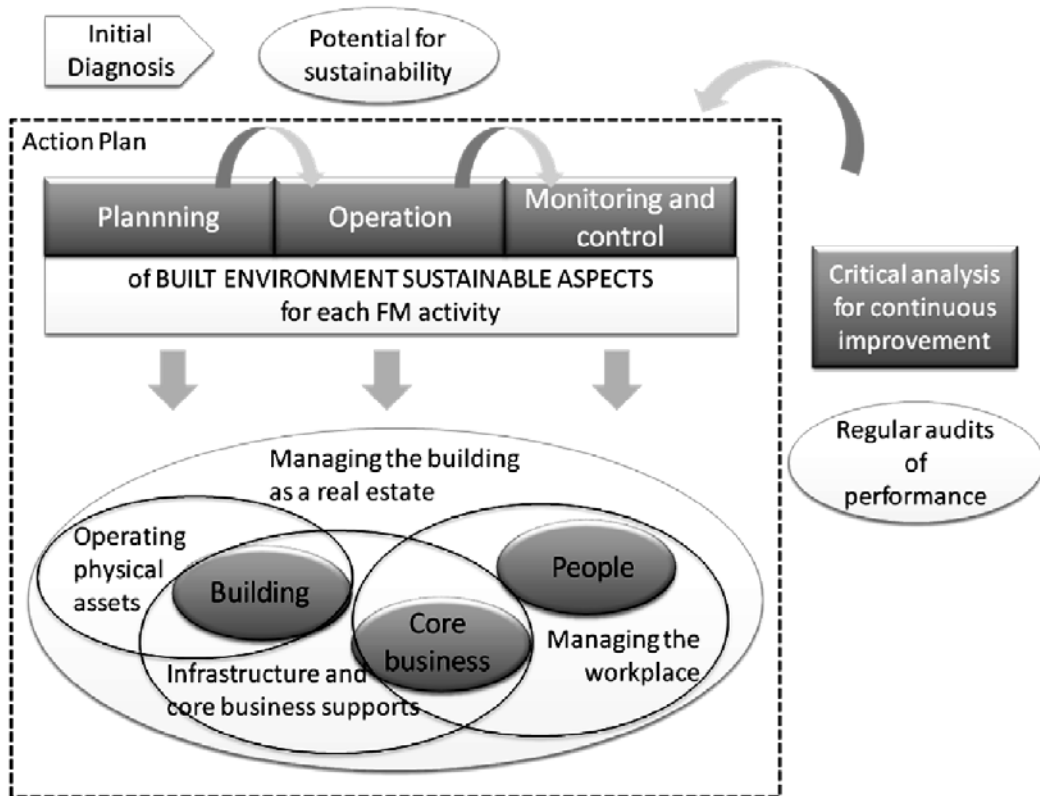


Figure 1: The management model for the sustainability of facilities (Degani, 2010)

In general, the management model for the sustainability of facilities presented on this paper includes the following steps: Initial diagnosis, Identification of the potential for sustainability, Planning, Operation, Monitoring and control, Regular audits of performance, Critical analysis for continuous improvement.

The Initial diagnosis is an essential phase and it must be a structured thinking that allows the evaluation of building initial situation and its facilities in terms of: (a) global policy and marketing strategy of the building, its values, its conduct and its history, (2) quality and adequacy, (3) environmental aspects and impacts, (4) human and social aspects, (5) economic aspects; (6) structure, formality and scope of its management system, (7) facilities management currently practiced.

Aware that management is only effective if what you need to be managed is known, this process of formal thinking promotes the understanding of many aspects of sustainability and, thereafter, the identification of strengths, weaknesses and priorities for the building. This is the Identification of the potential for sustainability phase of the presented management model.

It is assumed, therefore, a commitment to the buildings priorities considering social and environmental issues, making possible the development of a management planning for sustainability of building facilities, consciously and systematically, based on real analysis of context and its possibilities and also focused on well defined goals and targets.

From this step, it is suggested the development of an Action Plan, based on the guidelines proposed by Degani (2010). The “Guidelines for the management of sustainability of facilities” contains several practices and measures and they are proposed under the perspective of the four groups of FM activities described in chapter 3 of this paper. They are also detailed under three steps: Planning, Operation and Monitoring and control. The interfaces with the existing building elements: the building itself, the core business and its users, are considered.

These guidelines are the improvement brought by this proposed model. And based on them, it is suggested to detail the Action Plan, thereby ensuring that facilities managers can structure their commitment to the building sustainability, starting from the definition of their first actions, keeping objectives and goals clearly defined, and including on this Plan the allocation of responsibilities, the deadlines and the adequate resources provision always in terms of planning, operation, monitoring and control. It is the Planning step.

From the Planning, it moves on to the Operation step, in which the Action Plan is implemented, especially through routines of work and supplies and also by actual occupancy of spaces. At this time, skills are evaluated, contracts are formalized, training routines are implemented and routines of work and communication are validated.

The next step is the Monitoring and control routines, that are performed to ensure the continued good performance by a systematic registration of data and information that are essential to decision-making of the owner, manager or user of the building throughout its life cycle, providing feedback, for continuous improvement.

As a control routine, it is also proposed to carry out Regular audits of performance. They have larger scope comparing to monitoring and control routines, while they focus on the overall analysis of building performance and building management aspects. These audits have the purpose of maintaining the focus of facilities manager their building sustainability issues.

The performance audits should verify the evolution of the aspects of sustainability of the building, considering the achievement of its objectives and targets, which were established in the Action Plan. They also intend to identify, as early as possible, faults or deficiencies in facilities management that could compromise the performance of the building. All of that information is very important in raising significant elements to be considered by buildings decision-makers.

The results of each regular audit of performance are reviewed and afterwards a new plan of action and a new performance targets are set for the building. And finally, the Critical analysis for continuous improvement works on evaluating global facilities management model and building performance. It aims to continuously improve building performance; feed back the existing management system; assist the manager in making decisions related to the sustainability of facilities under environmental, social and economic perspectives; allow the return of experience for designers to refine their new projects by these verified existing building performance.

## 5. Conclusions

The formal management is fundamental to the sustainability of buildings. The concept of “managing to perform” is the base of the management model presented in this paper, which links facilities management with building environmental performance.

What makes this model unique is the fact that it can guide facilities managers on identifying prior environmental concerns and on their decision-making processes towards an improved environmental performance. The proposal combines facilities management and sustainable practices, in order to improve buildings performance and minimize the environmental impacts from built environment and its operation. It is considered an initiative to meet organizations strategic need on dealing with the sustainability of the built environment that they occupy.

The key is:

- to assign responsibilities for carrying out the four indicated task groups of facilities management;
- to undertake a strategic and operational planning which is appropriate to users needs, their building occupation, the equipment and systems available;
- to integrate all the players in order to add good practices and to act for the benefit of all building users, their core business and owner financial health.

Resuming, the management system presented on this paper can be easily applied to facilities managers as it presents a set of guidelines for managing the sustainability of existing buildings

and suggests a set of performance parameters to be controlled by regular audits. So, the proposed model aims at providing a concrete way to insert issues of sustainability in the daily routine of facilities managers.

## References

ANTONIOLI, Paulo Eduardo. **Estudo crítico sobre subsídios conceituais para suporte do planejamento de sistemas de gerenciamento de facilidades em edificações produtivas.** 2003. Dissertação (mestrado em engenharia) – Escola Politécnica, Universidade de São Paulo, São Paulo, 2003.

CASBEE. **Comprehensive Assessment System for Building Environmental Efficiency.** Japan Sustainable Building Consortium, 2002. 15 p.

CERTIVÉA. **Démarche HQE® « Exploitation. Référentiel Technique des Bâtiments Tertiaires en Exploitation. Version 0 Mai 2008.** Certivéa: Paris, maio 2008. Disponível em <http://www.certivea.fr>.

CSTB. Centre Scientifique et Technique du Bâtiment. **Référentiel Technique de Certification NF Bâtiments Tertiaires – Démarche HQE Bureau et Enseignement.** Paris, millésime 2005. Disponível em [www.cstb.fr](http://www.cstb.fr).

DEGANI, Clarice Menezes. **Modelo de Gerenciamento da Sustentabilidade de Facilidades Construídas.** 2010. Tese (doutorado) – escola Politécnica, Universidade de São Paulo, São Paulo, 2010.

FCAV. Fundação Carlos Alberto Vanzolini. **Referencial Técnico de Certificação. Edifícios do setor de serviços - Processo AQUA: Escritórios e edifícios escolares.** Versão 0. 15 de outubro de 2007. São Paulo, 2007.

GRAÇA, Moacyr Eduardo Alves da. *Palestra proferida no IV Congresso INFRA*, São Paulo, SP. Abril 2007.

NABERS. **The National Australian Buildings Environmental Rating System.** Draft final version. Dezembro, 2001. Robert Vale, Brenda vale, Roger Fay.

NRCan & iiSBE. **GBTTool User Manual.** Fevereiro, 2002. 70p. Disponível em [www.iisbe.org](http://www.iisbe.org).



THEN, Danny Shiem-Shin. **An integrated resource management view of facilities management.** MCB Univeristy Press: Facilities (1999) 17 (12;13); 462-469.

USGBC UNITED STATES GREEN BULDING COUNCIL. **LEED® for Existing Buildings: Operations and Maintenance.** USGBC, setembro 2008.

USGBC UNITED STATES GREEN BULDING COUNCIL. **LEED® Rating System.** Diversas versões. Disponíveis em [http:// www.usgbc.org](http://www.usgbc.org).



# The AQUA-FCAV Built Environment Sustainability Certification: an approach to water management

**Carla C.P. de Assis Santovito**

Escola Politecnica, University of São Paulo, Brazil  
santovito@hotmail.com

**Orestes Marracini Gonçalves**

Escola Politecnica, University of São Paulo, Brazil  
orestes.goncalves@poli.usp.br

## Abstract

The city of São Paulo has a high demand for urban and industrial use of water. This unfavorable situation is considered critical, making the management of water for public supply a fairly complex subject. Added to this, the potential shortage of drinking water resource availability justifies researches focusing on their efficient management and conservation. Into the Civil Construction sector context, the use and efficient management of drinking water is among the topics addressed by the indicators of methodologies for sustainable buildings certification. Since most of the water consumption takes place within any building, it can be argued that the use of efficient equipment reduces the consumption of this resource. One of the models applicable to the certification of a sustainable building is the AQUA-FCAV referential, which includes the necessary guidelines on water management from the design phase of the building, to the use and operation phase. This framework involves a management system that considers the development of water management in the aspect of the urban context in relation to the permeability of the land, choice of saving equipment, maintenance of the building in order to perpetuate its environmental performance and sanitary quality of water. In the present research, the characteristics of the standard AQUA-FCAV that are related to water management are presented, comparing them with other methodology for certification of buildings, namely the LEED. From this comparative analysis the existence of indicators that assess specific items for the Maintenance and Management of the project had been identified, which demonstrates the need for involvement of Facilities Management professionals since the design of the building, when the AQUA-FCAV certification is to be obtained.

**Keywords:** sustainability, water demand management, sustainable buildings assessment

## 1. Introduction

### 1.1 – The water demand management context

The scarcity of natural resources is a global concern, which can be perceived by the emergence of increasingly intense actions for managing these resources. As a leading authority on global environment, United Nations Environment Programme - UNEP (UNEP, 2010), emphasizes the importance of identifying the negative impacts to the environment caused by unsustainable production and consumption. Consequently, it seeks the efficient use of natural resources. An example for the natural water resource is the definition of one of the millennium development goals proposed by the United Nations Development Programme - UNDP as to "ensure environmental sustainability by increasing the proportion of population with permanent and sustainable access to safe drinking water (UNDP, 2010).

One of the means proposed by UNEP in order to achieve these goals is the realization of partnerships that integrate the private sector in a new culture of social responsibility, to prepare and joint participation of civil society and academic sectors in environmental management and sustainable development. In this sense, to ensure a systemic view, when treated the scarcity of water resources in the environment, it is appropriate an approach whit a sustainable focus, addressing the economic, social, cultural and environmental aspects of society.

As the main responsible for environmental management at national level, the Brazilian government monitors the data for the development of actions through their national agencies. For water, this management is performed by the National Water Agency - ANA. According to data collected by ANA, analyzing the situation of the water balance of the main Brazilian rivers, the situation in Brazil is considered comfortable; especially by high water availability of the Amazon Basin region (Brazil has 12% of the world's drinking water).

This analysis, however, does not consider the unequal distribution of water resources in the country. About 68.5% of water resources are located in the North region of the country. The region with the highest demand, the Southeast has about 6% of water resources (Tomaz, 2001), and the city of São Paulo (ANA, 2010), has high demand for urban use and industrial water. It appears therefore that the situation is quite unfavorable when compared with other regions. In this context, water management becomes critical, requiring large volumes of investments and the development of joint actions.

The Programa Nacional de Combate ao Desperdício de Água - PNCDA (National Program to Combat the Waste of Water) is an example of such actions. The program aims at promoting the rational use of public water supply in the Brazilian cities, through technological developments, regulatory, economic and institutional actions. Specifically, it seeks an effective economy of volumes of water demanded for consumption in urban areas. For this, the technical documents

defined in the PNCDA (PNCDA, 2010) are considered as a methodology applied by the public utility SABESP in the Integrated Water Supply in the metropolitan region of Sao Paulo.

Currently the water supplied to the city of São Paulo comes from the interconnection of major supply systems in the region, namely: System Cantareira Guarapiranga, Alto Tietê, Rio Grande, Rio Claro, Alto Cotia, Baixo Cotia and Ribeirão da Estiva, consisting of 24 dams that allow 1.5 billion m<sup>3</sup> of raw water treatment plants and eight of drinking water. Accordingly with the Regional Profile MRSP (2009) the city of São Paulo has a population of approximately 11 million people and is responsible for consuming 65% of the water produced by the Integrated System. The city is supplied by four of the eight production systems: System Cantareira the north and center, System Guarapiranga at the South and West, Rio Claro Systems and Alto Tietê at the east, with current rate of water supply by 100%.

The public utility concessionary SABESP, responsible for managing the water supply in São Paulo, based on PNCDA and based on the hydraulic capacity of São Paulo, developed in 1996 the Program for Rational Use of Water - PURE ( SABESP, 2010), which has as main objective to act in the consumer demand for this resource.

The PURA-SABESP (SABESP, 2010), uses a systems approach in the treatment of water resource use, and has the following objectives: a) raise awareness of environmental issues, aiming to change habits and vices of waste disposal, with a conservation focus and consequent increased availability of water resources, b) promote increased availability of water to needy areas and securing supplies, c) extend the useful life of existing water sources to ensure the short and medium term supply of water needed by the population, d) reduce the costs of wastewater treatment to reduce the volumes recorded in the public network, e) postpone investments needed to increase the water production system and Sewerage System in the Metropolitan Region of São Paulo, f) encourage the development of new technologies aimed at reducing water consumption, and g) reduce consumption of electricity and other resources.

It is perceived that the actions developed by the public sector focus on promoting rational use of water, but we need greater integration with the private sector to meet the full objectives set by UNEP. Considering the construction industry, one of the actions in order to preserve this natural resource is to encourage the construction of buildings considered sustainable in terms of use and efficient consumption of natural resources.

To demonstrate the sustainability of a building some methods of assessment of sustainable buildings were developed. Larsson (2004) define the assessment methods for buildings as a set of protocols or indicators and assessment criteria usually based on the life cycle and used to evaluate the environmental performance or sustainability of a building or its sub-systems.

According to Cole (2005), tools and methods for assessing environmental sustainability of buildings have emerged to provide an objective evaluation of the use of natural resources, the ecological burden and quality of internal environment, but also to raise awareness of environmental responsibility in construction industry.

The evaluation methods have two goals, says Gibberd (2003). The first is to ensure an adequate understanding between sustainable development, building / built environment and stakeholders so that effective communication is established on the discussion, development and agreement on performance objectives of sustainable development for the building.

The second is to ensure that the relationship between sustainable development and the built environment is explicit and intelligible. This includes understanding how the built environment can be used in sustainable development. This involves a process of prioritizing the aspects of sustainable development and ensures that these are reflected in performance targets chosen for the venture. Once established these performance goals, the management of the project will serve to monitor progress towards achieving certain goals.

Methodologies such as the AQUA-FCAV referential worry, at the design stage, with the systems that will be used during the use and operation. Accordingly, the efficient use and consumption of drinking water is considered in its various aspects, from the design stage. The AQUA-FCAV referential takes into consideration the aspect of the urban context, when considering the permeability of the land area, the flow of rainwater runoff, the choice of equipment and water-saving systems and also include in the project items to facilitate the maintenance in order to perpetuate their environmental and sanitary quality of water.

Through the certification certain actions are secured, for example, that the venture will have at least: sectorized water meters, leak detection systems; means for carrying out anti-fouling, corrosion and anti-development of microorganisms and the control of dosage; the means to balance the systems of water management, in addition to saving equipment aiming efficient power consumption of water resources.

This subject is addressed to develop pro-active actions to monitor the environmental performance of buildings in the design of projects, implementation of projects and operation of their systems. The professionals in the Facilities Management are primarily responsible for these actions. Therefore, it is appropriate to identify how the certification process affects or contributes to the performance of this professional in water management in the built environment.

## **1.2 Research objectives**

This work is part of a broader study that addresses water management in multi-floor commercial, its relationship with the energy management and their integration into sustainable development to reduce the environment impacts of the construction.

The specific objective of this research was to identify how the requirements of the standard AQUA-FCAV, in relation to water management, relate to the management of facilities. As a reference for recognition of environmental performance, this article uses the certification

AQUA-FCAV. However, there are some indicators which are compared with another U.S. certification widely used in Brazil, the Leadership for Energy and Environmental Design LEED

### **1.3 Research Methodology**

For this study, was initially performed a literature review on the themes: sustainability, sustainability in the built environment, use and efficient consumption of natural resources and water management. Under the specific issue of water management, we studied two methods for evaluating sustainability in the built environment: the technical reference AQUA-FCAV, adapted to Brazil from the French HQE method and U.S. LEED, which is widely used in Brazil but, according to Del Percio (2004) addresses the management of water very superficially.

The process of water management has been studied in the two methods in order, to analyze the criteria and indicators that are determined during the design phase and might have some interference or connection with the operation phase, and should therefore be object of study by Facilities Management professionals.

## **2. Models for the Built Environment Sustainability Certification**

The Brazilian market has been using two methodologies to assess the sustainability of buildings: LEED and AQUA-FCAV. These two methods, although have the same premises and goal of sustainable construction, present some conceptual differences that are here identified.

LEED was developed in the United States and released in 1996, representing the efforts of the United States Green Building Council - USGBC to develop a certification system for what is called the Green Building - building "green" or ecological - a term used more to designate environmentally friendly products. This assessment methodology was first developed for new construction. However, as demand evolved, new versions were developed to address other types of construction. Currently it can be applied to various types of buildings.

The compliance of the guidelines prescribed by the LEED is evaluated by the USGBC – United States Green Building Council, the only body responsible for certification. All documentation is posted online and reviewed by USGBC. The requirements of LEED certification are meant for a building in the design, construction, operation and maintenance of the in building systems.

The certification to the referential Alta Qualidade Ambiental-Fundação Carlos Alberto Vanzolini (AQUA-FCAV), object of this study is based on the French benchmark HQE, which was adapted to Brazil. It has as main objective to demonstrate the high environmental quality of the building through two processes: the management system development and environmental quality of the enterprise. Uses, for both, independent audits carried out by specialized teams. The requirements presented by Fundação Carlos Alberto Vanzolini for this certification involve

the user quality of life, the management of natural resources, the proper and conscious disposal of waste generated and the operations and maintenance of building systems, focusing on the regional socio-economic-environmental contribution.

According to the AQUA-FCAV, the building is certified in three phases: the first phase program, the second phase of the project design, and the third after the project execution and delivery to the end user. In these three moments, both the management system (SGE) employed and the project's profile in relation to environmental quality are evaluated. The SGE provides the necessary structure in meeting the performance criteria set and requested in order to monitor, review and evaluation of the environmental quality of the building throughout the life cycle of the enterprise.

Although both benchmarks are aimed at environmental management and sustainability of the building, each has different approaches when it comes to water management. For LEED certification, the requirements are contained in categories: Selection of location, flood control - Quantity, Runoff Control - Quality, Reduce use of water efficient irrigation technologies and innovative reuse.

By the AQUA-FCAV certification, the requirements are presented in a wider format than that proposed by LEED, as contemplated in Categories: Relationship building with its surroundings, Choice of integrated products, systems and construction processes, construction sites with low environmental impact (including water management), water management, waste management, building use and operation and sanitary quality of water.

The AQUA-FCAV considers the entrepreneur's decision to establish and maintain complete control of the project in all its stages, from adherence to the program design (design), implementation (construction) and operation (use), through the System Management Enterprise (SGE) to be treated all the performance criteria of the Building Environmental Quality, allowing the grant of approval at each stage, by checking their attendance to the technical reference (AQUA-FCAV).

Academic studies have shown the need to align these criteria. For this, Kalbusch (2006) proposes in his work to create a project checklist, whose aim would be to assist those involved in the construction industry, where the design of building systems and hydraulic plumbing office buildings. This list is subdivided into categories: reliability, quality and maintainability of building systems, hydraulic and sanitary, health and sanitary quality of water, water conservation, load on local infrastructure (storm drainage); load on local infrastructure (sewerage treatment); interference in underground aquifers, flooded areas and water courses, materials and building systems hydraulic toilets; water reuse and rainwater utilization.

Aiming to bring issues related to environmental sustainability in the built environment, Kalbusch (2006) explains the need to carry out further studies for integration of social and economic dimensions, and the development of evaluation methods for hydraulic and sanitary building systems, and water use that meet the macro needs in water management.



The current Brazilian experiences in sustainable certifications reflect on international experience, which for Serrador (2008) is not appropriate, considering the speed and location of development in Brazil. This leads to actions of individual professionals and companies without an effective planning for the development of the construction industry toward a more sustainable way of building.

### **3. Facility Management and the AQUA-FCAV model**

It is noticed that in technical references where sustainability of the built environment addresses the operations and use of the building, the Facilities Management will be present and may be subject to involvement from conception to proper use and maintenance of efficient operation originally envisaged.

The facilities management has representative importance in the life cycle of a building, as it acts on the longest stage of their life cycle, namely the use and operation phase. Degani (2010) presents the close relationship between facilities management and sustainability of the built environment as a challenge to owners and users of a building, because they involve issues of economic feasibility, demand-driven, social responsibility, minimization of environmental impacts, value market the building to reflect the performance of the enterprise and therefore the management of facilities.

The performance of routine operation and maintenance activities are the usual professional Facilities Management. However, as suggested by Degani (2010), when implemented a management system focused on continuous improvement, for example, the Facilities Management professional has a better view of the shortcomings and dissatisfactions of users and thus helps the owner and users to make important decisions, including asset value.

In this regard, the technical reference AQUA-FCAV, when establishing the Enterprise Management System (EMS) requires the existence of a mechanism for continuous improvement throughout the life cycle of the enterprise, which can be used by professional management facilities as an important tool. According to the definition of technical reference AQUA-FCAV, an enterprise management system allows an appropriate organization to work together from the different actors involved, better conditions for decision making and a structure for development and steady improvement and efficient the proposed system.

Degani (2010), when analyzing the AQUA-FCAV method, emphasizes the principle of balance in the classification of the weights or importance of the subject by the entrepreneur in terms of occupation, location of the project and their real needs and local sustainability certification for the building. As for LEED certification, considering the water management in the building and its hydraulic building systems as criticized by Hernandez (2007), the representativeness of water management represents 7% of the total points to meet the guidelines, which clearly identified the imbalance present this methodology, among other tracking issues such as: energy, materials

and resources, sustainable sites and internal quality, which represent 25% each in the attendance of proposed items for certification.

In a comprehensive and systemic analysis of the standard AQUA-FCAV perceives a concern focused on the life cycle of the building, including its operation and management of their facilities. The concern in water management has been present since the preparation of the "Enterprise Management System", given as an initial planning necessary to implement the certification criteria by presenting a detailed plan for water management in order to minimize deviations in environmental performance of the building during use.

As categorias do AQUA são fortemente inter-relacionadas, sendo que o atendimento aos critérios de uma pode corresponder ao atendimento dos critérios de outra. Como exemplo, na categoria "Gestão da Água", as diretrizes:

The AQUA-FCAV categories are strongly interrelated, and meeting the criteria of one may be the fulfillment of other criteria. As an example, in category "Water Management", the guidelines for:

- Use of pressure reducing valves
- Presence of saving systems that reduce the consumption of drinking water
- Use of rainwater or reuse
- Managing the retention of rainwater
- Management of infiltration
- Recovery and treatment of runoff prior to disposal

Find a match in the other categories, such as:

- Category "Relationship building with its surroundings, in the management of rainwater on the ground, lower sealing surfaces;
- Category "Choice of integrated products, systems and construction processes," in choosing water-saving equipment in accordance with nationally recognized certification program or whose characteristics are checked for technical or controls;
- Category "Maintenance - Permanence of environmental performance," in need of equipment to monitor and manage water consumption and to reduce waste and leaks including cleanup activities and conservation;
- Category "Sanitary quality of water", monitoring the health risks linked to the presence of network of rainwater;

It should be emphasized that the Enterprise Management System has as one of its requirements to develop a "Manual for use and operation of the building," which shall contain all information relating to the maintenance of equipment and systems to prospective users. This manual should provide all necessary information for the use of water saving equipment and the precautions to

be taken in case of dual network, and may extend these requests to the local political commitment to water management.

## 4. Final Considerations

Urban areas like Sao Paulo are big consumers of drinking water. The buildings make up the necessary infrastructure as the main pathway for the realization of this consumption. In this context the guidelines of assessment methodologies for sustainable built environment aimed at the rational use of water from designing a building to its effects on facilities management.

Thus, it is clear the need to consider in planning methodologies for assessing the sustainability of the built environment, operational guidelines systems, as well as its forms of control, generating the necessary information for proper management of facilities of a building and maintenance of the condition initially planned for its sustainability performance.

The implementation phase of a real estate enterprise generates a great impact on changing the landscape and the characteristics of the region in a short time. However the phase of usage and operation of an enterprise has a much longer duration and the tendency of sustainable construction will be to prolong this phase. It is for this reason that the management of facilities should be more efficient both to prolong the life of the enterprise, how to efficiently consume resources needed for their use and maintenance.

Looking at the references in the text that are used on national territory, we can see the differences in concepts and amplitudes of the certificates AQUA-FCAV and LEED, and may conclude that certification AQUA-FCAV has a structure that involves more intensely the Facilities Management on the design of the project by formalizing the request for an Enterprise Management System and the care planned arrangements for the design of the hydraulic system for building so-called "Maintenance - Permanence of Environmental Performance. "

It is understood that the national construction market is progressing in relation to sustainability. Practice a few years ago were not even imagined are becoming frequent, such as the installation of saving equipment, for example. In this sense, the fact of AQUA- FCAV referential be adapted to Brazilian facilitates its applicability, as the needs of entrepreneurs and professionals of Facilities Management increases.

## References

- DEGANI, C. M. – Modelo de gerenciamento da sustentabilidade de facilidades construídas – Ed. Revisada – São Paulo, 2010 – Tese (doutorado) – Escola Politécnica da USP – PCC – USP.
- HERNANDES, T. Z. – LEED NC como sistema de avaliação da sustentabilidade: uma perspectiva nacional? – São Paulo, 2006 – Dissertação (mestrado) – FAU/USP
- DEL PERCIO, S.T – The skyscraper, green design & the LEED green building rating system: The creation of uniform sustainable standards for the 21th century or the perpetuation of an architectural fiction? – Hein on line (2004-2005) *Environm Entvl L.& Pol’y J.*
- FCAV. Fundação Carlos Alberto Vanzolini. Referencial Técnico de Certificação. Edifícios do setor de serviços - Processo AQUA: Escritórios e edifícios escolares. Versão 0. 15 de outubro de 2007. São Paulo, 2007.
- COLE, R. J. Building Environmental assessment methods: redefining intentions and roles. *Building Research & Information*. v.33, n.5, p. 455-467. Especial Issue: Regionalism and Sustainability: Lessons from SB04. September-October 2005.
- GIBBERD, Jeremy. Integrating Sustainable Development into Briefing and Design Processes of Buildings in Developing countries: An Assessment Tool. Tese de doutorado. University of Pretoria, department of Architecture 2003
- LARSSON, N. An Overview of green building rating and labeling systems. *IiSBE*: 2004. Disponível em <http://greenbuilding.ca/iisbe/start/iisbe.htm>. Acesso em 20/05/2007
- TOMAZ, P. Economia de água para empresas e residências – um estudo atualizado sobre o uso racional da água, Ed. Navegar: São Paulo, 2001.
- USGBC UNITED STATES GREEN BUILDING COUNCIL. LEED for Existing Buildings: Operations and Maintenance. USGBC, setembro 2008.
- SERRADOR, M.E. – Sustentabilidade em arquitetura: Referências para projeto. Dissertação (mestrado) – Escola de Engenharia de São Carlos, Universidade de São Paulo, São Carlos, 2008
- KALBUSH, A. – Critérios de sustentabilidade ambiental dos sistemas prediais hidráulicos e sanitários em edifícios de escritórios. Dissertação (mestrado) EPUSP, São Paulo, 2006
- PNUD, (2010) - Programa das Nações Unidas para o Desenvolvimento – PNUD (available online [http://www.pnud.org.br/odm/objetivo\\_7/](http://www.pnud.org.br/odm/objetivo_7/))
- PNUMA, (2010) - Programa das Nações Unidas para o Meio Ambiente PNUMA (available online [http://www.onu-brasil.org.br/agencias\\_pnuma.php](http://www.onu-brasil.org.br/agencias_pnuma.php))
- ANA, (2010) - Agência Nacional de Águas. (available online <http://conjuntura.ana.gov.br/>) -
- RMSP, (2009) - Perfil Regional Município de São Paulo (available online <http://www.planejamento.sp.gov.br/des/textos8/RMSP.pdf>)
- SABESP, (2010) - Concessionária de serviço público SABESP (available online <http://site.sabesp.com.br/site/interna/Municipio.aspx?secaoId=18&id=6>)

## Session 6 - Special Topics in FM

Professor Edward F. Finch<sup>1</sup> & Prof. Dr. Lúcia Helena de Oliveira<sup>2</sup>

<sup>1</sup>University of Salford - Centre for Facilities Management - Salford/UK

<sup>2</sup>EPUSP Escola Politécnica, University of São Paulo - MBA/USP FM - São Paulo/Brazil

### Influence of FM Factors on Location Decisions of Manufacturing Firms

383

CIARAMELLA, Andrea<sup>1</sup>; DETTWILER, Paul<sup>2</sup>

<sup>1</sup>Dipartimento BEST, Politecnico di Milano, Italy

<sup>2</sup>IFM, Zurich University of Applied Sciences, Switzerland

### Performance-based procurement by the Dutch Governmental Buildings Agency

395

STRAUB, Ad

Delft University of Technology

### Developing a categorization matrix of Key Performance Indicators (KPIs): A literature review

407

LAVY, Sarel<sup>1</sup>; GARCIA, John A.<sup>2</sup>; DIXIT, Manish K.<sup>1</sup>

<sup>1</sup>College of Architecture, Texas A&M University, USA

<sup>2</sup>Alpha Facilities Solutions

### Risk Assessment of Ammunition Threats to Critical Infrastructures

421

SHOHET, Igal M.; SCHENKER, Andras; BENDOR, Gabi

Ben-Gurion University of the Negev, Israel

### System transferability of Facility Management

435

BANEDJ-SCHAFII, Mandana; LENNERTS, Kunibert

Karlsruhe Institute of Technology (KIT), Germany

### The Influence of Iranian Culture on the Attitude towards Built Asset Maintenance

447

KIAIE, Maryamalsadat; JONES, Keith

University of Greenwich, UK

### Risk, culture, and implementing environmental health in facilities management

457

LIEBER, Renato Rocha

UNESP - University Estadual Paulista, Brazil



## Influence of FM Factors on Location Decisions of Manufacturing Firms

### Andrea Ciaramella

Dipartimento BEST, Politecnico di Milano, Via Bonardi, 3, 20133 Milan, Italy; tel. +39 (0) 223995123; [andrea.ciaramella@polimi.it](mailto:andrea.ciaramella@polimi.it)

### Paul Dettwiler

IFM, Zurich University of Applied Sciences, Grüental, Postfach 335, CH-8820 Wädenswil, Switzerland; tel. +41 (0)589345623; [detp@zhaw.ch](mailto:detp@zhaw.ch)

### Abstract

This paper deals with two major questions (1) what alternatives does a manufacturing company has when current space use is not sufficient, or it exceeds its needs following changes and transformation of the business; and (2) what principal factors must be taken into account in the decision-making process about possible relocation. The corporate real estates of manufacturing firms in the Western world are very much similar to those of the tertiary sector. However, inertia compared to pure tertiary is apparent; a large part of the premises are in fact offices that to various extents are connected to stocks, laboratories, factories and manufacturing areas that cannot be relocated. Therefore intermediary alternatives between staying on the current location or total relocation have their reasons of being developed. This paper is based on literature studies and two independent surveys from two different geographical areas: Northern Italy and Sweden. Despite the various characters of the surveys, common conclusions can be made for a general understanding of the relation of FM factors that influence the location. A model is created that systematises location alternative when space change must take place and relates also to the European manufacturing sector of today.

**Keywords:** Location, Relocation, Manufacturing, Corporate Real Estate, Facilities

## 1. Introduction

In the recent two decades we have seen that major manufacturing industries have been transferred to East Asia from Europe due to more advantageous salary levels. However a significant part of the manufacturing sector has remained in Europe and even occasionally regained domain in Europe. Other competitive forces than low salaries of workers render argument to remain in Europe. This paper aims to reveal Real Estate Management and Facilities Management topics that relates to the dynamics of manufacturing firms to their decision of location and possible relocation of the properties. We intend to highlight and clarify the structure of background factors and the structure of location settings of manufacturing firms. The study is limited to small and middle sized enterprises (SMEs) within the manufacturing sector. During its lifetime every enterprise, be it small, medium-sized or large, might have to face some real estate or location issues. Being able to face these issues in a well informed and professional manner is a key element, regardless of the size of the enterprise. Regarding data from two independent surveys of manufacturing firms in Italy and offices of manufacturing firms in Sweden gives reason to sketch model (or a classification) that renders the relationships between general elements; real estate management and location of the alternatives of manufacturing sector exhibit special characteristics compared to other industrial sectors.

## 2. Findings and Methods

In 1826 von Thünen described a model of location of farms, which was an issue for early location theory. The von Thünen model for agricultural production describes a proportional relationship between costs on a particular location and the distance to market. The outcome of different gradients depending on alternative crops renders an optimal choice of competitive land possible. Other sectors, on the other hand, have a higher rent per square metre in the urban periphery (McCann, 2001). Location patterns have been categorized among the categories: a dominance of offices in city centres and peripheral location for manufacturing plants. Spatial limitations in the city centre combined with income growth and city growth results in augmented rent gradients. The supply and demand on the office space market are related to the fluctuations of business cycles where the dynamic relation to fluctuating office rents also has an impact on the propensity to acquire the real estates and thus incorporate the facility in the balance sheet of the firm as a part of the equity Edwards and Ellison (2004).

Both Barrett and Baldry (2003) and Cotts (1999) describe how special FM skills are required of a company that has spread their spaces on multisite locations from those firms that remain on single sites. It is thus of research interest to study the FM regarding those alternatives. Leaman (1998) forecasts higher demand on facilities from the surrounding city; the logistic city has incorporated time instead of space as the main prerequisite for the activity to deliver information and logistics. Network ideas previously described argue for increased knowledge of how FM varies not only considering multisite and single site solution but also where the firms locate. In congested areas it is probably easier to outsource compared to growth firms that locate



in rural areas where lack of transport, staff and supplier would encourage in house solutions. Research of McDougall (1993) has observed that multisite solutions have already occurred in the 1980's due to relocation of certain functions like back office from city core to suburbs where the prices were lower. McDougall (*ibid*) presented studies on functional location preferences which give a simple classification system: "in-town", "edge of town" and "out of town" which gives relevance by its simplicity to regional studies of quantitative character.

According to Pellenberg et al. (2002), Mariotti (2002) three categories of spatial scales of relocation appear: intra-regional, inter-regional and international relocations. Mariotti (2005) writes: *Intra-regional moves mainly concern the industrial suburbanisation around the larger urban agglomerations while inter-regional relocations mainly involve industrial decentralisation from the economic core areas to peripheral and/or development areas.* Mariotti (2005) presents three types of relocation: (1) Integral relocation, (2) Partial relocation which implies multiple sites location, (3) Foreign Direct Investment - FDI (4) International strategic alliance, ISA. FDI and ISA are international relocations. FDI is the direct investment whereas ISA is a co-operative relationship somewhere in the value chain. Furthermore, Mariotti (2005) highlights the increased internationalization since the middle of 1980s among small and medium sized firms. Porter (1990) highlights different factors that together constitute the competitive advantage of the nation and varies between countries. Porter (1998) writes: *Open global markets, rapid transportation, and high-speed communications should allow any company to source anything from any place at any time; but in practice, location remains central to competition.* Multiple conditions create climate for cluster creation within different industries. Two large surveys render an inspirational source for detecting common features in this paper: (1) an Italian survey of SMEs in the manufacturing sector, and (2) a Swedish survey encompassing all classified "Gazells" of 2003 in entire Sweden.

## 2.1 The Italian Survey

The empirical material was derived from the data and information collected during the various workshops on real estate organized by the GestiTec Lab of the Building Environment Science & Technology Department (BEST) of Politecnico di Milano since 2004. Meeting with businesses gave the opportunity to analyse over 200 member companies of Assolombarda (the Association of the Entrepreneurs of the Lombardy region, which counts nearly 6000 member companies) and to get an insight of the relationship between manufacturing activities and building or property assets (Ciaramella, 2008 and Ciaramella *et al.* 2010).

Following these meetings, data were collected concerning about 35 businesses in the area of Milan; these data were subsequently analysed in depth through case studies, which can be taken as representative examples of the most recurring problems. More specifically: (1) 36% of the interviewed businesses operate in buildings that were built before 1970; (2) 46% of the interviewed businesses own the buildings they operate from and 20% of the interviewed businesses are unhappy with their head offices. 17% of companies declared that, at the time of the interview, they were looking for a new solution for the location of their activities (i.e. they were searching for new headquarters).

Appropriate information seems to be the crucial factor of whether to relocate or not. Independently if the firm decides to stay on the premises or to relocate, various measures can be taken to match the needs of the core businesses; two alternatives of location are investigated for the SMEs: (1) Change of addresses (relocation) and (2) Extension of existing premises (no relocation).

The first case, Relocation primarily due to Lack of spaces and increasing problems of logistics and on the managerial level of (1) Dynamics of Socio economic advantages with relative nearness to the original site, (2) Real Estate factors that match the spatial needs of core business, and (3) Economic factors, Easiness of obtaining permissions from authorities and facilitated bank relations. Weak points of achieving the relocation were primarily keeping the knowledge on an accurate level of the gap between the needs and the creation of new spaces (Kerns F. 1999). Other problems occurred in finding appropriate contractors in the area and to find an optimal preference of space.

The second case, Extension of existing premises. Avoidance of relocation due to (1) strong bounds to the municipality and Socio-economic factors, (2) manufacturing spaces were extremely complicated to transfer to new location and (3) real estate factors; the existing premises exhibited large advantages (high quality for competitive cost structure) compared to alternatives. The acquired adjacent spaces and turned out to strategically advantageous on the long term perspective.

*Table 1: Scope of the intervention and relevant competences*

Location and real estate needs	Scope of the intervention and relevant competences		
	Location purposes	Building purposes	Functional considerations
Relocation	X	X	X
Extension		X	X
Rationalisation of current location			X

Generally the case studies taken into examination helped identify the main criticalities for a manufacturing company, whether it (1) decides to move to another location, or to change or (2) expand the spaces it already occupies.

### **2.1.1 Observations of critical points of the relocation or in the building of new manufacturing headquarters**

Generally the case studies taken into examination helped identify the main criticalities for a manufacturing company, Real estate audit and due diligence report: *Based on the analysed experiences, one of the major criticalities linked to important relocation or building decisions is the ability to define the company requirements in a precise way. Space requirements are often influenced by sudden events, and market needs force to make choices in short times; therefore businesses find it difficult to formulate strategies for the medium-to-long term that are*

*mandatory in the real estate sector. The greatest difficulty lies in the definition of priorities, which must translate into the choice of the best location since starting from the design stage.*

The issues related to the building process. *A business might find it difficult to identify an area or a building that meets its requirements.*

When evaluating an area, various characteristics of the site have been taken into consideration: its size and structure, the state of the area, any need for reclamation (which is particularly important if the area hosted other industrial activities previously), ease of access, infrastructures and services in the surrounding areas.

When the choice is in favour of an existing building, the most important parameters are the covered and uncovered floor areas, the height to the underside of the beam, the load-bearing capacity of the existing floors, the maintenance status, the architectural and systems quality, the flexibility of the distribution and functional layout. These requirements call for competences that small and medium-sized enterprises lack and, unlike large corporations, they hardly find these same competences on the market.

Logistic problems: *the operations involving production transfer and the length of the transfer may produce criticalities for the manufacturing activity. The most striking issue is the time required to move equipment from the old factory to the new one, since this forces a production shut-down. Some businesses find it impossible to move manufacturing equipment in short times, mainly because their plants are very delicate or particularly large-sized.*

Another likely critical element is the scarce willingness of workers and employees to move; in some cases they are not willing to follow the company especially if this means changing their place of residence. This fact should be taken into consideration if the business is to move to another region, because the availability of skilled labour on site must be checked for.

Time planning: *the rise of real estate issues and the need to find a solution in short times may make adequate planning difficult. It is rather difficult to define a timetable for the management of the various stages (analysis of needs, identification of the area or of the new headquarters, transfer management, etc.), mainly due to factors the company cannot control directly: the times required to purchase the area, the divestment/sale times of the old head office, the time required to be issued the necessary authorizations, permits etc.*

Financial requirements and management: *every stage/activity represents a cost for the business, and this cost must be defined with precision. The main critical elements are: collecting financial resources (access to credit or use of own capital), hence the preparation of a business plan; identifying the area or the building with characteristics that match the business needs at a fair and affordable price, whether it decides to move to another location (1), or to change or expand the spaces it already occupies (2).*

### 2.1.2 Observations of Critical Points of the extension of existing premises

*Feasibility:* if an extension is necessary, the most frequent criticality lies in the availability of a building area on the parcel owned by the business, or on bordering lands if these are available. This situation is particularly hard on the businesses located in towns or in highly built areas. If a bordering area is available for extension, various elements must be checked as: the size and the shape of the parcel, its town-planning indices and destination of use, ease of access, the possibility – if any – to connect/integrate the new building with the existing one, any sub-services or easements, any encumbrances. During the execution of works the building site must be organized so as to prevent any interference with the manufacturing activity and to minimize risks for people and goods on site.

If real estate requirements are confined to space re-configuration, usually this does not entail any criticality with economic or organizational repercussions. Moreover our observations reveal that space re-configuration seems to be a dynamic and non-irreversible activity that is usually characterised by constant changes to meet evolving needs. Nevertheless, this may have some repercussions on the manufacturing activity. The relationship between the flows of people and of goods or products and a balanced allocation of spaces/areas to the various functions may have a positive effect on company productivity: this is why the analysis of the space and functional requirements of the various activities is paramount.

To this aim, an internal audit should be performed of the sectors mostly interested by the change, and of the departments based in the same building. We have found that mistaken assessment of needs and a wrong configuration of functions produce negative consequences on the various activities performed in the building and, most importantly, require new commitment in space reconfiguration, with higher consumption of money and time.

A relevant observation concerning time planning is: *to gain efficiencies the existing head office is extended, stages or activities must be planned in a manner that is consistent and compatible with the manufacturing activity.*

An observation on financial needs: *Although the investment required for the extension is lower than the purchase of a new building, economic considerations might be crucial in any stage of this project depending upon the planned deadlines.*

### 2.1.3 Some observations of small and medium-sized enterprises

The limits that burden the action strategy may be related to time or to the territory. Often an SME sees the volume of its manufacturing activity and, hence, its requirements for space change, depending to the uneven trend of orders. As soon as new space needs emerge, little time is left to define and plan interventions. Where territorial conditions or town-planning indices allow for it, SMEs prefer extending their existing headquarters.

SMEs manage their real estate issues through in-house resources. The decision-making process concerning the list of priorities and strategies to solve the problem is in the hands of the company owner or of its directors, acting by proxy (Mazzarol T., Choo S. 2003). The managing director personally handles the contacts with each professional figure involved, and therefore acts as a coordinator among them. Some particular features of SMEs deserves to be mentioned: first of all limited long-term planning skills hinder the adequate planning of real-estate strategy; another negative factor often acting on the strategic decision-making process and on operational-stage management is the lack of in-house experts in the management of instrumental property assets (FM or the real-estate department).

### 3. Findings and Methods

A Swedish Study of six firms in the Gothenburg area revealed that the first choices of location were seldom preferred and a first relocation had taken place when the staff size was about 30 employees. The empirical material of this survey is assembled from an existing database, the Gaselle list, provided by Soliditet, owned by Bonniers Affärsinformation. The present survey is based on the Gaselle list of 2003 containing 967 listed firms. Ten variables (representing the period 2001 to 2003) are used for analysis in this paper.

With an ANOVA test we realise that there are significant differences between business sectors concerning the variables: One of the variables investigated whether events of outsourcing or change of core business (creation of a subsidiary, selling or acquisition) resulted in a space change. In fact here it was observed a significant difference between the business sectors (Sig.=.003). The variables of (1) location in rural areas, (2) frequencies of office location moves (Sig.=.001) and (2) preferences of renting office space (instead of owning) demonstrated as well a significant difference. The variable „Propensity to rent (instead of owning) office space“ correlates positively with the variable “office location in suburbs” with significance (0.365) level of 0.001. Similarly the propensity of rent preference correlates negatively with location in rural areas (-0.573) level of 0.001. It is interesting to observe that the variable frequency of office relocation moves correlates negatively (-0.295) with the variable “office in rural areas”.

In Sweden, manufacturing industry relocates apparently less than the other sectors (.27\*) and has propensity to have single site location (1.24\*). Some FM variables have no significant differences between business sectors: *Support individual work*, *Individual workplaces*, and *New work and design*. These indicate the importance of office spaces in all business sectors in Sweden. Other FM variables have similar characteristics among business sectors. *Support of distant work* is lower in the construction industry than in the manufacturing sector, whereas lowest FM values in manufacturing sector are *Support of teamwork* and *Informal meetings*. Intermediary ranking of the mean values of the manufacturing sector have the FM variables: *Image of offices* and *Layout, tech. flexibility*. These observations conclude that FM of manufacturing sector is highly relevant as in other sectors or indeed even more. Studies of Dettwiler (2008) reveal correlations on the same data between the dynamics of single site or multiple site location and the fluctuations of GDP. The propensity of changing between single

and multiple site is thus rather high and argues for further investigation of features between the two extremes of location settings.

## 4. A location model

Both the Italian and Swedish surveys have as a common denominator that there are a multitude of intermediary steps between staying and adjusting the current location toward the step to perform a total relocation to a new address. Furthermore the dynamics of multiple and single site location respond that there is no simple answer to what is the most optimal solution.

Every firm during its life cycle of growth and development must sooner or later endure the problematic issue of putting the current location into question. Manufacturing firms are often bound to machinery, laboratories and stocks and are thus less movable than firms in the tertiary sector that more easily can perform an entire relocation to a new address. The issue of partial relocation becomes therefore of our research interest. Our research material reveals that there is a complex relationship of background factors and relocation decision. Below we propose a classification of possible solutions that focuses on the intermediary steps between "Rationalisation" and "Total relocation".

### *1. Rationalisation on current location*

In this alternative FM becomes a crucial factor that optimises the spaces and reduces the gap between needs and obtained solutions. Appropriate office solutions similar to the businesses of the tertiary sector promote productivity and reduce costs. The office parts of the premises can be reconfigured with new office layouts. Optimisation can also be made on the contractual level where necessary flexibility of lease terms is agreed upon or whether an acquisition or a sale of property are the best strategic alternatives. Process analysis can increase effectiveness of the spaces of manufacturing and laboratories. Storage spaces can be optimized by outsourcing or just-in-time measures.

### *2. Extension on current location*

Location in rural areas and suburbs often offer possibilities to extend existing areas. The more central to congested areas and CBDs, the more difficult it is to carry out extension on the current site. Considering the inertia of equipment relocation of manufacturing firms and laboratories, firms should never from the beginning be located too near city centres. Well established firms with a historical record of a century often are located centrally. With expansion, logistic problems arise and if the firms entirely relocate from city centres, large plot gaps remain to be planned with both positive and negative consequences for the society. Extension on current location is often an intermediary solution because the processes of the core business have to adjust for the physical possible extension which might be less favourable compared to an entire new plant.

### *3. Partial relocation*

(The start-up of the second location; hence multisite location) The establishment of the second site often means either a midterm solution due to restrictions in the first location or a first step

of multisite location strategy that relates to the strategy of the core business. The challenge in FM arises between single site and multiple sites (Barrett and Baldry) in multiple dimensions. In this alternative standardisation of real estate and FM become significant. If manufacturing takes place on several places, infrastructure and logistics become a main issue also for the tasks of the core business.

#### *4. Combination of alternative above: 1, 2, and 3:*

When all premises are subject to simultaneous changes the production of core business is put to danger and production is lost. Due to inertia in the production system, this alternative might offer a securing alternative for solving space topics efficiently. The easiest part that can be subjected to relocation is the office part.

A new office has its pros and cons. Advantages: Higher efficiency and flexibility in team works, Adjustment of image, Optimisation to nearness considering infrastructure and stakeholders (clients, suppliers etc.). The challenge for FM in this alternative is the coordination, initially the incorporating new spaces and performing relocation. The decision of owning or renting the premises relates to the possibility to refurbish the spaces. Here modern technology within Knowledge Management, ICT and DSS (Decision Support Systems) becomes evident.

#### *4a. Combining alternatives 1 and 2*

Sometimes it is possible to refurbish a whole plant and simultaneously extend the spaces. Here accurate prediction of the probable development of the core business is of vital interest. If there is wrong estimation, spaces can either be superfluous and a cost burden or if expansion is larger than expected the new premises might become obsolete too early and an entire relocation is no longer possible due to lack of financial means.

#### *4b. Combining alternatives 1 and 3*

Also this alternative requires a total real estate concept. Some part or parts of the business can have a new start on the second location. This combination enables a chance for adjusting the image or mission of the business on a new site. The reason for the new location might be the necessity of being closer to stakeholders in order to improve the competitiveness. This category is similar to new establishment of spin-offs located in research centres and business parks.

#### *4c. Combining alternatives 2 and 3*

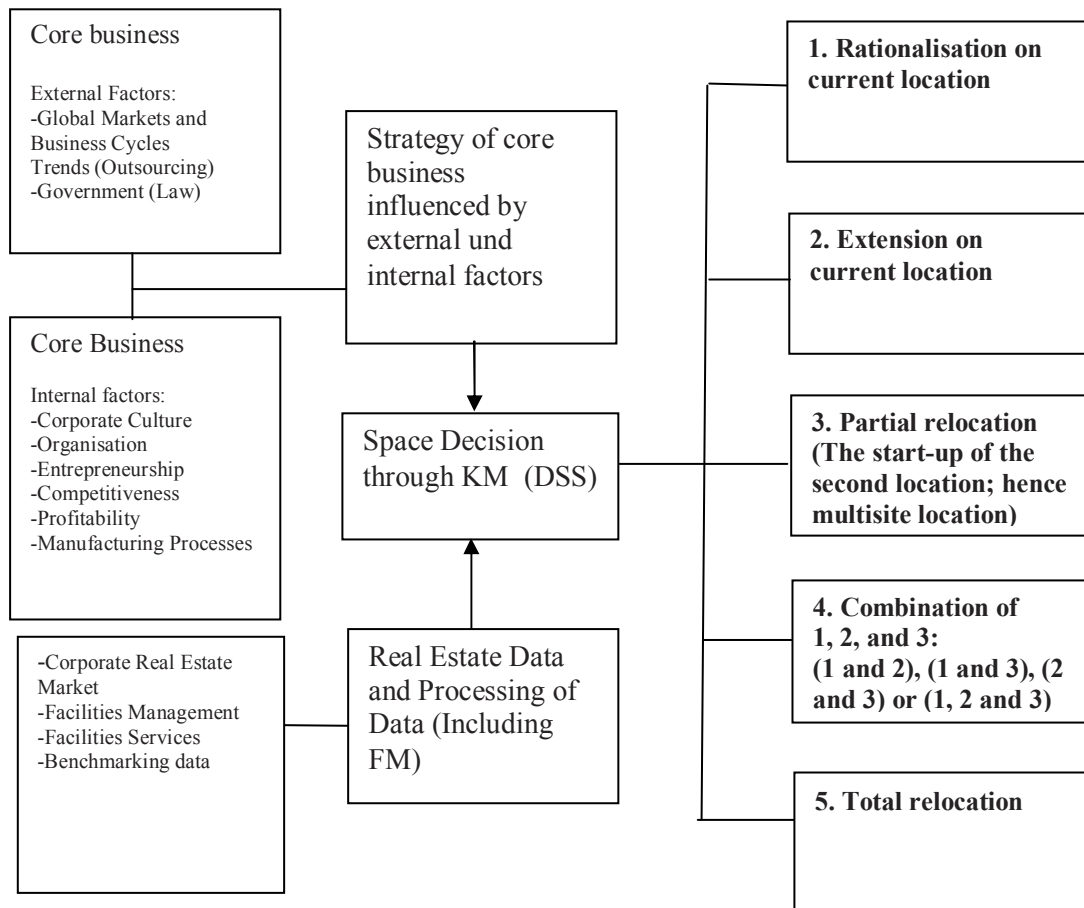
If this alternative is selected due to merely scarcity of space it should be indeed questioned whether a total relocation should instead have taken place.

#### *4d. Combining alternatives 1, 2, and 3*

This complex alternative expects that there will be a considerable expansion and space change. It must here be highlighted how sudden a downturn (or upturn) of core business would affect this complex alternative. The FM of this alternative must here be well aligned with the strategy of the strategic management.

5. Total relocation

(Leaving first location entirely and locate on one or several loc.) This is the less relevant for manufacturing companies due to the inertia of equipment (Dawkins C.J. 2003). The most mobile parts are the offices. This alternative is however possible for European manufacturing firms that have outsourced the manufacturing (of overseas) and only maintained the service related part (Head quarter, Finance, marketing).



### 5.Conclusive Remarks

Based on the research work and on the case studies produced in Italy and Sweden, we can conclude that there is no single way to face the real estate issues concerning company headquarters, whether these consist in changing, expanding, or rationalizing internal spaces. Real estate strategy must prove able to support the core business of enterprises; to this aim, the traditional separation between *core business* and *no core business* should be reviewed. The choice of the location, a correct and adequate definition of spaces and the provision of services to the enterprise and to the organization are true strategic decisions that can influence the success of a company.



The case studies highlight the tight relationship among the core business of enterprises, real estate decisions and the material contribution given by the right strategy implemented by the Facility Management or the Real-Estate Management departments. Managers have the responsibility to govern the whole process along its individual stages, involving the participating subjects and allocating the necessary resources. Facility managers are to monitor the correct development of the process and, if necessary, will intervene promptly. The main indicator of their efficiency is success in achieving the set targets in the set deadlines and costs.

This paper has revealed the complexity of background factors that can be related to a relocation decision. Manufacturing firms are less movable than pure “white collar firms” that entirely produce their work in offices and can more easily change offices. For this reason, it is important to analyse from a logical point of view possible solutions other than staying at the current properties and performing there space changes or carrying out a total relocation. We have proposed a model of classification that deserves to be further developed and connected to the background factors.

## References

- Barrett, p. and Baldry, D. (2003), 2<sup>nd</sup> ed, *Facilities Management, towards Best Practice*, Blackwell Publishing, Oxford.
- Ciaramella, A., Tronconi O., Guffanti M., Da Rold. G., (2010), *I servizi a supporto dell'impresa*, Quaderni del Territorio, n.1, Assolombarda, Milan.
- Ciaramella, A., Bellintani S., (2008), *L'audit immobiliare*, Il Sole 24 Ore, Milan.
- Cotts, D., G., (1999), *The facility management handbook*, 2<sup>nd</sup> ed., AMACOM, New York.
- Dettwiler (2008), Modelling the Relationship between Business Cycles and Office Location: The Growth Firms, Facilities, Vol. 26, No. 3/4, pp. 157-172.
- Leaman, A. (2006) (2 ed.), The Logistical City, In *Reinventing the Workplace*, ed. Worthington, J., Architectural press, York, pp. 11-23.
- Mazzarol T., Choo S.,(2003), A study of the factors influencing the operating location decisions of small firms, Property Management, Vol.21, N.2, Emerald, MCB University Press
- Mariotti, I. (2002), Methodological problems in firm migration research. The case of Italy. In: Cucculelli M. & R. Mazzoni, eds., *Risorse e competitività*. Milan: Franco Angeli
- Mariotti, I. (2005), *Firm relocation and regional policy, A focus on Italy, the Netherlands and the United Kingdom*, Doctoral thesis, Royal Dutch Geographic Society/ Department of Spatial Sciences University of Groningen, Utrecht, Groningen.

McCann, P. (2001), *Urban and Regional Economics*, Oxford University Press, Oxford.

McDougall, B., (1993), The changing geography of location, In *The Responsible Workplace: The redesign of work and offices*. Eds. Duffy, F., Laing, A. and Crisp, V. (1993), Butterworth Architecture and DEGW, London.

Pellenberg, P.H., van Wissen, L.J.G. and van Dijk, J., (2002) Firm Migration. In: McCann P., eds., *Industrial Location Economics*. Cheltenham: Edward Elgar Publishing.

Kerns F., (1999), Strategic facility planning (SFP), *International Journal of Productivity and Performance Management, Work Study*, Vol.48, N.5, pp.176-181, Emerald, MCB University Press

AA.VV (2009), *A white paper on strategic facility planning*, IFMA, Houston

## Performance-based procurement by the Dutch Governmental Buildings Agency

**Ad Straub**

Delft University of Technology, Research Institute for the Built Environment  
a.straub@tudelft.nl

### Abstract

The Dutch Government Buildings Agency (GBA) is the largest property owner in the Netherlands. Through its buying volume, the GBA can give strong impetus to the development of innovative building concepts, products and services. In 2008 a new methodology has been set up for the inspection, maintenance planning, risks analysis, and budget allocation of the properties: 'Rgd/BOEI'. Related to the new inspection and planning methodology, the GBA has the intention of procuring maintenance work in a performance-based manner.

The aim of the study is to give insight into the preconditions of performance-based maintenance by owners of corporate real estate, particularly the Dutch Government Buildings Agency and to develop directions for the process of performance-based maintenance and performance requirements. The maintenance of low-sloping roofs is treated as a case study. The study encompasses desk research and interviews with internal clients of the GBA (facility managers), property managers of other corporate real estate, and interviews with roofing companies.

Performance-based procurement of maintenance work by the Dutch Governmental Buildings Agency offers opportunities for product and process innovations and implementing whole-life costing principles by contractors. Environmental issues can easily be implemented in performance criteria for the service lives of roofs. The measurement of performance degradation of roofs and the linked risk setting and price-fixing is seen as a problem for existing roofs. Manufacturers of durable bituminous roofing sheets certify roofers to apply their products and to guarantee their products. A tripartite contract between the client, the roofer and the manufacturer could be a solution. However prescribing products is not allowed for public tendering and generally it is not within the spirit of performance-based specifications. Roofers have to take risks for less durable materials too, for clients that require maintenance scenarios for existing buildings and a limited foreseen service-life.

To implement performance-based maintenance the GBA has to change their lowest-bid tendering procedures into a most economically advantageous tender or, meeting the requirements of the EC Public Procurement Directives, strategic partnering and framework arrangement with roofers (and manufacturers).

**Keywords:** corporate real estate, green public procurement, maintenance, performance-based specifications, roofs

## 1. Introduction

### 1.1 Performance-based maintenance by the Dutch Governmental Buildings Agency

The Dutch Government Buildings Agency (GBA) is the largest property owner in the Netherlands, with a total portfolio of around 2,200 properties and more than 7 million m<sup>2</sup>. The portfolio is very distinctive due to its variety, from centuries-old monumental buildings, modern office buildings, penitentiaries, courthouses until archive buildings, museums and laboratory buildings. 45% of the stock is in use as an office building. With this the GBA is responsible for 10% of the total office building real estate in the Netherlands. Approximately 70% of the stock is owned and 30% is leased or hired.

In 2008 a new methodology has been set up for the inspection, maintenance planning, risks analysis, and budget allocation of the properties: 'RgdBOEI'. Related to the new inspection and planning methodology, the GBA has the intention of procuring maintenance work in a performance-based manner. Performance-based specifications and contracts have to be developed for the work disciplines mechanical engineering (HVAC), electrical engineering, transport and the maintenance of the buildings' envelope. GBA expects a decrease in maintenance (and renovation) costs and management involvement by making use of the knowledge of contractors and appropriate risk setting between the GBA and contractors and by incorporating whole-life costing principles.

A great concern is the energy performance of the properties. The Dutch government has the ambition to make the Netherlands one of the most energy-efficient countries in Europe. The Dutch government, together with organizations and institutions in the building sector has agreed that in 2020 CO<sub>2</sub> emissions must be reduced by 30% and that 20% of the total energy use will stem from renewable energy sources (Ministerie van VROM, 2007). Green public procurement of products and services relating to the construction of new office buildings and renovation and maintenance of existing ones will make the most significant contribution to achieving the climate, energy and air quality targets. The central government has the intention to buy all products and services green in 2010 and have set up a green procurement program to realize this intention. For all products, including the maintenance and renovation of office building, criteria for green procurement has been set up (SenterNovem, 2009).

### 1.2 Aim and methodology

The aim of the study is to give insight into the preconditions of performance-based maintenance by owners of corporate real estate, particularly the Dutch Government Buildings Agency and to develop directions for the performance-based maintenance process and performance requirements. The maintenance of low-sloping roofs is treated as a case study.

The study encompasses desk research and interviews with internal clients of the GBA (facility managers), property managers of other corporate real estate: KPN Real Estate and the University of Technology Eindhoven, and interviews with three roofing companies. The corporate real estate owners are both in a process to performance-based contracting of

maintenance. The interviewed roofers can be considered as the most innovative and largest firms within the roofing market. The performance-based maintenance process and performance requirements for roofs in the residential sector, owned by housing associations, have been studied previously (Straub, 2007; Straub and Berlee, 2008). However, the preconditions of corporate real estate owners and especially public procurers as the GBA for the process and performance requirements might differ from the preconditions of housing associations. Performance requirements for office buildings may differ from the requirements for residential building and especially for the GBA European, public procurement legislation is mandatory and the preconditions of green public procurement have to be incorporated.

The next section gives a description of performance-based maintenance. Then pre-conditions for performance-based maintenance by the GBA are described. Further the performance-based maintenance process and performance requirements of the GBA are worked out.

## **2. Performance-based maintenance**

### **2.1 Performance concept**

The performance concept in construction implies that the demands of the buildings are specified according to the outcomes of the process rather than according the prescribed detail of activities. The performance approach is concerned with what a building is required to do, and not with prescribing how it is to be constructed (Meacham et al., 2005). Gruneberg et al. (2007: 691) say it somewhat different: "Unlike a technical specification focussing on 'how' a facility should be delivered by specifying the dimensions, materials and workmanship, an output specification focuses 'on what a building does rather than its inputs'. Performance-based specification allows concentrating in the outcomes and leaves flexibility for the contractor and designer of the service. Performance-based maintenance means that the clients' performance criteria are directly linked to the required function.

### **2.2 Performance-based maintenance process**

Performance-contracting means an overall responsibility for the functions of building components. Figure 1 illustrates the process model of strategic and/or project performance-based maintenance partnering incorporating planned maintenance and corrective maintenance services. Feedback loops are not shown in the figure. The model is adapted from the process model by Straub (2007) of long-term co-operation. The framework arrangement can hold a price model and a risk sharing model.

The contractor for the project is selected from the firms that are within the framework arrangement. Together with the client the contractor specifies performance requirements and determines the starting points for the maintenance strategy: the processes, conditions for execution of maintenance work, provisional operational performance criteria for building components and services, and provisional risk setting between client and contractor.

Parts A and D of the figure deal with the consultancy phases of the process. Part B shows the execution phase of the processes and part C the evaluation phase. Consultancy activities conducted by maintenance contractors include: executing condition assessments, designing a maintenance strategy, designing maintenance scenarios and activity plans and designing reactive maintenance procedures for end-customers. Contractors' activities of the execution phase are periodic performance measurements, and the intake of requested repairs for corrective maintenance with setting appointments for repair works with end-customers. In the latter the end-customer is taking the initiative for maintenance work. The end-customer could be the facility manager of an office building or a tenant.

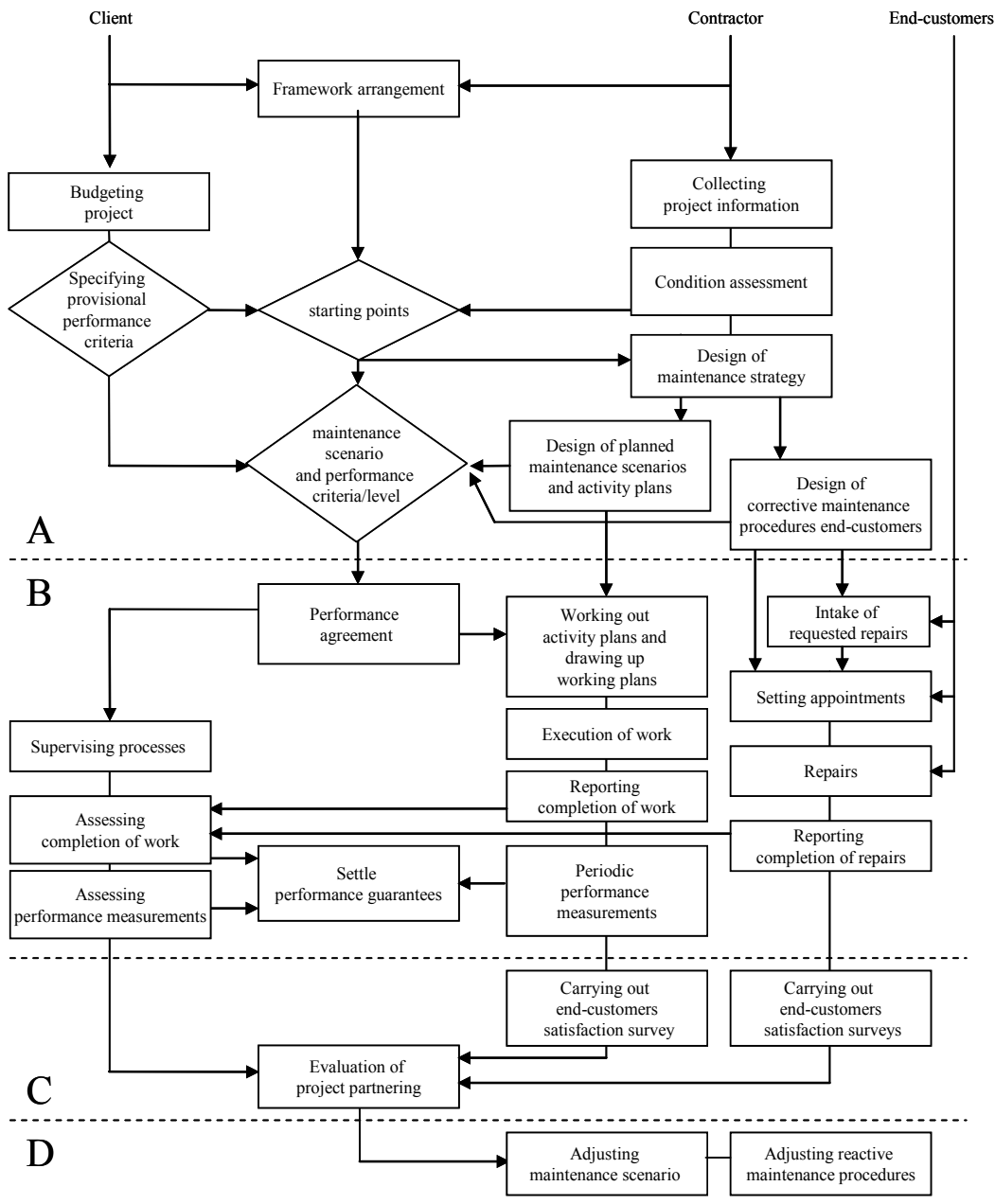


Figure 1: Flowchart of performance-based process model

Initially, contractors need to assess the conditions of the elements to diagnose the causes of deterioration and the external conditions to advise on the likely success and performance of remedial measures. A key issue of the maintenance scenario for discussion between the client and contractor is re-design of the relevant building components by the contractor, to have a thorough command of the degradation process by taking the necessary initial maintenance activities. A project-specific performance agreement is concluded that covers a maintenance scenario - consisting of several maintenance cycles and activity plans that may last for the entire service life of the building -, performance criteria and service level. The client chooses a maintenance scenario that accords best with net present values of life cycle costs, performances and risks. The contractors themselves monitor the degradation processes of the building components by using performance measurements. Contractors also monitor the entire planned maintenance process, especially end-customer satisfaction during maintenance interventions and thereafter. In the case of corrective maintenance the contractor measures tenant satisfaction during maintenance interventions and, as well as the result of the maintenance actions. The primary purpose of control and supervision by the client is to review the maintenance processes, identify problems and then take the necessary action. They have to assess the completion of the work and the performance measurements done by the contractors. Theoretically on-site supervision by the client is not needed if performances are specified.

### 2.3 Performance requirements

Generally, classifications of performance requirements originating from performance-based building networks such as the European PeBBu and the Australian aus-PeBBu mainly focus on new construction. Lützkendorf et al. (2005) made a comparison of international classifications for performance requirements and building performance categories used in evaluation method. Their proposed performance categories are:

- functional performance;
- technical performance;
- economic performance;
- environmental performance;
- social performance;
- and process performance.

In performance-based maintenance contracting performance requirements may involve:

- process performance: cooperation with the client and the end-customers (facility managers of the properties), e.g. process management (reports, budgeting and invoices), process control, process innovations;
- Service Level Agreement for corrective maintenance;
- the performance of new and existing building components: initial performance of new components and during the service-life.

Performance-based maintenance contracts applied by Dutch housing associations are based on performance criteria of building components and a service level agreement for corrective or reactive maintenance. The service level comprises response times, service windows,

appointments for repair times offered and kept, and the time taken to rectify urgent and non-urgent repairs. Performance requirements (qualitative) and criteria (quantitative) of building components are directly linked to the client's functional needs and a building component's specific functions (Straub, 2007). The performance criteria of building components, especially performance loss, are mainly determined by assessing defects through a visual inspection. A minimum percentage of measurements, taken randomly, should meet the criteria.

## 2.4 Performance-based specifications of roofs

Performance-contracting means an overall responsibility for the functions of the building component, for roofs in the first place the water proofing system from the covering sheet to the sewer system. See Table 1.

*Table 1: Elements and functions of roofs*

Elements	Functions
Construction	Stability, fire safety
Covering, gravel fillets, feed through tubes	Stability, fire safety, tightness, visual appearance, passable
Insulation	Energy saving, noise-insulating, passable
Entrance	Fire safety, accessibility
Openings	Stability, fire safety, daylight, ventilation, accessibility
Gutters, drain pipes, lead-through water tubes	Water drainage
Fall protection systems	Safe working conditions, safe escape route (public escape routes)
Climb protection	Inaccessibility

## 3. Pre-conditions for performance-based maintenance by the GBA

### 3.1 Maintenance responsibilities

The GBA is responsible for maintenance to the building envelope and the building services. The clients – facility managers of the individual buildings – are responsible for the 'daily maintenance' (Ministerie van VROM/Rijksgebouwendienst, 2007). In practise, by providing services to their clients, the GBA performs all technical maintenance activities: planned (condition-based as well as preventive maintenance), and corrective maintenance. However, the GBA does not coordinate preventive maintenance to the building envelope. Clients are free to perform the preventive maintenance, e.g. cleaning of flat roofs and small repairs. Not doing this hampers the product guarantees for (new) facades and roofing.



### 3.2 Procurement rules

The GBA has to tender according to the Dutch legislation and the EC Public Procurement Directives. Although the legislation does not restrict the tendering of maintenance work to the lowest bid and to descriptive specifications, and the fact that maintenance work of buildings often is below the 'European thresholds', the GBA generally tenders maintenance work in a traditional manner, based on descriptive specifications of the work and the lowest bid. One of the other Dutch governmental public real estate organisations, the Ministry of Traffic and Public Works, is more and more making use of the principle of the most economically advantageous tender. Green public procurement means that public purchasers take account of environmental factors when buying products, services or works. For public facilities new legislation for green public procurement has been put in operation in 2010. Remarkable is that this legislation gives a clear preference to performance-based procurement of the maintenance of facilities (SenterNovem, 2009).

### 3.3 RgdBOEI and performance contracting

The new inspection methodology 'RgdBOEI' evaluates a property on four aspects: fire safety, technical condition, energy and insight in compliance with legislation for building services. The technical condition is assessed using the Dutch standard for condition assessment (NEN 2767) (NEN 2006; NEN 2007). A six-point scale is the basis of the standard. The condition categories are of a chronological order that describe possibly occurring defects without references to remedial work. Standardised condition assessments should be performed visually by trained inspectors using some small equipment and measuring tools (Straub, 2009).

Every five years an overall inspection will be held. The surveys are done by certified consultancy firms using the standard and extensive guidelines of the GBA. New education for building surveyors has been set up to become certified. Next to the registration of parameters of defects the building surveyors advise for maintenance activities taking into account the building maintenance policy and legislation.

In 2009 the GBA has developed a performance-based contract for mechanical engineering, electrical engineering and transport. The contract duration is 4 years. Responsibilities of the contractors are to execute corrective and preventive maintenance and to design a planning for the replacement of elements. Contractors have to guarantee the function and operational safety of the building services. The contracts aim at preserving the existing condition of the elements. Critical defects according to the Dutch standard, that harm directly the function of a building component, are not allowed. Inconvenience for users should be restricted. The contractor is asked to propose improvements for reduce of energy and to improve the thermal comfort conditions.

The GBA thinks that main contracting for the whole building envelope is one step beyond because of the fragmented maintenance market and lessons learnt from Design, Built, Finance, Maintain and Operate (DBFMO) projects. They aim for at least different contractors for the facades (especially for paintwork and for curtain walls) and roofs. Fall protection systems are procured separately from other maintenance work of properties and for the whole building portfolio.

### 3.4 Roofers

The Dutch construction and maintenance market is characterised by many small firms and some large companies and by heterogeneity in the types of firms (Bremer and Kok, 2000). The firms that has specialised in roofing can be divided into three groups: a very large group of very small firms (1-10 employees), a small group (30-40) of medium-sized firms (up to 80 employees) and a limited group of large firms. The larger firms offer more and more solutions for e.g. energy generation and green roofing.

For roofers of bituminous and synthetic roofs the independent approval system 'Dakmerk' exists. The firms need certificates of proficiency for working processes and working conditions to become certified. Every project of the roofer is controlled at site. If the work is done under the conditions of 'Dakmerk', the client is guaranteed for a waterproof roof for 10 years. Besides 'Dakmerk' some manufacturers of durable bituminous roofing sheets have their own quality control system and a related approval system for certified dealers. They can guarantee the roof for 20 years.

### 3.5 Measurement of performance criteria

The need to properly assess the condition of the roof system is critical from a performance contracting point of view. The visual inspection of the roof is the first step in deciding whether to repair, replace or recover the system. Although a lot of research has been done (e.g. RILEM 166-RMS/CIB W083 Joint Committee on Roofing Materials and Systems, 2003) the measurement of the degradation of low-slope roof systems is very complex because of the variety of the roofing systems. Condition assessment based upon the Dutch standard does not provide enough information being just a visual assessment. The interviewed roofers acknowledge that physical assessments are necessary and are not willing to take risks for existing roofs that were not executed by them.

## 4. Performance-based contracting

### 4.1 Process

KPN Real Estate procures all maintenance work of buildings in a performance-based manner. For the building envelope they gradually reduced the number of companies they work with: for flat or low-slope roofing systems two, for sloping roofs one and for all facades two. The process took almost 10 years. The measurement of the degradation processes of the roofs related to product guarantees, risk setting en price-fixing was an obstacle to convert the tendering processes into performance-based contracting. The found solution is to prescribe the use of certain durable products by replacements and making a performance contract with the roofer and the manufacturer. Performance criteria are the number of water leakages and a minimum condition mark according to the Dutch standard for condition assessment.

The University of Technology Eindhoven (TUE) has chosen for far-reaching co-operation forms with contractors. For the building envelope one contractor has been selected as well as

for mechanical engineering (including transport), electrical engineering, grounds and ICT. The TUE and the contractors decide together about the maintenance planning of the properties and replacements of elements. For preventive and corrective maintenance standard prices are set. The assumption is that preventive maintenance actions does not influence the condition status of elements and by that the replacement of these. In co-operation with the contractor performance criteria will be established within the coming three years. Established requirements involve the co-operation with the TUE and the management of the maintenance processes.

## 4.2 Performance-based contracting GBA

Proposed characteristics for performance-based maintenance contracting by the GBA are shown in Table 2, taking the pre-conditions and the experiences of corporate real estate owners into account. Between brackets specific characteristics for roofs are given.

*Table 2: Characteristics of traditional and performance-based contracting of the GBA*

	<b>Traditional</b>	<b>Performance-based</b>
Specifications	Prescriptive (throughput)	Performance requirements (output)
Responsibilities for maintenance GBA	Planned maintenance	Planned (preventive) maintenance and corrective maintenance
Responsibilities for maintenance clients of GBA	Daily maintenance	-
Responsibilities contractor (roofer)	Execution of work	<ul style="list-style-type: none"> <li>• Inspection</li> <li>• Design of maintenance scenarios and activity plans</li> <li>• Advise</li> <li>• Performance measurements</li> <li>• Execution of planned (preventive) maintenance and corrective maintenance</li> <li>• Analysis corrective maintenance</li> <li>• <i>Coordination of all activities on the roofs performed by others</i></li> </ul>
Condition assessment by GBA	Building surveyor of consultancy firm	Building surveyor of consultancy firm
Maintenance planning	Building surveyor of consultancy firm	Building surveyor of consultancy firm and contractor (maintenance scenario)
Performance measurements	Not Applicable	Contractor
Performance control by GBA	Not Applicable	GBA/building surveyor of consultancy firm
Supervising by GBA	Execution of work and processes contractors	Processes of contractors
Guarantees	Product guarantees ( <i>flat roofs 10 years</i> )*	Performance guarantees

\* Often not recognised

In the proposed performance-based process the roofer acts as the ‘functional manager’ of the roofs calling attention to all activities on the roofs performed by others, e.g. assessment of fall protection systems, maintenance work to building services, antennas and lightning conductors. Coordination of all activities of other contractors that have to enter the roof is very important to secure its own performances. The starting point for the performance-based contracting of roofs is the replacement or recovering of the system. A new system enables appropriate risk setting between the GBA and the roofer and the steering for whole-life costing and green procurement. The contract duration is at least the guaranteed product period of 10 years, which is two cycles of RgdBOEI inspections. The inspection cycle of RgdBOEI functions as performance control by the GBA. The GBA requires that the advice of the contractor based on his own inspection and information given by the GBA should be independent from the execution of the work. This means that the contractor should verify the needed maintenance work by an independent consultancy firm.

### 4.3 Performance-based specifications for roofs of GBA

The GBA thinks that working with a minimum condition mark and the exclusion of critical defects according to the Dutch standard will not secure the minimum required performance of roofs. At least the maximum number of leakages of parts of the roof should be set as a performance requirement. A set of performance requirements and measurement methods for new and existing roofs (during the service life) are worked out, incorporating criteria for the green procurement of roofs: insulation of the roof to 4m<sup>2</sup>K/W, if replacement of the roof: or a green roof or making the roof suitable for solar energy techniques or disconnect the drain pipes from the sewer system are (SenterNovem, 2009). See Table 3 for some examples.

*Table 3: Performance requirements of flat roofs during the service life*

Elements	Performance requirements
Construction	Water drainage Energy generation
Covering, gravel fillets, feed through tubes	Water tightness: number of leakages Visual appearance: pollution, algae, plants
Insulation	Retaining insulation value

## 5. Conclusions and practical applications

### 5.1 Conclusions

Through its buying volume, the GBA can give strong impetus to the development of innovative building concepts, products and services. E.g. the GBA took the initiative for the Dutch standard for condition assessment. The standard is widely accepted in the market and used by almost all property owners and consultancy firms.

Performance-based procurement of maintenance work by the Dutch Governmental Buildings Agency offers opportunities for product and process innovations and implementing whole-life costing principles by contractors. Environmental issues can easily be implemented in performance criteria for the service lives of roofs.

The measurement of performance degradation of roofs and the linked risk setting and price-fixing is seen as a problem for existing roofs. Manufacturers of durable bituminous roofing sheets certify roofers to apply their products and to guarantee their products. A tripartite contract between the client, the roofer and the manufacturer could be a solution. However prescribing products is not allowed for public tendering and generally it is not within the spirit of performance-based specifications. Roofers have to take risks for less durable materials too, for clients that require maintenance scenarios for existing buildings and a limited foreseen service-life.

Trinius and Sjöström (2005) pose that contractors only can succeed in a performance-based building environment if manufacturers provide performance and service life information. The route from user requirements and whole-life costing to product-related references is very complex in performance-based specification where user requirements concern performance of building components in-service rather than product specifications. Maintenance contractors need expert knowledge based on a wide range of empirical data about performance of building components in-service.

## 5.2 Practical applications

To implement performance-based maintenance the GBA has to change their lowest-bid tendering procedures into a most economically advantageous tender or, meeting the requirements of the EC Public Procurement Directives, strategic partnering and framework arrangement with roofers (and manufacturers). Award criteria in an economically advantageous tender could be:

- energy costs;
- total costs of ownership;
- and the sustainability of the design and materials (based upon a Life Cycle Analysis).

## References

Bremer, W. and Kok, K. (2000) "The Dutch construction industry: a combination of competition and corporatism," *Building Research & Information*, **28** (2): 98-108.

European Commission (2005) *Buying green! A handbook on environmental public procurement*, Office for official Publications of the European Communities, Luxembourg.

Gruneberg, S. Hughes, W. and Ancell, D. (2007) "Risk under performance-based contracting in the UK construction sector." *Construction Management and Economics*, **25**(7): 691-699.

Lützkendorf, T., T. Speer, F. Szigeti, G. Davis, P.C. le Roux, A. Kato and K. Tsunekawa (2005) "A comparison of international classifications for performance requirements and building performance categories used in evaluations methods", In: *Performance Based Building*, Huovila P. (ed.), VTT RIL, Helsinki.

Meacham, B., Bowen, R., Traw, J. and Moore, A. (2005) "Performance-based building regulation: current situation and future needs." *Building Research & Information*, **33(2)**: 91-106.

Ministerie van VROM (2007) *Nieuwe energie voor het klimaat. Werkprogramma Schoon en Zuinig*, MVRM, Den Haag.

Ministerie van VROM/Rijksgebouwendienst (2007) *Regeling Taakverdeling Beheer 2007*, MVRM, Den Haag.

NEN (2006) *NEN 2767 Conditiemeting van bouw- en installatiedelen – Deel 1: Methodiek* [Condition assessment for building and installation components – Part 1: Methodology; in Dutch]. NEN, Delft, The Netherlands.

NEN (2007) *NEN 2767 Conditiemeting van bouw- en installatiedelen – Deel 2: Gebrekenlijsten* [Condition assessment for building and installation components – Part 2: List of faults; in Dutch]. NEN, Delft, The Netherlands.

RILEM 166-RMS/CIB W083 Joint Committee on Roofing Materials and Systems (2003) *Condition Assessment of Roofs*, CIB Report: Publication 289, Rotterdam.

SenterNovem (2009) *Criteria voor duurzaam inkopen van Beheer en onderhoud van kantoorgebouwen*, SenterNovem, Utrecht.

Straub, A. (2007) "Performance-based maintenance partnering: a promising concept." *Journal of Facilities Management* **5(2)**: 129-142.

Straub, A. and Berlee, A.B. (2008) *Prestatiegericht samenwerken bij onderhoud. Proces en prestatie-eisen daken*, SBR, Rotterdam.

Straub, A. (2009) "Dutch standard for condition assessment of buildings." *Structural Survey* **27(1)**: 23-35.

Trinius, W. and Sjöström, C. (2005) "Service life planning and performance requirements", *Building Research & Information*, **33 (2)**: 173-181.

# Developing a categorization matrix of Key Performance Indicators (KPIs): A literature review

**Sarel Lavy**

Department of Construction Science, College of Architecture  
Texas A&M University, College Station, TX 77843-3137, USA

**John A. Garcia**

Alpha Facilities Solutions, LLC, 17120 Classen Road,  
San Antonio, TX 78247, USA

**Manish K. Dixit**

Department of Architecture, College of Architecture  
Texas A&M University, College Station, TX 77843-3137, USA

## Abstract

**Aim:** Facility asset management includes effective and efficient management of built facilities, which can be achieved by controlling basic services and space management in order to enhance performance. The physical environment in a built facility has a major impact on successful and efficient operations of an organization. Selecting measures of efficiency typically takes into account the type of user, aim of the study, and to some extent, the public or private nature of the organization for which the indicators are being considered. Key Performance Indicators (KPIs) developed in past research studies have included mainly cost related measures, while current studies emphasize using cost related as well as non-cost related performance measures. This paper aims to gather, analyze, and develop a list of Key Performance Indicators and categorize them by relevance to the demands of the facility management industry.

**Research Methods:** An extensive literature search was performed and data from valid sources was collected, through which the need for KPI categorization was identified. The KPI categories were further validated by a survey of facility management professionals.

**Conclusions:** It is vital to measure facilities performance in order to establish an understanding of current conditions and situations, and to postulate future changes in facility asset management practices to achieve the desired objectives. Furthermore, KPIs must be measurable and quantifiable in order to use them effectively.

**Limitations of the Research:** The scope of this paper is limited to built facilities. The information is provided and analyzed from the user's/client's perspective only.

**Practical Applications:** This study provides a list of KPIs that could be used for a holistic performance evaluation of a built facility. Furthermore, they are categorized in such a way that facility management professionals could choose a set of KPIs most relevant to their situation.

**Keywords:** Facility Management, Key Performance Indicators, Performance Measurement, Categorization, Literature Review

## 1. Introduction

Facility management deals with the management of built assets and it incorporates controlling the services necessary for successful business operation of an organization. It should not aim at simply reducing the operating expenses of a built facility, but also at enhancing the facility's efficiency, as well (Amaratunga et al., 2000b). The physical environment has a major influence on the successful operation and efficiency of an organization; by modifying it, an organization's desired efficiency may be achieved (Amaratunga et al., 2000a). Thus, to gauge the effectiveness of facility management, it is necessary to reach an understanding of the facility's current conditions and to postulate changes in facility management practices in order to achieve desired performance. Cable and Davis (2004) warn that poor facility management could result in inadequate facilities to support functioning, excess facilities not contributing to the organization's mission, cost inefficiencies, inadequacy, and unavailability of facilities for future needs. Conversely, a strong facility management approach provides needed support to an organization's mission, the realization of future facility requirements, greater cost efficiency, and the ability to anticipate results of current management decisions.

Due to impacts on strategic decision-making and organizational performance, a facility should be assessed periodically. Performance measurement extends opportunities to review past and present functioning, derive strategies for future endeavors, compare performance within and among facilities, assess the performance towards the organization's goals, and provide directions to management for decision-making (Amaratunga et al., 2000a; Amaratunga et al., 2000b; Cable and Davis, 2004; Lebas, 1995; Douglas, 1996; Barret and Baldry, 2003; Kincaid, 1994).

Douglas (1996) emphasizes the importance of facility performance assessment in both inter-building (evaluating against other facilities) and intra-building (within itself) senses. Amaratunga et al. (2000b) argue that performance measurement is vital to an organization as it provides much-needed direction to management for decision-making.

Previous research studies propose a wider range of KPIs that could cover the performance of a facility in a comprehensive manner; however, these KPIs are too numerous and narrow in perspective, thus lacking, applicability across a range of projects and quantification (Shohet, 2006;



Neely et al., 1997). The literature suggests that there needs to be a list of KPIs that demonstrate wider applicability, holistic approach to the performance evaluation, conciseness, relevance and proper categorization, and are quantifiable and easily measurable (Shohet, 2006; Hinks and McNay, 1999; Slater et al., 1997; Augenbroe and Park, 2005; Cohen et al., 2001; Ho et al., 2000; Douglas, 1993/94; Douglas, 1996; Amaratunga and Baldry, 2003; Gumbus, 2005)

Among major facility performance measurement practices are benchmarking, the balanced scorecard approach, post occupancy evaluation, and measurement through metrics of Key Performance Indicators (KPIs). Cable and Davis (2004) assert that performance measurement through the establishment of KPIs helps senior management make strategic decisions. Developing performance metrics is a necessary step in the process of performance evaluation, as it includes relevant indicators that express facility performance in a holistic manner (Cable and Davis, 2004; Varcoe, 1996; Brackertz, 2006; Amaratunga et al., 2000a; Amaratunga et al., 2000b; Lebas, 1995). Consequently, it is tremendously important to identify a set of KPIs to establish effective performance evaluation metrics for the facility under consideration.

## 1.1 Research Objectives and Research Methods

This paper aims to identify the need for a succinct and properly categorized list of KPIs that can respond to the current needs of the facility management industry. Furthermore, it aims to provide a list of KPIs from which facility management professionals can select to perform the desired (general or specific) performance assessment. Following are the objectives of this study:

- Realize the need to provide a succinct and relevant list of KPIs; and
- Identify a set of criteria that could be used to narrow down the list of KPIs.

The research method used is similar to the concept of discovery through literature, as proposed by Swanson (1986), which emphasizes the creation of new knowledge by referring to bibliographic information available in the form of peer-reviewed papers, conference proceedings, and other valid forms of literature. This approach is gaining wider acceptance and being used in a large number of research studies (e.g., Kostoff et al., 2006; Srinivasan, 2004; Weeber et al., 2001). This paper refers to literature pertaining to facility performance assessment and KPIs to perform this task. Research efforts to establish a relatively comprehensive list of KPIs, peer-reviewed papers discussing the performance metrics and suggesting improvements, and published papers stating the urgency to categorize the KPIs are selected in order to derive findings.

## 2. Background

### 2.1 Facility Performance Measurement

The importance of facility performance measurement has been consistently emphasized in the facility management literature. Amaratunga et al. (2000b) and Brackertz (2006) indicate that performance relates not only to the functional quality of the building, but also to the contribution made by the building in achieving the organization's goals. Hence, buildings do support organizations by helping them meet their long-term business and other goals. Cable and Davis (2004) assert that performance measurement addresses issues related to the buildings or facilities owned, their current condition, additional facilities required for achieving organizational goals, issues to be addressed, and the results of investment or no-investment decisions. Moreover, the purpose of performance measurement extends to understanding the impacts of management decision-making on success or failure of a facility's portfolio, and to suggesting possible improvements. Barret and Baldry (2003) assert, "When the facility management unit lacks reliable and comparable data on building performance and costs, its ability to make its most basic decisions is impaired, as well as its ability to make a convincing case for its recommendations." Douglas (1996) points out the importance of performance measurement in terms of user satisfaction, which includes both assessing the extent to which the facility is serving its users, and understanding the user's satisfaction level. Kincaid (1994) and Lebas (1995) emphasize the importance of performance assessment in making comparisons within the organization, or with other organizations, to develop strategies for improvement. Furthermore, its focus must be not only on costs, but also on issues that shape the physical environment of the organization. Cohen et al. (2001) assert that rapid feedback about the condition of a building is essential for consistent and continuous improvement in building performance.

### 2.2 Performance Indicators

Ho et al. (2000) state that performance metrics can be used for genuine comparisons within and between organizations. Performance metrics provide an essential common platform of comparison, upon which improvement can be sought for any individual indicator. Deru and Torcellini (2005) and Spendolini (1992) explain that relevant, clear, compatible and authentic performance metrics facilitate the understanding of driving forces of a building's performance, assist designers in creating efficient facilities, support owners in operating buildings in an efficient manner, and help management and decision makers to take necessary steps and to track performance. Hitchcock (2002) and O'Sullivan et al. (2004) state that performance metrics can define performance objectives clearly and quantifiably. Yuan et al. (2009) identified KPIs according to five major perspectives: the physical characteristics of the project, financing and marketing, innovation and learning, stakeholders, and project processes. They state that a genuine performance measurement is only possible after the major KPIs are identified, finalized, and monitored.

Ho et al. (2000) argue that the development of performance measurement metrics is the first step in a facilities benchmarking process. Performance metrics assist in establishing benchmarks that guide management in decision-making and indicate the success of current facility management practices. Furthermore, authentic, well-defined and compatible performance indicators could easily be transformed into strategies through analysis and decision-making. Douglas (1996) emphasizes the importance of indicators that portray space in terms of amount (area and volume), quality (appropriateness, visual and environmental qualities), and shape (plan and layout), claiming that space planning and management is a key element in building performance management.

Research efforts have identified performance indicators for facility condition assessments. Cable and Davis (2004) state that a set of KPIs must be identified and tracked over a period of time so that it can be compared against a baseline in order to examine improvements or deterioration. Amaratunga et al. (2000b) and Brackertz (2006) argue that, unlike past performance measurements, which focused primarily upon financial issues, current measurement practices must emphasize aspects like business, business goals, and job satisfaction. Popular metrics, like those relating to financial and space aspects, express the level of performance of the building, but do not indicate the contribution made to the organization's strategic results (Brackertz, 2006).

The selection of performance measures as KPIs depends on the types of users of performance assessment (i.e., managers, supervisors, etc.), the public or private nature of the organization, assessment objectives (financial, functional, or physical), and prevailing trends in the industry (Lebas, 1995; Cable and Davis, 2004; Amaratunga et al., 2000b; Hinks, 2004; Eagon and Joeres, 1997; Cripps, 1998). Moreover, since different users require different measures for their purposes, their selection of performance indicators varies (Lebas, 1995). Baldwin et al. (2000) state that customers and providers select metrics that reflect their respective expectations and goals. Customer-related metrics tend to converge upon output, while provider-related metrics emphasize the processes implemented. The public vs. private nature of the organization and its facilities influences the preference of performance indicators to a certain degree. Cable and Davis (2004) assert that private sector organizations have a profit-oriented approach in selecting KPIs, while federal government organizations, like other public entities, emphasize excellent delivery of goods and services to the public.

Eagon and Joeres (1997) emphasize the growing significance of environmental performance measurement on a facility. They mention that the International Standards Organization (ISO-14031), British Standards (BS-7750), and the European Union's Eco-Management and Auditing Schemes (EMAS) are among organizations that have developed or are developing guidelines for environmental performance evaluation of building facilities. Eagon and Joeres (1997) complain that most current performance metrics include indicators relating to processes, results, and customer satisfaction, but very few mark environmental performance. Epstein and Wisner (2001) mention two organizations (Bristol-Myers Squibb and Severn Trent) that successfully use a Balanced Scorecard approach to measure environmental or sustainability performance of buildings. They

propose adding an environmental and social perspective to the Balanced Scorecard method. Jasch (2000) asserts that measuring and monitoring the environmental performance of a facility is essential in learning about the level of compliance with environmental requirements, and it must include indicators to express the environmental goals achieved.

Critical Success Factors (CSFs) are also used to assess the performance of an organization. Boynton and Zmud (1984) state that CSFs relate to the most vital issues of an organization – operations and future success. Moreover, these factors reflect crucial areas for managerial or organizational success (Boynton and Zmud, 1984; Leidecker and Bruno, 1984). CSFs incorporate issues that, to some extent, govern the success and failure of an organization, and thus, are vital for the assessment of that organization (Chua et al., 1999; Grunert and Ellegaard, 1992; Leidecker and Bruno, 1984; Belassi and Tukul, 1996). Belassi and Tukul (1996) argue that, although efforts are undertaken to enlist CSFs, they emphasize only one specific aspect of an organization rather than the organization as a whole. There has been no attempt to group these factors together so that their interrelationships could be understood and analyzed. Furthermore, most lists of CSFs demonstrate a single emphasis and thus possess limited applicability. The emphasis should be on not only generating a list that incorporates all CSFs that contribute to the success of an organization, but also on grouping these CSFs (Belassi and Tukul, 1996).

### **3. Findings: Inferences from the Literature**

#### **3.1 Need to Categorize the List of Indicators**

One need identified by Douglas (1996) is for a proper categorization of KPIs so that they represent broader applicability and potential use. Studies have developed and built lists of large numbers of indicators, but some of these indicators are not usable because they are not categorized clearly. For example, professionals interested in short-term financial appraisal have nothing to do with long-term functional or survey-based assessment, and vice versa. Thus, categorization must provide the opportunity for facility management professionals to select the list of performance metrics in which they are most interested (Douglas, 1996; Ho et al., 2000; Gumbus, 2005). Lavy et al. (2010) categorized the list of indicators into four categories and conducted a brief survey to obtain opinions from the facility management industry on this categorization (see Table 1). The survey demonstrated respondents' approval of the categories of financial, physical, functional, and survey-based performance indicators. However, the study also revealed that some indicators from the survey-based category may fall into one of the other categories; hence, this category may be unneeded, or may need to be modified.

Amaratunga and Baldry (2003) categorized KPIs according to four basic principles: customer relations, FM internal processes, learning and growth, and financial implications. Augenbroe and

Park (2005) divided indicators into four categories, as well: energy, lighting, thermal comfort, and maintenance. Hinks and McNay (1999) classified a long list of 172 KPIs into eight categories: business benefits, equipment, space, environment, change, maintenance/services, consultancy, and general. Gumbus (2005) derived a list of performance measures organized into categories relating to four perspectives of the Balanced Scorecard approach. Ho et al. (2000) proposed a comprehensive and detailed set of KPIs categorized into eight major classes. As indicated previously, Lavy et al. (2010) derived a relatively large list of Key Performance Indicators (KPIs), categorized into four major categories of financial, functional, physical, and survey-based (see Table 1). Table 2 shows how various studies categorize KPIs, and how these categories fall into the proposed four categories, as mentioned earlier.

Table 1: Responses of facility management industry professionals on proposed categorization (Source: Lavy et al., 2010)

<b>Respondents</b>	<b>Do you agree with the proposed categorization?</b>	<b>Do you agree that the proper categorization would help in facility management</b>	<b>Additional comments</b>
<b>A</b>	Agree	Agree	Survey-based category includes indicators that could fall under other three categories. Anything that can be done to standardize KPIs related to FM would be appreciated
<b>B</b>	Agree	Agree	-
<b>C</b>	Agree	No response	Survey-based indicators are a big factor in performance standards
<b>D</b>	Agree	Agree	Many of these indicators listed are used by a federal facility. Survey based indicators seems to address the physical and functional indicators in a qualitative manner. Categorization helps facility management professionals in selecting set of indicators of their choice.
<b>E</b>	Agree	Agree	Any effort to accumulate and translate data would support facility management practice.
<b>F</b>	Agree	Agree	-
<b>G</b>	Agree	Agree	Kilowatt-hour usage must be tracked and measures to reduce this consumption needs to be surveyed

Table 2: Literature categorization of KPIs (Source: Lavy et al., 2010)

<b>Categories</b> <b>Sources</b>	<b>Financial</b>	<b>Functional</b>	<b>Physical</b>	<b>Survey-based</b>
Amaratunga and Baldry, 2003	Financial implications	FM internal processes Learning and Growth		Customer's relations
Gumbus, 2005	Financial implications	Operational Learning and Growth		Customer's relations
Hinks and McNay, 1999	Business benefits	Space Equipment Change Consultancy	Maintenance and service	Environment General
Ho et al., 2000		Cleaning Energy consumption Ground and environment Safety and security Parking	Size and use of facility Maintenance Refurbishment	
Augenbroe and Park, 2005		Energy Lighting	Maintenance Thermal comfort	
Massheder and Finch, 1998	Business	Acquisition Disposal	Portfolio Building performance	

### 3.2 Need to Narrow Down the List of Indicators

Establishing a long list of indicators must not be the only goal of facility performance assessment. Such a comprehensive list must be filtered through a certain set of genuine criteria to develop a concise list of those indicators that effectively express one or more aspects of performance assessment (Ho et al., 2000; Slater et al., 1997). Ho et al. (2000), Slater et al. (1997), Hinks and McNay (1999), Cohen et al. (2001) and Gumbus (2005) advocate minimizing performance indicators in order to obtain a more precise but relevant set of KPIs.

Hinks and McNay (1999), referring to research studies performed by Varcoe (1998) and Slater et al. (1997), suggest that there must not be more than four to six performance indicators tied with, at the most, five to six well-defined business or facility objectives. Slater et al. (1997) claim that the

number of KPIs must be kept at a minimum of seven and a maximum of twelve for a comprehensive evaluation of a facility's performance. Literature suggests the following criteria to consider when narrowing the list of KPIs:

### 3.2.1 Indicators Ensuring Holistic Assessment

Unlike past assessments of facility performance that emphasized financial aspects, current assessment must concentrate on aspects like business, organizational goals, job satisfaction, work environment, environmental issues, and other non-financial qualitative aspects, in a detailed manner (Amaratunga et al., 2000b; Brackertz, 2006; Douglas, 1996; Cotts and Lee, 1992; Cable and Davis, 2004; Cripps, 1998; Eagon and Joeres, 1997; Jasch, 2000; Epstein and Wisner, 2001). There must be a holistic approach to performance measurement and assessment in order to cover facilities comprehensively. Consequently, the set of KPIs must be broad, and it should cover the evaluation of overall performance of facilities or organizations, rather than one single aspect (Hinks and McNay, 1999; Douglas, 1993/94; Douglas, 1996; Gumbus, 2005; Cable and Davis, 2004).

### 3.2.2 Quantifiable and Measurable Indicators

Research studies have been unsuccessful in providing a set of quantifiable KPIs required for strategic decision-making for an organization (Shohet, 2006). Furthermore, Shohet notes that most research efforts in the past, focused on maintenance management, have not offered quantifiable indicators for decision-making. Shohet also points out a lack of "quantitative tools and well-based methodologies" in this field of research. Augenbroe and Park (2005) add that not only quantification, but also a precise definition, is vital for key performance indicator development. Moreover, they argue that there is resistance from the research community to quantitatively evaluating the design performance of a building, as design performance has conventionally been assumed to be qualitative. Essentially, performance metrics should be quantifiable in order to provide a common platform for comparing a building's performance. According to Balanced Scorecard Collaborative Vice President Geoffrey Fenwick, very few companies have come up with complete, measurable, and quantifiable performance indicators (Gumbus, 2005). Cable and Davis (2004) mention important characteristics of KPIs, and assert that KPIs must be quantifiable in order to perform aggregation, calculation, and valid comparison. The performance indicators to measure facilities and/or organizations must be not only easily measurable, but also quantifiable in order to make valid comparisons and decisions (Shohet, 2006; Augenbroe and Park, 2005; Ho et al., 2000; Gumbus, 2005; Tsang et al., 1999; Cable and Davis, 2004; Tsang, 1998; Chan et al., 2001).

### 3.2.3 Indicators Showing Wider Applicability

Most research studies so far have focused either on specific aspects or on specific project requirements, and thus, they demonstrate limited applicability to a wider range of projects (Shohet, 2003). Hinks and McNay (1999) performed extensive research to establish a list of KPIs, pointing

out the difficulties in executing valid performance measurement, due to a lack of indicators that exhibit wider applicability. Furthermore, they assert that performance measures should be derived in order to be replicated or transformed easily to suit to the requirements of a range of projects. Performance metrics must be generalized so they can be applied across the facility management industry (Shohet, 2003; Hinks and McNay, 1999; Neely et al., 1997).

## 4. Conclusions

Facility performance assessment is vital for reviewing past strategies, improving current measures, and for future decision-making. The literature suggests that performance measurement should include not only cost related, but also, non-cost related indicators covering aspects relating to user perception and organizational goals. Furthermore, it is emphasized that performance assessment should be carried out periodically and facilities should be evaluated within the organization and against other organizations. The inclusion or exclusion of certain performance measures depends on the user's needs, public or private nature of organization, performance evaluation objectives, and prevailing trends in the industry. About two decades ago, the trend in performance measurement was moving toward the management of maintenance activities, while current trends concentrate on sustainable energy and economic savings. These can be seen in endeavors to develop performance indicators toward these measures. Qualitative data are at times difficult to calibrate; hence, there is a tendency to convert this data into quantifiable data, which creates new complexities. Current trends at local, regional and global levels tend to impact performance metrics significantly, as they represent the demands of the industry.

Efforts have been made in the past to derive a relatively comprehensive list of KPIs (as discussed in the literature review section); however, the literature suggests that these lists of KPIs need to be categorized in such a way that professionals in the facility management industry may select KPIs according to the aspects being evaluated. The lack of proper categorization often results in less use of performance metrics, because the categories selected have no meaning to the industry. Furthermore, there is a need to minimize the number of KPIs, so that effort is not wasted on redundant, overlapping, or unwanted information. In spite of these significant efforts, researchers are still trying to establish a comprehensive list of KPIs. Some reasons for this may be the lack of applicability (to a broad range of facilities,) lack of a holistic approach, and failure of proper categorization. Facility performance metrics must have broad applicability so that with slight modifications, metrics could be used in a broad range of buildings. Clearly, KPIs that demonstrate wider applicability and are quantifiable and measurable should be included. Performance indicators that express more information or cover a wider aspect of performance evaluation should also be incorporated.



This study suggests that broader applicability, a holistic research approach, and better categorization of performance indicators would benefit the field of performance measurement, and would provide a more pragmatic perspective to research studies. This paper identified the need to establish a succinct but relevant list of KPIs that demonstrates wider applicability and includes quantifiable and measurable core indicators.

## References

- Amaratunga, D., and Baldry, D. (2003), "A conceptual framework to measure facilities management performance," *Property Management*, 21(2): 171-189.
- Amaratunga, D., Baldry, D., and Sarshar, M. (2000a), "Assessment of facilities management performance in higher education properties", *Facilities*, 18(7/8), 293-301.
- Amaratunga, D., Baldry, D., and Sarshar, M. (2000b), "Assessment of facilities management performance – what next?", *Facilities*, 18(1/2), 66-75.
- Augenbroe, G., and Park, C.S. (2005), "Quantification methods of technical building performance", *Building research and information*, 33(2), 159-172.
- Baldwin, L.H., Camm, F., and Moore, N.Y. (2000), *Strategic Sourcing – Measuring and Managing Performance*, Report-Project Air force, Research and Development (RAND) Corporation, Santa Monica, California, USA.
- Barret, P., and Baldry, D. (2003), *Facilities Management: Towards Best Practice*, Blackwell Science, Oxford, UK.
- Belassi, W., and Tukel, O.I. (1996), "A new framework for determining critical success/failure factors in projects", *International Journal of Project Management*, 14(3), 141-151.
- Boynton, A.C., and Zmud, R.W. (1984), "An assessment of critical success factors", *Sloan Management Review (pre-1986)*, 25(4), 17-27.
- Brackertz, N. (2006), "Relating physical and service performance in local government community facilities", *Facilities*, 24(7/8), 280-291.
- Cable, J. H., and Davis, J. S. (2004), *Key Performance Indicators for Federal Facilities Portfolios*, Federal Facilities Council Technical Report 147, National Academies Press, Washington, D.C., USA.
- Chan, K. T., Lee, R. H. K., and Burnett, J. (2001), "Maintenance performance: a case study of hospitality engineering systems", *Facilities*, 19 (13/14), 494-503.
- Chua, D.K.H., Kog, Y.C., and Loh, P.K. (1999), "Critical Success Factors for different project objectives", *Journal of Construction Engineering and Management*, 125(3), 142-150.
- Cohen, R., Standeven, M., Bordass, B., and Leaman, A. (2001), "Assessing building performance in use 1: the Probe process", *Building Research and Information*, 29(2), 85-102.
- Cotts, D.G., and Lee, M. (1992), *The Facility Management Handbook*, AMACOM (American Management Association), New-York City, New-York, USA.

- Cripps, S. (1998), "Calgary K-12 District benefits from the facilities management evaluation program", *Facilities Manager Magazine*, The Association of Higher Education Facilities Officers (APPA), Alexandria, Virginia, USA.
- Deru, M., and Torcellini, P. (2005), *Performance Metrics Research Project – Final Report*, National Renewable Energy Laboratory, Golden, Colorado, USA.
- Douglas, J. (1993/4), "Developments in appraising the total performance of buildings", *Structural Survey*, 12(6), 10-15.
- Douglas, J. (1996), "Building performance and its relevance to facilities management", *Facilities*, 14(3/4), 23-32.
- Eagan, P.D., and Joeres, E. (1997), "Development of a facility-based environmental performance indicator related to sustainable development", *Journal of Cleaner Production*, 5(4), 269-278.
- Epstein, M.J., and Wisner, P.S. (2001), "Using a Balanced Scorecard to implement sustainability" *Environmental Quality Management*, 11(2), 1-10.
- Grunert, K.G., and Ellegaard, C. (1992), "The concept of Key Success Factors: theory and method", in: Baker, M.J. (Eds.), *Perspectives on Marketing Management*, vol. 3, pp. 245-274, Wiley, Chichester, UK.
- Gumbus, A. (2005), "Introducing the Balanced Scorecard: creating metrics to measure performance", *Journal of Management Education*, 29(4), 617-630.
- Hinks, J. (2004), "Business-related performance measures for facilities management", in Alexander, K., Atkin, B., Brochner, J, and Haugen, T. (Eds.), *Facilities Management: Innovation and Performance*, pp. 97-107, SPON Press, New-York City, New-York, USA.
- Hinks, J., and McNay, P. (1999), "The creation of a management-by-variance tool for facilities management performance assessment", *Facilities*, 17(1/2), 31-53.
- Hitchcock, R.J. (2002), *High Performance Commercial Building Systems Program, Element 2 – Project 2.1 – Task 2.1.2, Standardized Building Performance Metrics, Final Report*, Building Technology Department, Lawrence Berkeley National Laboratory, Berkeley, California, USA.
- Ho, D.C.H., Chan, E.H.W., Wong, N.Y., and Chan, M. (2000), "Significant metrics for facilities management benchmarking in the Asia Pacific region", *Facilities*, 18(13/14), 545-555.
- Jasch, C. (2000), "Environmental performance evaluation and indicators", *Journal of Cleaner Production*, 8(1), 79-88.
- Kincaid, D.G. (1994), "Measuring Performance in facility management", *Facilities*, 12(6), 24-27.
- Kostoff, R.N., Stump, J.A., Johnson, D., Murday, J.S., Lau, C.G.Y., and Tolles, W.M. (2006), "The structure and infrastructure of the global nanotechnology literature", *Journal of Nanoparticle Research*, 8(3/4), 301-321.
- Lavy, S., Garcia, J.A., and Dixit, M.K. (2010), "Establishment of KPIs for facility performance measurement: Review of literature", accepted for publication in *Facilities*.
- Lebas, M.J. (1995), "Performance measurement and performance management", *International Journal of Production Economics*, 41(1-3), 23-35.
- Leidecker, J.K., and Bruno, A.V. (1984), "Identifying and using critical success factors", *Long Range Planning*, 17(1), 23-32.

- Massheder, K., and Finch., E. (1998), "Benchmarking metrics used in UK facilities management", *Facilities*, 16(5/6), 123-127.
- Neely, A., Richards, H., Mills, J., Platts, K., and Bourne, M. (1997), "Designing performance measures: a structured approach", *International Journal of Operation & Production Management*, 17 (11), 1131-1152.
- O'Sullivan, D.T., Keane, M.M., Kelliher, D., and Hitchcock, R.J. (2004), "Improving building operation by tracking performance metrics throughout the building lifecycle (BLC)", *Energy and Buildings*, 36(11), 1075-1090.
- Shohet, I. M. (2003), "Building evaluation methodology for setting maintenance priorities in hospital buildings", *Construction Management and Economics*, 21 (7), 681-692.
- Shohet, I. M. (2006), "Key Performance Indicators for Strategic Healthcare Facilities Maintenance", *Journal of Construction Engineering and Management*, 132 (4), 345-352.
- Slater, S.F., Olson, E. M., Reddy, V. K. (1997), "Strategy-based performance measurement", *Business Horizons*, 40 (4), 37-44.
- Spendolini, M.J. (1992), *The benchmarking Book*, AMACOM (American Management Association), New-York City, New-York, USA.
- Srinivasan, P. (2004), "Text mining: generating hypotheses from MEDLINE", *Journal of the American Society for Information Science and Technology*, 55(5), 396-413.
- Swanson, D.R. (1986), "Fish oil, Raynaud's syndrome, and undiscovered public knowledge", *Perspectives in Biology and Medicine*, 30, 7-18.
- Tsang, A.H.C. (1998), "A strategic approach to managing maintenance performance", *Journal of Quality in Maintenance Engineering*, 4(2), 87-94.
- Tsang, A.H.C, Jardine, A.K.S., and Kolodny, H. (1999), "Measuring maintenance performance: a holistic approach", *International Journal of Operations and Production Management*, 19(7), 691-715.
- Varcoe, B.J. (1996), "Facilities performance measurement", *Facilities*, 14(10/11), 46-51.
- Varcoe, B.J. (1998), "Facilities as a production asset", *Facilities Management*, April, pp. 6-8.
- Weeber, M., Klein, H., de Jong-van den Berg, L.T.W, and Vos, R. (2001), "Using concepts in literature-based discovery: simulating Swanson's Raynaud-fish oil and migraine-magnesium discoveries", *Journal of the American Society for Information Science and Technology*, 52(7), 548-557.
- Yuan, J., Zeng, A.Y., Skibniewski, M.J., and Li, Q. (2009), "Selection of performance objectives and key performance indicators in public-private partnership projects to achieve value for money", *Construction Management and Economics*, 27(3), 253-270.



# Risk Assessment of Ammunition Threats to Critical Infrastructures

**Andras. Schenker**

Protective Technologies R&D Center, Department of Mechanical Engineering, Ben-Gurion University of the Negev, P.O. Box 653, Beer-Sheva 84105, Israel

**Igal M. Shohet**

Construction Management Program, Department of Structural Engineering, Ben-Gurion University of the Negev, P.O. Box 653, Beer-Sheva 84105, Israel [igals@bgu.ac.il](mailto:igals@bgu.ac.il)

**Gabi Ben-Dor**

Protective Technologies R&D Center, Department of Mechanical Engineering, Ben-Gurion University of the Negev, P.O. Box 653, Beer-Sheva 84105, Israel

## Abstract

One of the key facilities that are required to ensure the continuous and reliable performance of the built environment are Critical Infrastructures (CI) such as power plants, central transportation stations, communication facilities and facilities that provide critical services such as acute care hospitals, energy, governance, etc. CIs are often exposed to ever growing spectrum of threats such as terror and military attacks. Such infrastructures are expected to be capable of performing continuously and reliably including whilst under adversary attacks. This means that a higher order of preference is given to the protection of CIs rather than to protect its operators or the public safety and security. The goal of the research is to develop a method for quantification of the spectrum of adversary threats on CI, to define the consequent risk envelope, and to develop protective strategy to reduce the risk caused by a given threat envelope. A conceptual risk assessment and management model has been developed and is presented. The model is composed of four key parameters:  $P_A$  – Probability of attacks;  $P_E$  – Preventive measurement effectiveness;  $C$  – Consequences of loss and damage as results of an attack;  $R$  – Risk as a result of an attack on the facility. The proposed method follows three Phases: (I) Threat scenario analysis; (II) Risk Profiling; and (III) Assessment of consequences under alternative protective structures. The model can be used as a tool for strategic decision makers in Critical Infrastructures, in order to assess the true value of a given protective strategy.

**Keywords:** Critical Infrastructures, Decision Trees, Risk Assessment, Threat analysis.

## 1. Introduction

The performance of Critical Infrastructures (CI) such as energy and water supply is essential for the civil society security and well being. Such Infrastructures are required to perform in a diversity of conditions, beginning with routine events, through extreme events such as fatal mass events.

State-of-the-art reviews (Karim, 2004; Warfield, 2004; Thissen and Herder, 2003) suggest that risks caused by extreme events in critical infrastructures are seldom analyzed by analytical methods, methods are often non-quantitative and implementation of methodologies is sporadic.

The objective of the present research is to develop an integrated method for risk analysis, caused by ammunition threats against critical infrastructures. The research will deal with the following basic questions:

- What are the decision variables of the protection of Critical Infrastructures against ammunition threats?
- Does a typical pattern (model) of interdependence between the variables exist? What are its parameters?
- Does an analytical relation between the variables exist?
- Is it possible to categorize Critical Infrastructures with respect to ammunition risks?

## 2. Background

Increasingly complex and interconnected infrastructures are exposed to ever growing wide range of risks such as functional impairments associated with technological failure, natural hazards and malicious acts. The protection of infrastructures becomes therefore more and more an important issue for decision makers. Existing methods for identifying critical infrastructures are mainly based on risk analysis techniques. These approaches were found to be insufficient and need to be complemented with evaluations of potential impacts and consequences. (Di Mauro et al., 2010; Haines et al. 2008). The ever growing dependency of critical services in infrastructures, contributed to the recognition in the need to design CIs to withstand extreme events. CIs, such as healthcare facilities, transportation infrastructures, power plants and critical security facilities are required to function continuously including at emergency times. This requirement is possible but it requires an innovative integrated model for the evaluation and assessment of risks caused by extreme events such as ammunition threats. The methodology proposed is based on the analysis of failure mechanisms of critical mechanisms and the transition to Probabilistic Failure and Decision Making Trees for the treatment of critical mechanisms. The methodology will identify critical failure mechanisms resulting from ammunition threats on CI, will identify the risk expectancy in relation to the facility itself and regarding the methodology (natural resources, population, other facilities), and quantitatively determine the feasibility of elimination or restraint of risk factors.

The conflict zones on the North and the South of Israel are characterized by threats from a variety of lethal conventional weapons ("Katiusha", Mortars, "Kassam" and "Grad" artillery etc). These kinds of threats are intended to disrupt the ordinary course of life of the citizens and

at the same time, cause injuries and casualties and in addition to damage buildings and Critical Infrastructures.

The innovation expected of this research is to provide decision makers with a scientific tool to protect the Critical Infrastructures, and the capability to sustain performance during adversary attacks.

## 2.1 Definition of Critical Infrastructures

Critical Infrastructures consist of those physical and information technology facilities, services and assets which, if disrupted or destroyed, would have a serious impact on the health, safety, security and well-being of citizens and the effective functioning of the governments. Critical Infrastructures (CI) are organizational and physical structures and facilities of such vital importance to a nations society and economy that their failure or degradation would result in sustained supply shortages, significant disruption of public safety and security, or other dramatic consequences (Moteff et al. 2003; Gheorghe et al. 2007). Infrastructures are crucial in sustaining minimum operation of a society and its government. The most critical ones are:

- Transportation
- Telecommunication and information
- **Energy (electricity, gas and power plants) and water**
- Hospitals and healthcare facilities
- Public facilities such as schools and governance buildings.

Many CI have historically been physically and logically separated systems. Advances in technology, and especially in information technology, however, have led to an integration and interlinking of the various infrastructures. Often, CI's depend upon another CI, e. g. a stable and reliable electricity supply. Failure in the electricity infrastructure consequently harm other CIs such as healthcare, transportation, etc.

## 2.2 State of the Art Review

This paragraph reviews the state-of-the-art in the disciplines of the research domain.

### 2.2.1 Probabilistic Risk Assessment (PRA)

PRA has recently become increasingly important in dealing with Information and Information Technology (IT) security. The implementation of PRA to solve Critical Infrastructures employs Risk Management (RM) frameworks, advanced RM tools for Decision Making, and implementation of probabilistic risk assessment tools. Haimes and Jiang, 2004; Haimes and

Barker, 2009; Haimes, 2009; Gulati and Bechta, 1997; Manoj and Jha, 2009 stress that the subject of critical and interdependent infrastructures requires the employment of static and dynamic fault trees, and risk-based decision making. Probabilistic Risk Analysis (PRA) is a systematic and comprehensive methodology to evaluate risks associated with a complex engineering technological entity.

Consequences are expressed numerically (e.g., the number of injured or casualties) and the likelihood of occurrence is expressed as probabilities or frequencies (probability density function i.e., the number of occurrences or the probability of occurrence per unit time). The expectancy of risk is the loss expectancy: the sum of the products of the consequences multiplied by their probabilities. The common methods of implementation of PRA are to use Fault Tree Analysis and Decision Trees.

### **2.2.2 Fault Tree Analysis (FTA)**

is a deductive procedure for determining the various combinations of hardware and software failures, and human errors that could result in the occurrence of specified undesired events (referred to as top events) at the system level. The main purpose of FTA is to evaluate the probability of the top event using analytical and statistical methods. The analysis is generally undertaken in two stages: qualitative analysis of the logical relations between the hardware composites of the systems according to logical gates and quantitative analysis that implements probabilities of basic events and logical gates to explore the probability of the occurrence of the top event. FTA may be implemented for decision making through Binary Decision Diagrams (BDD), and Markov Chains (Frohwein, et al.1999; Sinnamon and Andrews, 1996).

### **2.2.3 Failure Mode and Effects Analysis (FMEA)**

FMEA was originally developed in the United States Army in 1949 and titled MIL-P-1629; it was helpful in avoiding preventable failures. Since then, FMEA has been used as a reliability evaluation technique to determine the effect of system and equipment failures. FMEA is an analytic approach that identifies potential failure modes in a system, determines their effect on the operation of the system, and identifies actions to mitigate the failures. It also identifies critical design chains or critical process characteristics that require particular control measures to prevent or detect failure modes (Gofuku et al.2006).

### **2.2.4 Failure Mode and Effects Criticality Analysis (FMECA)**

FMECA is an extension of the FMEA method. In addition to the basic FMEA, it includes a criticality analysis, which is used to chart the probability of failure modes against the severity of their consequences. The result highlights failure modes with relatively high probability and



severity of consequences, allowing remedial effort to be directed according to the highest effectiveness. FMECA is typically performed as part of a design project, to eliminate failure modes with high severity and probability, and to reduce as much as possible those with high severity and/or probability (Saglimbene, 2009).

### 3. Objectives

This paper focuses on risks caused by ammunition threats in critical infrastructures in light of the knowledge gap between quantitative methods in risk assessment and the methods implemented in critical infrastructures. In light of the questions, this paper addresses the following objectives:

- Development of analytical-probabilistic method for the assessment of risk expectancy caused by ammunition threats;
- Development of a function expressing the dependency between protective level of critical infrastructures ( $P_e$ ) and expectancy of Risk ( $R$ );
- Development of the function of Costs of Protective Effectiveness (CPE) dependency in the critical infrastructure Protective Effectiveness ( $P_e$ );
- Development of an algorithm for the analysis of consequences resulting from ammunition threats to Critical Infrastructures (CIs);
- Derivation of protective solutions in Critical Infrastructures from the integrated model.

### 4. Hypotheses

A - Risk Management of Ammunition Threats against Critical Infrastructures is composed of three Decision Variables:

1. Risk Expectancy resulting from the threats - ( $R$ );
2. Quantification of the consequent performance implications of an adversary attack (critical and non-critical (overall)) - Consequences ( $C$ );
3. The total cost of a Critical Infrastructure Protection against Ammunition Threats depends on the level of the Protective Effectiveness against Ammunition Risks - Costs of Protective Effectiveness (CPE).

B - Risk Expectancy resulting from adversary Ammunition Threats against Critical Infrastructures is linearly dependent on the effectiveness of the Critical Infrastructures Protection.

C - The Cost of CI protection is non-linearly dependent on the Protective Effectiveness of CI; it is assumed that the slope of the graph steepens as the protective effectiveness increases.

### 5. Method

Figure 1 below depicts the stages of the research as well as the structure of the model. Main research stages are: Threat Scenario Analysis, Ammunition Threat Risk Profiles, Development of analytical procedures for assessment of the principal variables of the model:  $P_e$  - Protective Effectiveness,  $P_a$  - Probability of Attack,  $C$  - Consequences of event, and  $R$ - Risk expectancy.

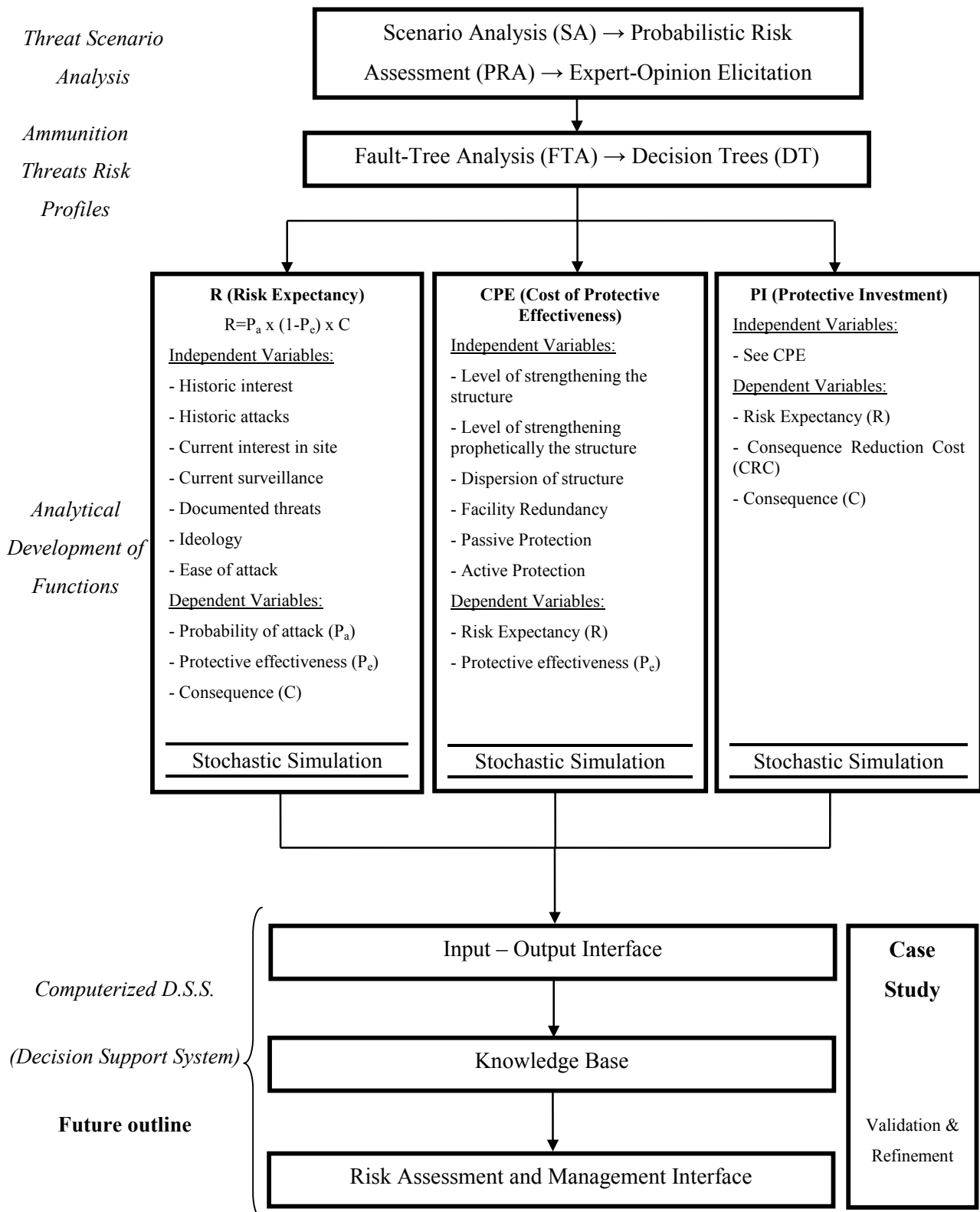


Figure 1: Method

### 5.1 Risk Expectancy Equation

Security Risk is estimated by the following risk equation:

$$R = P_A \times (1 - P_E) \times C \tag{1}$$

Where:

R - **Risk Expectancy** associated with adversary attack [\$]

$P_A$  - Probability/of attack

$P_E$  - Probability that the security system is effective against the attack

$(1 - P_E)$  - System ineffectiveness or Preventive Measurement Effectiveness

C - **Consequence** of the attack [\$].

The first parameter of the risk analysis model is the threat potential, particularly; the Probability/Likelihood of adversary attack ( $P_a$ ) is assessed in the way seen in Figure 2 below.

**Threat** - this includes the types of possible adversary, tactics, and capabilities (number of adversary groups, weapons, equipment, and transportation modes).

After the adversarial threat spectrum has been reviewed, the information can be used together with statistics of past event and site-specific perceptions to categorize threats in terms of likelihood that each type of threat would be realized

The second parameter of security risk **Consequence (C)** is determined according to four categories: Catastrophic, Critical, Marginal, and Negligible as defined in Table 1 below.

Table 1: Classification of consequences categories

Consequence category	Consequence level
Could result in casualties, permanent total disability, loss exceeding \$1M, or irreversible severe environmental damage that violates law or regulation	Catastrophic
Could result in permanent partial disability' injuries, or occupational illness that may result in hospitalization of at least three personnel, loss exceeding \$200K but less than \$1M, or reversible environmental damage causing a violation of law or regulation.	Critical
Could result in injury or occupational illness resulting in one or more loss workday(s), loss exceeding \$10K but less than \$200K, or mitigatable environmental damage without violation of law or regulation, where restoration activities can be accomplished.	Marginal
Could result in injury or illness not resulting in a lost workday, loss exceeding \$2K but less than \$10K, or minimal environmental damage not violating law or regulation.	Negligible

The third parameter in assessing risk, the **system ineffectiveness (1- $P_e$ )**, can be derived from a security system effectiveness assessment. Security system ineffectiveness and security **system effectiveness ( $P_e$ )** are complementary functions.

### 5.2 Phase I - Threat Scenario Analysis

Figure 2 depicts the Threat Scenario Analysis procedure:

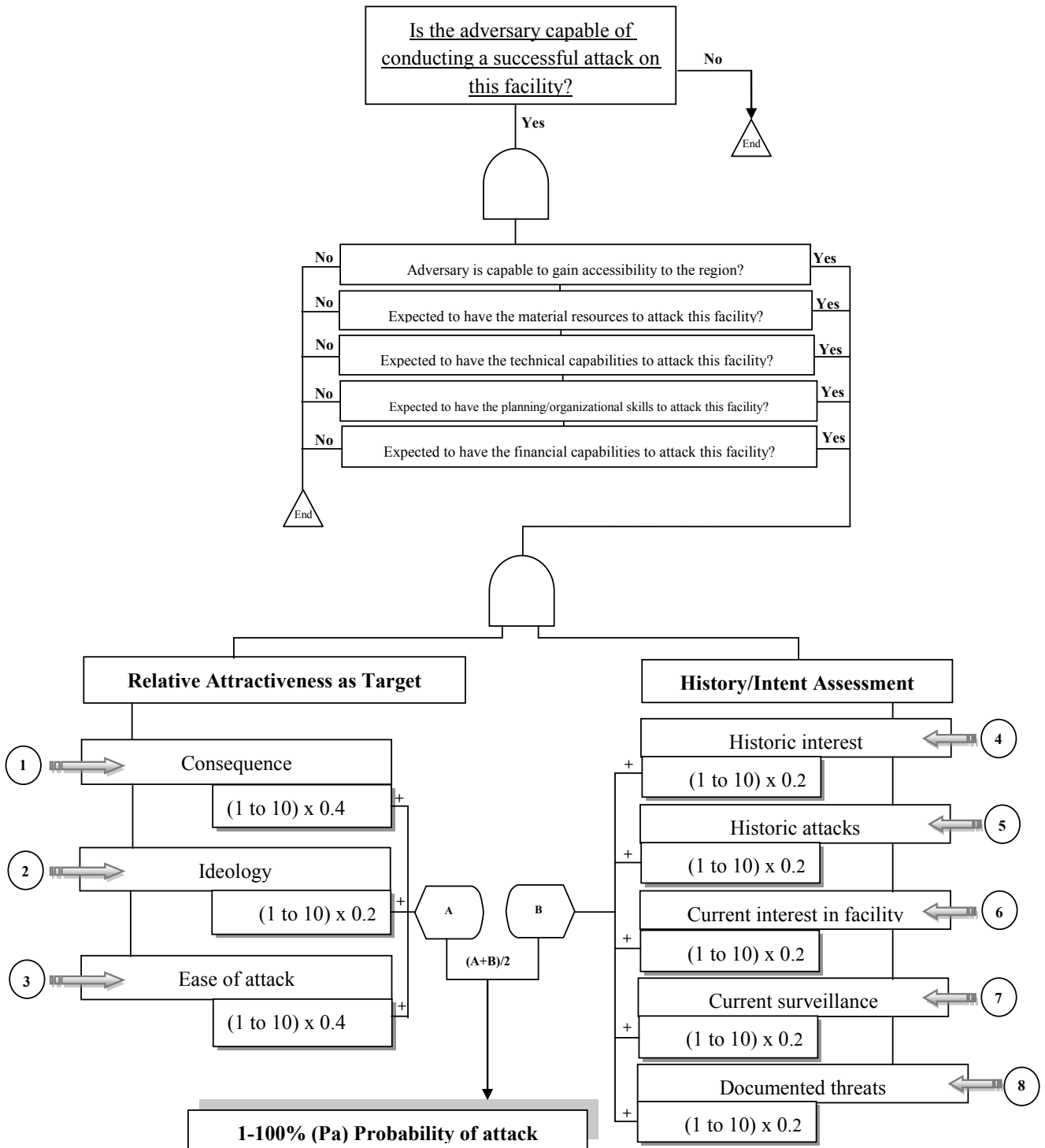


Figure 2: Flowchart of the threat analysis model

5.3 Phase II - Preventive Measurement Effectiveness

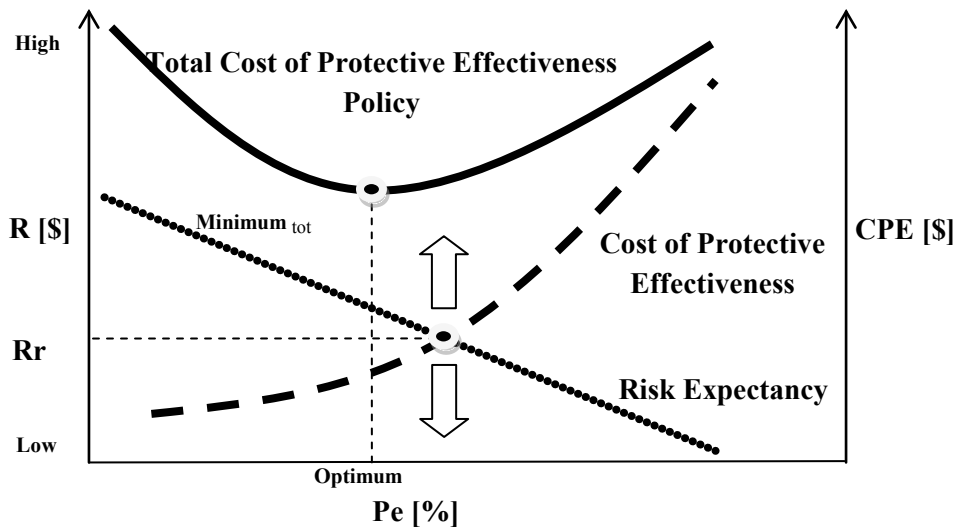


Figure 3: Total Cost of Protective Effectiveness Vs. Protective Effectiveness

Figure 3 depicts the concept of the assessment of the Cost for continues performance of Critical Infrastructure. The independent variable  $P_e$  – is the independent variable ranging between 0-100 [%],

Dependent variable Y1: R-Risk Expectancy [\$],

Dependent Variable Y2: CPE – Cost of Protective Effectiveness [\$].

The solid graph is the Total Summation of the dot and the dash graphs and representing Risk Expectancy and Cost of Protective Effectiveness respectively. The intersection point is a balance point between the level of Protective Effectiveness Investment and Risk expectancy of the Protection (Risk-Protective Cost-Equilibrium). Moving upwards from the balance point, means the Investment is increased and the Risk is reduced, while shifting to the left of the balance point, means the Protective Effectiveness is reduced (and so does the Investment), and moving to the right of the balance point, means the Protective Effectiveness is increased (and so does the Investment). The dash graph represents the extent of Investment needed to increase the Protective Effectiveness. Actually, what is required is to develop a function for this dash graph, from data on the particular CI.

Let us define the Total Cost of Protective Effectiveness - (CPE) represented by the solid graph, in Figure 3, where:

$R$ = Risk Expectancy,  $R=f(P_e)=a \cdot P_e+b$

$CPE$ = Cost of Protective Effectiveness,  $CPE=f(P_e)$

$TCPE$ = Total Cost of Protective Effectiveness,  $TCPE= R + CPE.$

The following insights may be drawn on the Total Cost of Protective Effectiveness diagram:

- 1- The research hypothesis regarding the CPE function presumes that it is a non-linear monotonic increasing function of  $P_e$ . This function will be investigated within the next stage of research;
- 2- The TCPE minimum point ( $\text{Minimum}_{\text{tot}}$ ) and the R-CPE balance point are independent;
- 3- The TCPE  $\text{Minimum}_{\text{tot}}$  point is the optimum of the Critical Infrastructure Protective Effectiveness Problem we are looking for;
- 4- The TCPE graph gives us the Risk/Cost estimate with reference to maintaining the continuous performance of the Critical Infrastructure;
- 6- In the development of the CPE graph, we will investigate the slope of the function at the highest resolution possible. As can be seen in the in the conceptual graph, the optimum is highly sensitive to the derivative of the TCPE graph;
- 8-  $R = f(P_e)$  function, is a linear decreasing function;

The CPE graph development: The analysis refers to Steep Path Weapons, such as, Mortars, earth to earth Rockets, and earth to earth Missiles. Table 2 below shows analysis of 4 alternatives of protective solutions: Light Weight Structures, Conventional Reinforced Concrete Structure, RC with RC cores and protected spaces, and Protected Reinforced Concrete Structure (High Strength Concrete).

## 6. Case Study

A case study on a critical energy facility was carried out. The case study aimed at validating the proposed model and conducting sensitivity analyses so as to examine the implications of the model on the decision process. The case study followed the following stages: (1) Threat Scenario, (2) Assessment of Preventive Measurement Effectiveness, (3) Assessment of consequences thru sensitivity analyses. The fundamental concepts of the mode, i.e. the costs of protective effectiveness, Risk Expectancy resulted from the threat scenario as well as the Total Costs of Protective Effectiveness were validated and be presented in the oral presentation in detail.

Sensitivity analyses convert the trade-off between the protective effectiveness ( $P_e$ ) of the facility (independent variable) and the Expectancy of Risk (R) (dependent variable). The analysis was carried out for different levels of probability of attack ( $P_a = 4.2, 4.5, \text{ and } 4.8 \%$ ). The analysis depicts that the expectancy of risk decreases by 138-169 K\$ for 1% increase in the protective expectancy. The result gives a threshold value for the feasibility of projects for improvement of the protective effectiveness of a given critical facility.

## 7. Conclusion

A quantitative-analytical algorithm has been developed for the assessment of the risk expectancy and the outcomes of adversary threats. The model can be used by decision makers in Critical Infrastructures, as a tool for preventing the most undesirable scenario – being caught off guard. In today's world, where Critical Infrastructures are ever exposed to growing threat scenarios the implementation of such a tool is of a high significance in the development of protection strategy. The proposed model combines probabilistic tool for the assessment of the threat potential, it follows with an analytic assessment and estimate of protective alternatives. The research hypotheses presume that the protection problem of CIs is composed of three Decision Variables: The level of Protective Effectiveness, the Cost of Protective Effectiveness and the Risk Level at the facility. There exist an analytic optimum of the protective policy that brings the Total Costs of Protective Effectiveness to a minimum. The model proposed clearly shows that investment in reducing the threats is of a greater impact than investment in increasing the protective measures.

Table 2: Assessment of Cost of Protective Effectiveness

Structure Characterization	Light Weight Structure	Conventional Reinforced Concrete Structure	RC Structure with Reinforced Concrete Cores and Protected Spaces	Protected Reinforced Concrete Structure (HSC)
Level of strengthening the Structure, Upgrading (Upgrading protection)	$0.25x(C_E)$	$0.50x(C_E)$	$0.75x(C_E)$	$0.95x(C_E)$
Level of strengthening prophetically the structure (Additional Barricade Walls)	$1 \cdot (B/L) \cdot C_W$	$0.75 \cdot (B/L) \cdot C_W$	$0.50 \cdot (B/L) \cdot C_W$	$0.25 \cdot (B/L) \cdot C_W$
Dispersion of Structures	Costs of Relocation	N.A.	N.A.	N.A.
Facility Redundancy	Costs of Structure and Equipment	Costs of Structure and Equipment	Costs of Structure and Equipment	Costs of Structure and Equipment
Passive Protection	+	+	+	+
Active Protection	N.A.	N.A.	+	+
<b>Total Protection Cost</b>	<b>CPE (25%) \$</b>	<b>CPE (50%) \$</b>	<b>CPE (75%) \$</b>	<b>CPE (95%) \$</b>

**Legend:**  $C_E$  = Reinstatement Cost of the Structure

$B$  = Peripheral Protection required

$L$ =Length of protective element (Wall barricaded unit)       $C_w$  = Cost of wall barricade for a length unit

## References

Di Mauro, C., Bouchon, S., Logtmeijer, C., Pride, R.D., Hartung, T., Nordvik, J.P. (2010). "A structured approach to identifying European critical infrastructures", *International Journal of Critical Infrastructures*, Vol. 6(3), 277-292, June 2010

Frohwein, H., Lambert, H., Haimes, Y. (1999). "Alternative measures of risk of extreme events in decision trees", *Reliability Engineering and system safety*, VOL. 66, pp. 69-84.

Gheorghe, A.V. Masera, M., De Vries, L., Weijnen, M., Kroger W. (2007). "Critical infrastructures: the need for international risk governance", *International Journal of Critical Infrastructures*, Volume 3, Number 1-2 / 2007, 3 – 19.

Gofuku, A., Koide, S., Shimada, N. (2006). " Fault Tree Analysis and Failure Mode Effects Analysis Based on Multi-level Flow Modeling and Causality Estimation", *SICE-ICASE International Joint Conference*, pp. 497-500.

Gulati, R. and Bechta, J. (1997). "A Modular Approach for Analyzing Static and Dynamic Fault Tree", *proceedings Annual reliability and maintainability symposium*, IEEE ,pp.57-63.

Haimes, Y. (2009). "On the Complex Definition of Risk: A Systems-Based Approach", *Risk Analysis*, VOL.29, No.12, pp.1647-1654.

Haimes, Y., Barker, K. (2009). "Assessing uncertainty in extreme event: Applications to risk-based decision making in interdependent infrastructure sectors" *Reliability Engineering and System Safety*, VOL.94, pp.819-829.

Haimes, Y.Y., Crowther, K., and Horowitz, B. M. (2008). "Homeland security preparedness: Balancing protection with resilience in emergent systems", *Systems Engineering*, 11(4), 287-308, Winter 2008

Haimes, Y., Jiang, P. (2004). "Risk Management for Leontief-Based Interdependent Systems", *Risk Analysis*, VOL.24, No.5, pp.1215-1229.

Karim N (2004) "Options for Floods and Drought Preparedness in Bangladesh", *Proceedings of the Second International Conference on Post-disaster reconstruction: Planning for Reconstruction*, 22-23 April 2004, Coventry University, UK.

Manoj K. and Jha, M, (2009), "Dynamic Bayesian Network for Predicting the Likelihood of a Terrorist Attack at Critical Transportation Infrastructure Facilities" – *ASCE*.Thissen, W. A. H. and Herder, P. M. (Editors) (2007). "Critical Infrastructures – State of the Art in Research and Application".

Moteff, J., Copeland, C., Fisher, J. (2003). "Critical Infrastructures: What Makes a n Infrastructure Critical?" – LIBRARY OF CONGRESS WASHINGTON DC



CONGRESSIONAL RESEARCH SERVICE. <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA467306&Location=U2&doc=GetTRDoc.pdf> (accessed April 9, 2010)

Saglimbene, M. (2009). "Reliability Analysis Techniques: How They Relate To Aircraft Certification", *Annual Reliability and Maintainability Symposium*, IEEE, pp.218-222.

Sinnamon, M., Andrews, J. (1996). "Fault Tree Analysis and Binary Decision Diagrams", *Proceedings Annual reliability and maintainability symposium*, IEEE, pp. 215-222.

Thissen, W. A. H., Herder, P.M. (2003). "Critical Infrastructures – State of the Art in research and Application", Springer-Verlag, New York. ISBN 9781402076015.

Warfield C (2004) *The disaster management cycle*, (available online [http://www.gdrc.org/uem/disasters/1-dm\\_cycle.html](http://www.gdrc.org/uem/disasters/1-dm_cycle.html) (accessed on 19/06/2010).



## System transferability of Facility Management

**Dr.-Ing. Mandana Banedj-Schafii**

Karlsruhe Institute of Technology (KIT); Institute for Technology and Management in Construction, Facility Management, Germany  
mandana.banedj-schafii@kit.edu

**Prof. Dr.-Ing. Dipl.-Wi.-Ing. Kunibert Lennerts**

Karlsruhe Institute of Technology (KIT); Institute for Technology and Management in Construction, Facility Management, Germany  
kunibert.lennerts@kit.edu

### Abstract

Can Facility Management be transferred? Is it possible to use learned and employed systems in one country and adopt them in another one? These were the first questions of a young scientist, once she had to establish the first FM department in the Building and Housing Research Centre in Iran - after having lived and studied for more than twenty years in Germany.

A research project started to find out the grade of transferability between different countries. The research was done based on the research project OPIK (Optimization and Analysis of the Processes in Hospitals) which has been successfully running since 2001 with cooperation partners from science, hospitals, professional associations and industry at the KIT, Germany. Three processes that were analyzed in the OPIK-Germany project (laundry management, maintenance and repair of technical facilities and medical equipment) were chosen exemplarily and compared with their pendants in the OPIK-Iran project which was implemented in three hospitals in Tehran. With the perceptions of the process analysis and the comparisons of the hospital management, the health system and country-specific conditions nine main parameters were recognized which influence the transferability of facility management. These are management, economy, politics, culture, judicative, education, public and private institutions, infrastructure and geography. By using system theory, models were defined and specific analysis and methods were developed to rank these main parameters. Based on those results proposals were worked out for the implementation of facility management in the Iranian hospitals. The assessment with the help of the transferability methods however can only serve as a guide or a "trend barometer". The level of the ranking indicates the degree of importance. It gives a direction, which parameters should be considered for the successful transferability of a FM-system. Facility management is dynamic; the system must however be matched to the boundary conditions and be adapted to the specific situation in the country or even in the hospital to which it is applied. Concluding from this comparison; a transfer of knowledge, information and know-how took place which led to the start of a dual Master Course at Tehran University and a Facility Management Competence Centre.

**Keywords:** facility management, hospital, system theory, transferability, process optimization

## 1. Introduction

The increasingly globalizing markets offer beside transfer of products also transfer of services. This is valid for management systems like Facility Management as well. This modern management system have been being implemented and used in more and more countries worldwide in the recent years. Different markets, regions or countries however have their own conditions and frameworks, so that the understanding and the implementation of Facility Management can vary from one region to the other one. The question which arises here is which parameters and factors play key roles in this subject. To answer this questions this paper describes an analytical approach to investigate and verify the parameters of influence for the transferability of Facility Management from one country to another one. After having lived and studied for more than twenty years in Germany a young scientist started to work in Iran and took the responsibility to establish the first FM department in the Building and Housing Research Centre in Tehran. Having started the work it turned out to be enormously difficult to apply the knowledge of the German Facility Management. To find out the differences a research project started, to analyze the transferability of Facility Management using the project OPIK [Optimizing and Analyzing of the Processes in Hospitals].

## 2. The research project

### 2.1 The research project OPIK

The huge cost pressure on the German hospitals, especially with the implementation of the “Diagnosis Related Groups” (DRG) in 2003, made the detailed analysis of the hospital processes necessary.

This was the birth of the research project OPIK which started in 2001 initiated by the University of Karlsruhe (TH) in cooperation with the Professional Union for Hospital Technology (Fachvereinigung für Hospitaltechnik (e.V.) (FKT)). To fulfill the requirements and to guarantee a quick market access of the research results additional cooperation partners, hospitals and the industry were involved. The heterogeneous character of the participating partners guaranteed “an interdisciplinary exchange of specialist knowledge which created a unique connection between practice and research in the Health Care System of Germany” (Lennerts 2002).

To be able to optimize the processes four steps had to be taken. In the first step the processes were described, visualized and standardized by a group of experts. Then the cost- and quality factors were determined theoretically for every process step and the related interfaces to the “primary processes”- the core business in the hospital- were defined. In the third step data for the cost and quality factors were collected in the participant partner hospitals. This data that formed the core of the process analysis was finally evaluated in the fourth step.



Figure 1: OPIK-partners (based on Lennerts, 2002a)

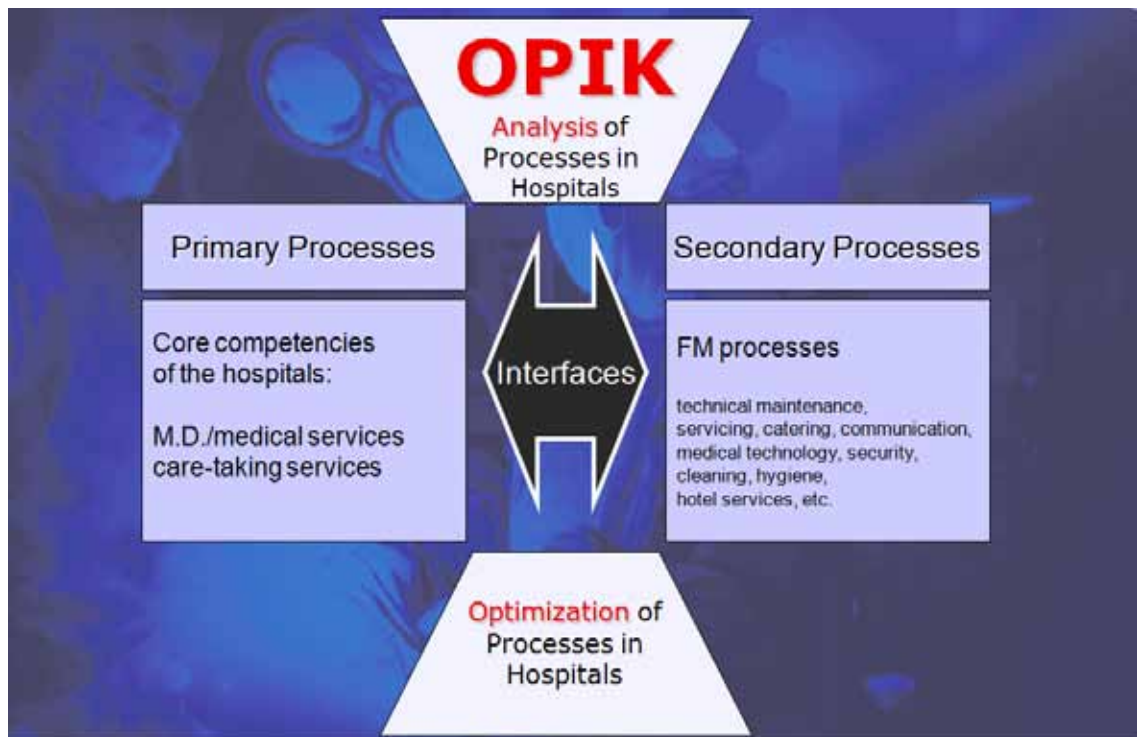


Figure 2: The idea of OPIK (based on Lennerts, 2002b)

The standardization of the process results was implemented in three phases:

1. Analysis and optimization
2. Verification
3. Development of a standard process

The results were discussed in regular workshops with the partners and the process standardization was progressed in this way. Studies and censuses in the different hospitals were conducted by the scientific staff and supported by research studies and theses.

## 2.2 OPIK-Iran

In February 2006 the OPIK-Iran project started similar to its German origin. The Iranian cooperation partners (service enterprises, subcontractors, management, representatives of the Health Institute, the Medical University of Tehran and the Ministry of Health and Medical Education [MOHME]) started the kick-off meeting and selected three hospitals in Teheran (Vali Asr Hospital, Shariati Hospital and the Tebie - Children's Hospital) as pilot objects. In general and specific workshops that were accompanied by long, intensive and suggestive discussions the theoretical part was elaborated. Here the current status of the processes (single process steps, interfaces, responsibilities, Iranian laws and regulations) and the current management and organization were analyzed. Surprisingly, there were significant differences between the hospitals, although they were all public institutions under the head of Tehran University of Medical Science in the capital. So for example one of the pilot hospitals did not have a department for medical equipment (what reflects the situation of 90% of the country). These tasks were administrated by university authorities. The laundry management units were coordinated in completely different ways. Some of them had their own centers while other ones worked with external suppliers.



*Figure 3: The analyzed processes in the OPIK-Iran project (Banedj-Schafii, 2010)*

The results of the data collection were 211 reports for the maintenance of medical equipment and 976 reports for the technical facilities within 20 days. This time period was chosen exactly equal to the German pendent, so that a precise comparison could take place.

## 2.3 Comparison of the Processes

The comparison of the processes began after the data collection. The Iranian processes, which were split in single process steps, the analysis of the interfaces, the characteristic variables and

responsibilities were compared with their German pendants. In this way the differences became visible (see figure 4) and the verifications could start to recognize these differences.

Germany possesses a global leading position in the field of maintenance of medical equipments. Years of experience have been reflected in numerous powerful and active unions and federations. Numerous laws and regulations have been established that are applied to daily processes and have proved their suitability. In Iran, however, laws and regulations have been introduced and legislated since 2006.

Regular maintenance and repair is a part of the process in Germany. It is normally performed by local companies and suppliers. In Iran however maintenance is very rare and is primarily restricted to very expensive equipments. Planning, analysis and the documentation takes an important position in the German departments while in Iran the lack of specialized staff, insufficient training and documentation as well as missing control of equipments characterize the medical equipment technology. It is noticeable that in Iran much more departments are involved and integrated in single process steps, which causes more time and costs.

A similar analogy can be taken considering the technical facilities. Numerous regulations and laws which are strictly controlled by different authorities show the significance of this field in Germany. Very rare maintenance, lack of specialist staff, low level of documentation, a low budget and the lack of control of the mostly elder facilities influence the situation of the technical facilities in Iran.

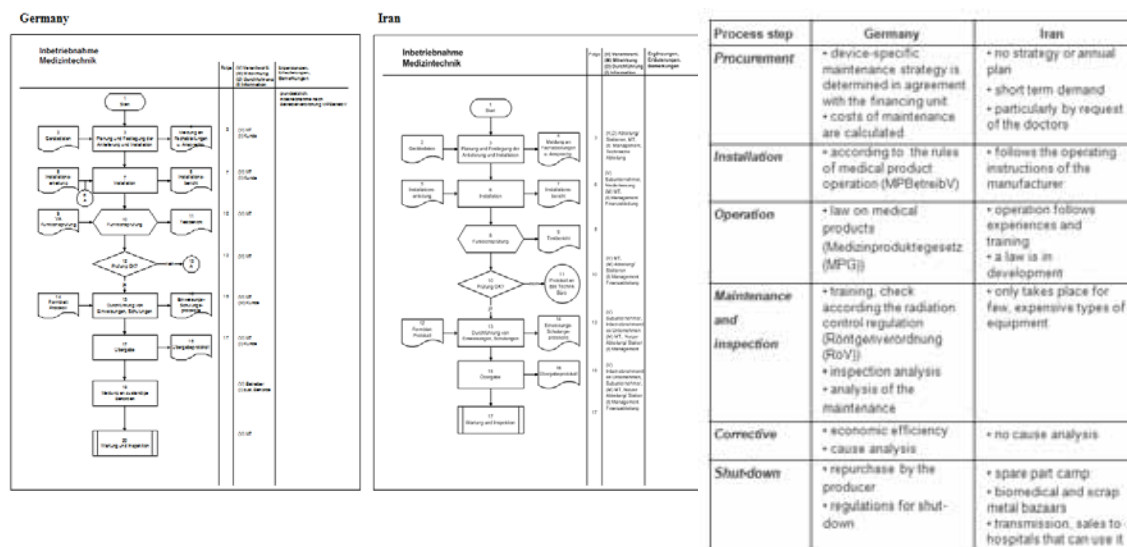


Figure 4: Comparison of the processes (Banedj-Schafii, 2010)

### 3. Transferability of Facility Management

With the process analysis and the comparison of the hospital management and health systems and country-specific conditions nine main parameters were recognized which influence the

differences between the two countries. These are management, economy, politics, culture, judicative, education, public and private institutions, infrastructure and geography.

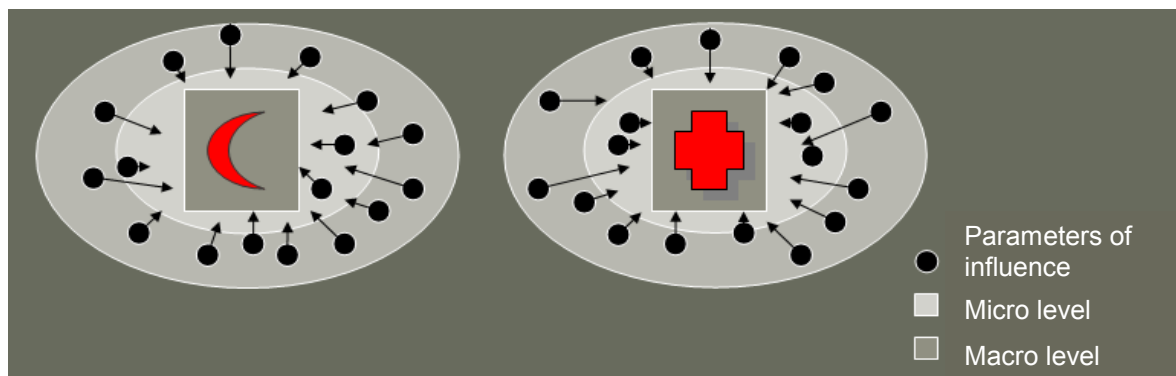
In order to be able to apply the transfer of FM-processes or a FM-system a “FM-transferability-model” was developed and derivated from the system theory.

### 3.1 Model investigation with the help of system theory

Based on the system theory that requires detailed “choice of the system boundaries and of the perspective of the view” [MATTHIS2002], a precise description of the targets and the purpose of the model were defined.

The Goal was the development of a “FM-System Transferability Model” that should assist facility managers to transfer a FM system into another environment or to implement a “foreign“ FM-system in their own organization (hospital).

According to EN 15221/1 “*The integration of processes within an organization to maintain and develop the agreed services which support and improve the effectiveness of its primary activities*” the FM-system comprises the services which are provided in a hospital. In the model shown in figure 5 these are symbolized by the Red Cross (symbol of the German FM in hospitals) and the Red Crescent (standing for the FM services in Iranian hospitals).



*Figure 5: The system model (Banedj-Schafii, 2010)*

Two levels of analysis were distinguished, the micro level and the macro level. At the micro level or hospital level all processes, structures, functions and influence factors which are decided or performed at the hospital level are investigated. The parameters influencing the FM processes at the country or state level are however analyzed at the macro level.

As shown in figure 5, many parameters of influence act on the system, on both the micro and the macro level. These parameters were grouped according to subject and collected under generic names in order to make it possible to analyze their impact on the system and their interactions with each other. The parameter groups were both quantitatively and qualitatively



measurable and ratable; they were assessed based on their significance and influence<sup>1</sup>. Some of the parameters have fixed values that can be reliably determined, e.g. Gross Domestic Product (GDP) of the countries, other parameters must be estimated or are very difficult to assess, for instance working morale, sense of responsibility, religiousness, etc..

### 3.2 Methods and Analysis

The idea of the creation of a transferability method started with the development of ranking methods, to find out which parameters have higher impact and must be analyzed or considered more precisely.

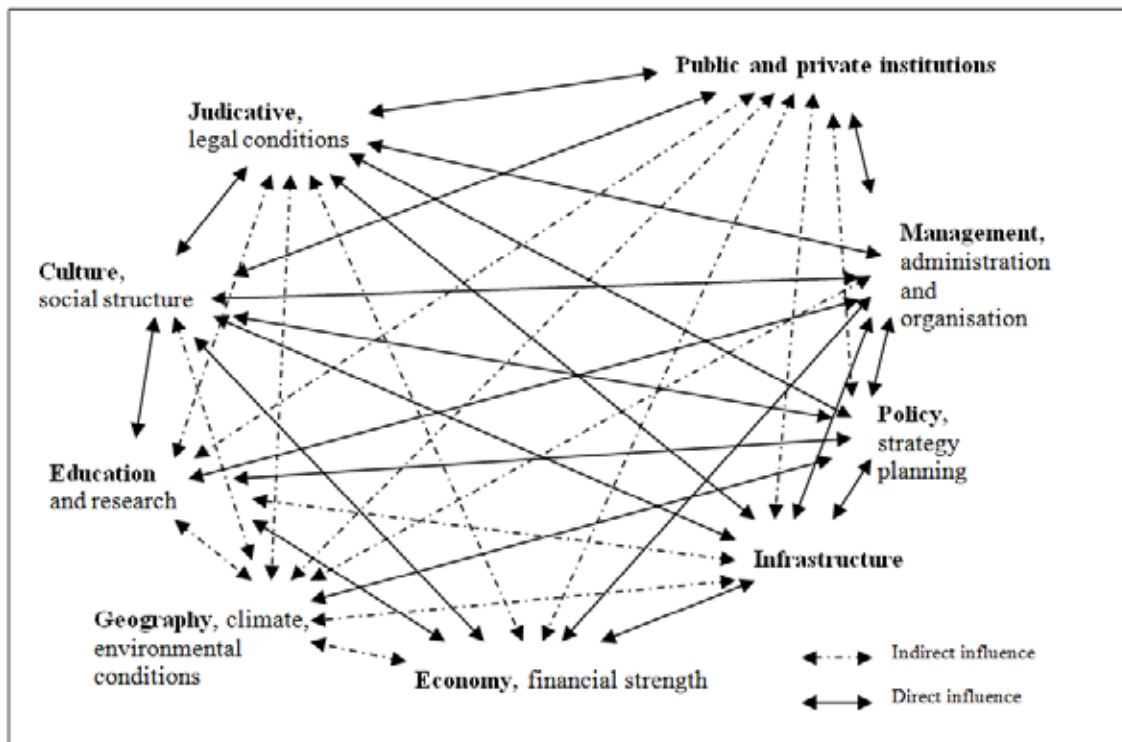
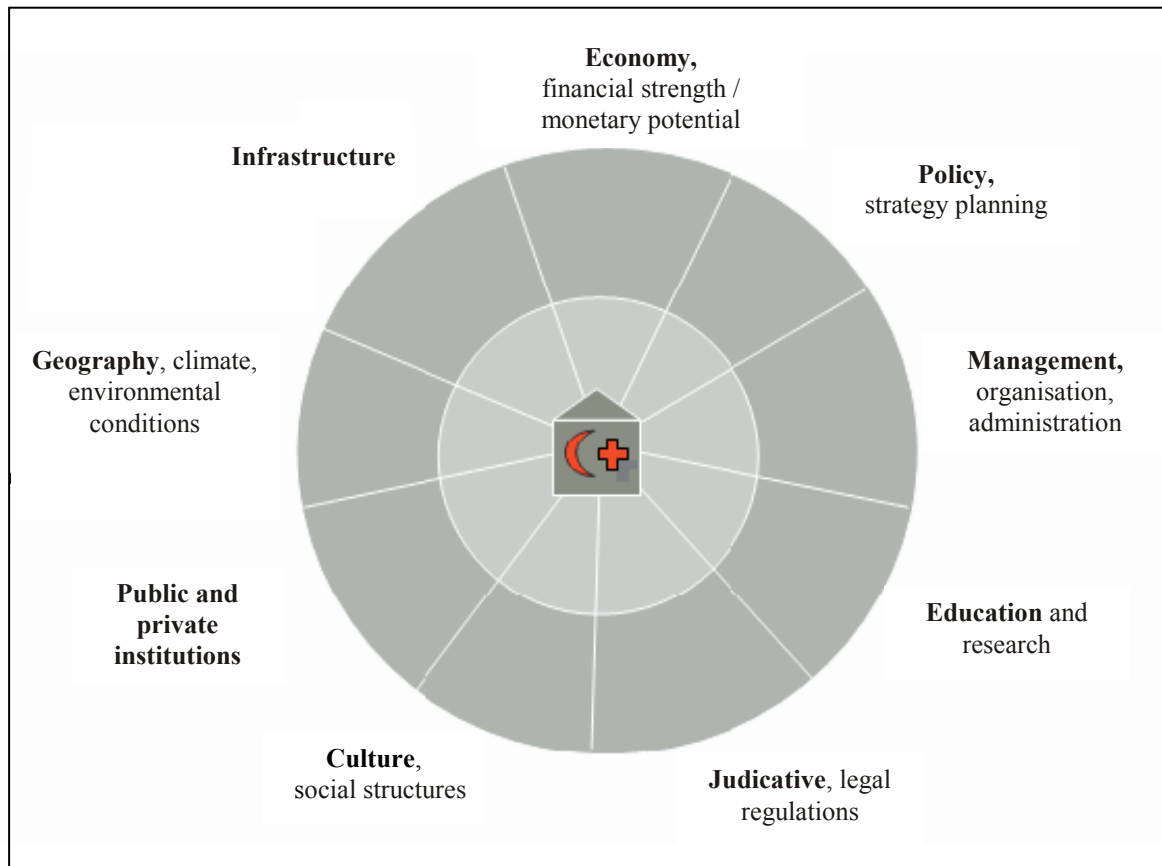


Figure 6: Parameter of influence model (Banedj-Schafii, 2010)

In this way, nine main parameters management, economy, politics, culture, judicative, education, public and private institutions, infrastructure and geography were compared in the first step. “The parameter of influence model” describes the relationship between the main parameters and defines the direct and indirect influences between them (see figure 6).

<sup>1</sup> The assessment depends on the viewer und can fluctuate with country and perception

In the next step the “matrix model” and the “share model” were developed. Both models compare the nine defined main parameters. While the matrix model works with digits, the share model reflects the relation between the parameters.



*Figure 7: The share model (Banedj-Schafii, 2010)*

After the development of the different ranking models, the analysis of the parameters started. To weight the single parameters qualitatively and quantitatively indicators were defined and compared. The “indicator analysis” is mostly based on OECD and WHO indicators. So for all nine main parameters indicators were defined for the macro level (country and health sector) and the micro level (hospital and department), as can be seen in Table 1.

Another approach to acquire detailed information is the expert analysis. The advantage of this method is its low time consumption and that the results are based on expert’s opinions that have many years of experience in the specific working field.

<i>Indicators of the macro level:</i>	
<i>Country</i>	<i>Health sector</i>
<ul style="list-style-type: none"> <li>• GDP (per capita) in US \$</li> </ul>	<ul style="list-style-type: none"> <li>• Portion of the expenditures for health of GPD in %</li> </ul>
<ul style="list-style-type: none"> <li>• Economic growth to sectors (real, %)</li> </ul>	<ul style="list-style-type: none"> <li>• Per capita government expenditure on health at average exchange rate US \$</li> </ul>
<ul style="list-style-type: none"> <li>• GDP – emergence (%)</li> </ul>	<ul style="list-style-type: none"> <li>• Expenditures for medicine (per capita) US \$</li> </ul>
<ul style="list-style-type: none"> <li>• Unemployment rate (%)</li> </ul>	<ul style="list-style-type: none"> <li>• Cost structure of ambulant health facilities</li> </ul>
<ul style="list-style-type: none"> <li>• Inflation rate (%)</li> </ul>	<ul style="list-style-type: none"> <li>• Expenditure for rehabilitation</li> </ul>
<ul style="list-style-type: none"> <li>• Foreign depts. (Bil. US \$)</li> </ul>	<ul style="list-style-type: none"> <li>• Total expenditure for health in US \$ per capita</li> </ul>
<ul style="list-style-type: none"> <li>• Export/ import</li> </ul>	
<ul style="list-style-type: none"> <li>• Currency, monetary value</li> </ul>	
<i>Indicators of the micro level:</i>	
<i>Hospital</i>	<i>Department (e.g. medical equipment)</i>
<ul style="list-style-type: none"> <li>• Costs of the hospitals according to cost type and hospital size range</li> </ul>	<ul style="list-style-type: none"> <li>• Expenditure of material, personnel, training</li> </ul>
<ul style="list-style-type: none"> <li>• DRG-case-based lump sum, revenues and benefits</li> </ul>	<ul style="list-style-type: none"> <li>• Budget of the department</li> </ul>
<ul style="list-style-type: none"> <li>• Income</li> </ul>	<ul style="list-style-type: none"> <li>• Budget for maintenance/ repair</li> <li>• Budget of purchase</li> </ul>

*Table 1: The indicators for the economy parameters (Banedj-Schafii, 2010)*

### 3.3 The transferability method

After having the different models and parameter and indicator analysis a final result should be achieved. Each ranking of the models (parameter of influence model, share model and expert analysis) is compared with the others, so that a final ranking can take place. This assessment serves as a guide or a "trend barometer". The level of the ranking indicates the degree of importance. It gives a direction which parameters should be considered for the successful transferability of a FM-system. Table 2 shows the result of the transferability method used for the FM of hospitals between Germany and Iran.

<i>Rank</i>	<b>Transferability parameters</b>		
<i>high</i>	Management	Economy	Politics
<i>middle</i>	Culture	Judicative	Education
<i>low</i>	Infrastructure	Public and Private institutions	Geography

*Table 2: Result of the transferability method (Banedj-Schafii, 2010)*

It must be considered that the systems are dynamic and especially the expert analysis carries the risk to have a subjective opinion which may not reflect the real situation.

## 4. The practical application of the theory

### 4.1 Post graduated training courses

Concurrent to the research work, the World Bank project "Facility Management and Healthcare Management" was implemented at the University of Karlsruhe (TH) in 2004 and 2005. This post graduated trainee course was designed for 250 high-ranked employees of the Iranian Ministry of Health and Medical Education (MOHME). Beside the content of the different lectures which were held in these courses, the acceptance, the handling and transfer of the participants helped to understand transferability of new ideas and systems.



*Figure 8: The world bank project 2004/05 (University of Karlsruhe, 2005)*

### 4.2 The Master Course FM and the FM-Competence Centre in Iran

In 2009 the cooperation project "FM for health objects" supported by German Academic Exchange Service (DAAD) started. The development of the Master course FM should take place in three steps. Additionally, a German-Iranian Competence Center should be founded that should support the knowledge exchange and information transfer between universities, research centers, public authorities and the economy (industry, service suppliers, ..) within the country and across the borders.

The start is done, the implementation is in action, the field is very stony but the first offsprings are growing and will hopefully develop to a strong and fertile plant.

## References

Banedj-Schafii, M. (2010): *System transferability of public hospital facilities management between Germany and Iran*, KIT Scientific Publishing, Karlsruhe 2010

Lennerts, K., Abel, J. and Pfründer, U. (2002a): *Hospital Facilities Management – the OPIK research project*, IFMA, World Work Place Congress, Paris, France, July 2002

Lennerts, K., Abel, J. and Pfründer, U. (2002b): *Optimisation and Analysis of processes in hospitals (OPIK) – a research project* May 2002, IFHE, Bergen, Norway

Matthies Michael Prof. Dr., *Einführung in die Systemwissenschaft*, WS 2002/2003, Studiengang Angewandte, Systemwissenschaft an der Universität Osnabrück, S.2



# The Influence of Iranian Culture on the Attitude towards Built Asset Maintenance

**Keith Jones**

University of Greenwich, United Kingdom  
k.g.jones@gre.ac.uk

**Maryamalsadat Kiaie**

mary\_kia2002@yahoo.com

## Abstract

Tehran, the largest city in the Middle East, has a population of more than 13 million people; and attracts large migration from all around Iran which places an additional burden on the city's housing and infrastructure stock. According to the Parliament Energy Department, over 75% of the buildings in Tehran were built by private developers; at the same time about 66% of total energy consumption is attributable to the residential sector. It has become evident that in the 21st century, with a growing importance of cities, it is essential to maintain the existing and new housing stock in a sustainable manner that takes into account not only the economic performance but also the environment and quality of life of residents. This paper examines the attitudes towards building maintenance in Tehran's privately owned housing sector from a social, cultural, economical and regulatory perspective. The paper reports the findings from 24 in-depth interviews with building regulators, architects, engineers, construction companies and government ministers in relation to their maintenance strategies, policy criteria, likely innovation and other aspects which influence building performance and maintenance.

What was noticed was that those responsible for Tehran's residential stock presently lack a comprehensive design and maintenance culture; which in turn has resulted in an ad-hoc approach to the design and maintenance of housing, which is unsupported by regulation and where it is preferable to demolish and rebuild rather than maintain and refurbish. This view is counter to that held in most Western countries and must bring into question how sustainable Tehran is as a world city. The paper concludes that, if Tehran to improve the sustainability, including environmental performance of its housing, the gap between people's cultural beliefs and attitudes towards housing maintenance and refurbishment must be understood and addressed.

The implications of this work are to gain an insight into the role that culture plays in forming attitudes towards housing, and in particular maintenance and refurbishment and to use this knowledge to better understand how sustainability, in its broadest terms, can be better integrated into housing maintenance and refurbishment thinking. This in turn will help Tehran residents and building professionals address the challenges that Tehran faces in the 21<sup>st</sup> century.

**Keywords:** Maintenance, Residential, Culture, Sustainability, Obsolescence

## 1. Introduction

Tehran is the capital of Iran and the biggest city in the Middle East region. Being the capital of the country it has been the site of industrial and the economic development. The development has drawn a large number of immigrants to the city. They come to the city to benefit from economic prosperity. The present population of the city is 13 million and it is constantly growing. The large number of immigrants has placed increased pressure on the residential spaces in the city. The residential sector has been influenced by globalization (in the economy) and Western culture, which is widely seen in the construction of the buildings. The influence of the Western culture started in the early part of the 19<sup>th</sup> century with the conquests of the British and the Russian army. The result was the confluence of modern and traditional practices; the merchant class were the group who advocated the use of traditional practices. The newer generation championed the need for modernisation to support the development of the economy. Both the groups formed the ruling class in Iranian society.

The topology of Tehran changed in two phases - 1860s under the rein of Naseer-Al-Din Shah and during 1930s under Reza Shah. During the first phase, the walls of the city were demolished and the area of the city was increased. New walls were built around it. During the second phase the walls were completely demolished which improved transportation within and around the city. In the case of the first phase, the traditional values were observed when new buildings were constructed besides the older ones but there was no attempt made to refurbish the older ones – they remained as they were. In the second phase, the old buildings were destroyed and the modernization process started. Madanipour, (2003) noted that the rise of the modernity was due to the influence of Western cultures in the country. One may argue that this view may not be right since most Western cultures follow rigorous urban planning regulations and these were not seen in Tehran.

The modernisation process that started in Tehran drew people from the countryside into the city in search of a better life; as a result the demand for residential stock increased. Developers responded by constructing high rise buildings in place of the old buildings. They paid little attention to the fact that the infrastructure of the city could not support the construction of these high rise blocks. Most of the buildings that were demolished had not reached the end of their operating lives and some were demolished simply because they were in poor decorative order.

As Tehran faces the latest challenge, that of becoming more sustainable, the attitudes of the past may influence the approach that the current generation take to its development. This paper will examine issues associated with building professionals' attitudes in Tehran and the degree to which building legislation needs to be put in place support a more sustainable future. The paper will also examine attitudes to maintenance in the residential development sector and people's reaction and behaviour towards sustainable building technologies imported from the West.



## 2. Building Construction and Usage Stage

Reducing energy consumption has been one of the key challenges facing the construction industry. Therefore it is the duty of engineers and architects to make buildings viable in terms of energy conservation. Although technology can help reduce energy consumption in the construction phase, it is important for engineers and architects to take into account the future maintenance of the building and the encompass sustainable technologies at the design stage that support sustainable operation over the building life cycle. In the UK, it has been argued that the inclusion of renewable energy technologies has been stimulated by rebates from the climate change levy and lower CO<sub>2</sub> targets (Ekins & Etheridge, 2005). One question for this project is whether the existence of similar legislation could provide the same type of stimulus in Tehran.

In Tehran over 75% of the buildings were built by private developers; at the same time about 66% of total energy consumption is attributable to the residential sector according to the 2008 Iranian Parliament Energy Department. It has been argued by Aune, Berker, and Bye (2008) that the use of the electricity in cooling, heating and vertical transit (lift) systems consumes large amounts of energy, especially when there are large numbers of people in the building. Therefore it is important that these systems perform as efficiently as possible. This requires regular inspection and maintenance to ensure that they continue to operate and do not suffer from premature failure. Unfortunately, such an inspection and maintenance regime is often lacking in Tehran and systems fail prematurely. Once the systems have failed, the preferred solution in Tehran is to demolish the building and rebuild it. However, the demolition of buildings is not an acceptable practice for Governments in light of the sustainable agenda because demolition of buildings brings hazards to the environment and is waste of raw material.

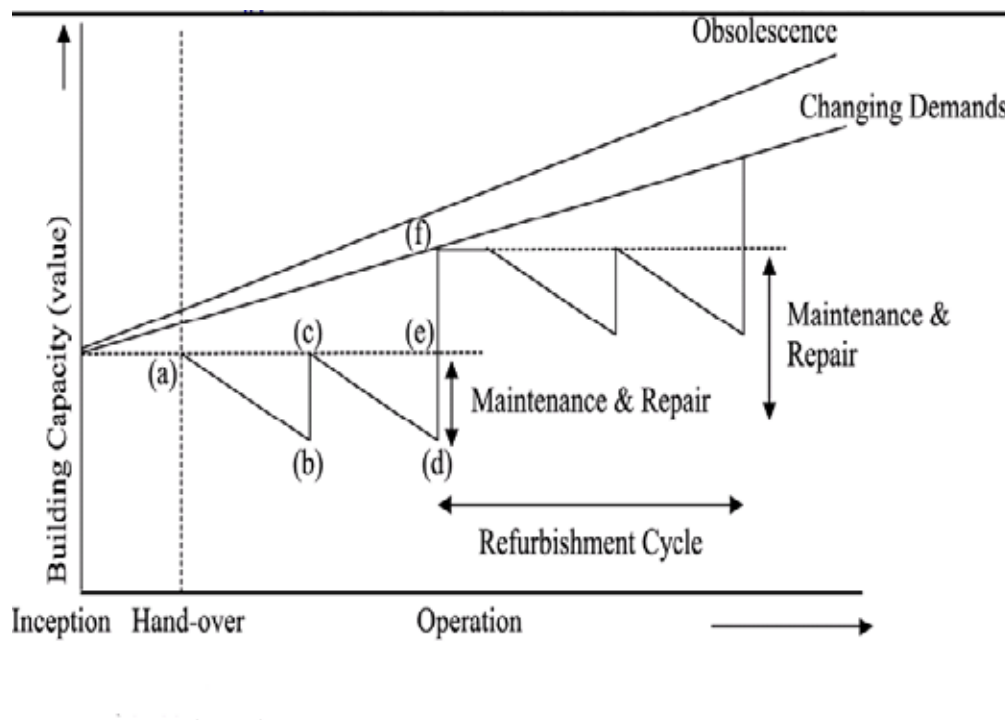
### 2.1 Maintenance

Traditionally built environment maintenance (Dann, 1999, Umeadi and Jones, 2003) is a capital cost driven activity which relies upon the subjective assessment of an asset's condition (stock conditions survey) to identify maintenance need. Jones et al. (2010) stated that in order to avoid problems and issues related to economic, environmental and social aspects of any development, infrastructures and buildings need to be designed and kept unimpaired to minimise any obsolescence. Technologies deployed need to be monitored maintained and kept in appropriate condition. Therefore maintenance strategies need to be considered at the design stage, and the maintenance information, upgrades and monitoring for the life-cycle of the built asset need to be considered.

Cigolini et al (2008) wrote that any development cannot be sustainable as long as the three parameters of sustainability are not accounted for throughout the life cycle. According to Finch, (1996) the role of maintenance is to render the property back to its prior condition where it can fulfil basic function and is within legislative compliance. Finch further argued that one role of facilities management is to address the constantly increasing gap between existing property condition and future demands, which is directly related to constant technological advancement;

user demands; and market forces. Jones (2002) re-interpreted Finch's obsolescence model to one in which repeated maintenance cycles (a to d) occur until the point at which a building fails to satisfy the occupier's demands and a major refurbishment is required (Figure 1). Even after refurbishment some residual obsolescence remains and this grows over repeated refurbishment cycles until the obsolescence gap is too great for an organisation to bear. At this point the organisation either re-locates; the building is demolished and re-built; or the building is refurbished beyond its original purpose and a change of use occurs (Jones 2002).

A similar model does not appear to apply in Tehran, where buildings are constructed without considering the role of maintenance and refurbishment within the building life cycle, and reliance on replacement or redevelopment results in a throw-away approach to buildings. Such an approach would appear unsustainable, resulting in not only socio-economic problems but also adverse environmental impacts (waste). These problems and issues sooner or later lead to financial costs and consequently stress the economy. To avoid such problems and issues it is desirable that maintenance and refurbishment are introduced into the life cycle of a development at the outset (the design stage). The question is how can this be achieved when there is no maintenance culture within society or the built environment industry?



**Figure 1: Model of the Maintenance Refurbishment Life Cycle (Source Jones (2002))**

The issue of obsolescence, and the challenge that this poses to facilities managers should not be underestimated. From a building systems perspective, Thompson (1994) states that the building services engineer has to have a regard of capital costs, plant reliability, operational economies,

and maintenance, as the building operator will be interested in the lifetime costs of the building and not just initial purchase and installation. From a building fabric perspective Wood (2003) states that if buildings are demolished prematurely, then the cost of the buildings goes to waste and the capital cost is not recovered. Further, Zavadskas, Bezder, and Kaklauskas, (1998) wrote that the waste material generated by demolition is dumped into the environment which increase pollution as they are not recyclable.

Beggs, Moodley & Thomson (1994), states that the main aim of the facility manager is to increase the value and comfort factor of a property and that facility manager's are responsible for 85% of the costs associated with the life cycle of any built asset. Jones (2002) suggested that facilities management goes beyond merely the consideration of building technology issues, to one that acknowledges the impact of the built asset on the long-term viability of an organisation. In essence, Jones argued that "value" should be explicitly linked to the ability of the built asset to support user/occupier performance expectations and built asset maintenance viewed as a strategic issue managed within the broader context of an urban strategic planning framework. What was noticed was that those responsible for Tehran's residential stock presently lack a comprehensive design and maintenance culture; which in turn has resulted in an ad-hoc approach to the design and maintenance of housing, which is unsupported by regulation and where it is preferable to demolish and rebuild rather than maintain and refurbish. Thus the final question being investigated in this project is whether the role of facilities manager (currently not recognised in Tehran) is critical to the development of a whole life built asset management culture?

### 3. Methodology

The primary methodology used in this research is that of a semi structured interview with key built environment stakeholders. Twenty four (24) interviews were conducted with representatives from a regulatory and construction industry background including architects, engineers, construction companies and government ministers. The issues covered during the interviews included: maintenance strategies; policy criteria; the role of innovative technology; and any other aspect that the interviewee wanted to talk about that influence their building performance and maintenance decisions.

The questions covered the following subject areas:

- Maintenance strategies, frequency of maintenance and the use of existing manuals on the upkeep of buildings;
- Maintenance plans for historical buildings;
- Building management systems and rules and regulation;
- Creativity and innovation in the choice of materials, design, construction and maintenance of buildings and motivations for using innovative solutions;
- Attitudes towards maintenance;
- Perceptions of building life span, time to demolition and replacement;
- Sustainability issues including economic, environmental and social issues;

- Any problems encountered when designing and constructing buildings.

The response to the interviews are summarised and discussed below.

## 4. Results

In response to maintenance strategies and frequency of maintenance action it was clearly stated that although the role of facility managers in building maintenance is well known in the Western World, similar positions do not generally exist in Tehran. In contrast, in Tehran, there has been little regard paid to building performance/maintenance and the need to preserve quality architectural buildings. Instead the dominant trend is to demolish and rebuild rather than refurbish and preserve. Further, it is clear from the interviews that there are no proper systems or rules (regulations) in relation to building maintenance and refurbishment in Iran. Indeed, what was further evident was that the Iranian Government does not look into the detailed aspects of the construction of buildings (beyond that required to for lift installation) and as such there has been no control on, for example, electricity and the water consumption. Further, even where rules and regulations have been introduced very few people seem to care about obeying them. The lack of 'second hand' building market (for example no mortgages are given for the buildings which are over 10 years old) or system to allow properties to be passed from one generation to the next, coupled with the lack of buildings insurance reduces the incentive to refurbish buildings and instead it has become the norm for building owners to demolish old buildings and construct a new one.

What came across from most respondents was the view that the Iranian construction industry lacks a professional structure, with in many cases building quality not properly monitored during construction and maintenance issues not really considered. Thus architects are not motivated to produce quality designs as only cost and time (quick turnaround) are the key drivers of the construction process. This focus has also affected the level of innovation adopted by the Iranian construction industry; with architects selecting known (safe) solutions over innovative ideas. Most interviewees attributed the lack of interest on design and construction quality to a move to a semi skilled workforce as a result of increased wages paid to skilled workers. One example cited by interviewees of this lack of focus is the way buildings address Tehran's climatic conditions. The building facade receives the least attention due to lack of regulation regarding visual aspect of the Tehran's buildings and it has become common that many newly built residential complexes are constructed with chillers and centralised cooling system without proper maintenance strategies in place. As such these buildings perform poorly and Tehran residents have lost confidence in both the design and construction process. This disregard for construction professionals' in Iran has led to poor relationship within the industry and a lack of cooperation between architects and engineers through design, construction and post construct phase – where maintenance is largely ignored and a demolish/replace mentality exists. Twenty out of the twenty-four interviewees believed that Iranian culture plays an important role in people's attitude towards maintenance. However, the other 4 interviewees,

whilst acknowledging the issue of culture, believed that Iranian society can learn from Arabic Countries such as UAE which have adapted to use all the technology imported from west.

There were mixed views as to the impact that the rise in migration from other towns and cities into Tehran, and the associated increase in demand for rented accommodation. On the negative side, most of the 2 to 3 storey buildings have being demolished and replaced with 8 storey or higher buildings without fully considering the implications to the city infrastructure. Most of the buildings that are being demolished are less than 20 years old and are still functional as working homes. On the positive side, since 1951 (in Tehran), 75% of new buildings are constructed by the private sector and financed through income from oil exportation. Investment in the construction industry became popular among wealthy people as there were few other investment opportunities open to them. Thus the construction sector is economically buoyant; central to Iranian industrialisation; and seen as a solution to the ever growing demands for residential accommodations. As a result Tehran's residential stock presently lack a comprehensive design and maintenance culture; which in turn has resulted in an ad-hoc approach to the design and maintenance of housing and is unsupported by regulation. It could be argued that some sectors of the Iranian media have begun to question the practice of demolishing old houses and replacing them with new apartment complexes. There have been TV series and movies that have considered the cultural consequences that such an approach may bring; a potential severing of the links between people, architecture (buildings) and their past and in turn people's attitudes toward their history and belongings.

Finally, although there have been debates about environmental issues in Iran in the past 2 years, culturally the consequences of environmental sustainability are not widely accepted as an issue by either the general public or built environment professionals. In order to raise attention to the issues, governmental organisations have been conducting research and have recommended the application of sustainable technologies to government and some residential buildings. However, the impact that such technologies have is undermined by the lack of education/training that occupier's of the buildings have received in their importance and use.

## 5. Discussion

Arditi and Nawakorawit (1999) argued that a growing recognition amongst building owners of the need to plan and manage their maintenance alongside other corporate assets requires building managers to effectively communicate with building users and consider their concerns (alongside physical condition) when developing maintenance programmes. Such an approach would not only improve the performance of the built asset in Tehran but, would also influence stakeholders and 'add value' to the City of Tehran. However, the interview findings underline the fact that the society (in general) and the economic and political climate in the country has contributed to the lack of a building maintenance sector and if such a sector is to be developed then major changes in attitudes towards buildings needs to take place in all levels of Iranian society.

It is widely cited in Hirsch (1997) that heredity, influenced by an individual's ancestry and environment, influence their attitude and behaviour. In the case of Tehran inhabitants; these genetically influenced factors (the traits that are present in the ancestors of replacing old with new) manifest themselves through the willingness to accept the demolition of existing buildings and their replacement with new ones irrespective of their state of obsolescence (many are still performing well) or regard to the environment. A study by Altshuler and Gusella (2009) found that behaviour that repeats for 10 generations becomes part of a person's genetic makeup. If this is indeed true, then it is unlikely that user lead demands will underpin the development of a building maintenance sector. Instead other drivers will need to be used.

Given the lack of user demand for maintenance and refurbishment of buildings, government could enact legislation to force the construction sector to adopt new rules and regulations. However, bringing in new rules and regulations may not be the answer in the case of Iran. According to Hirsch, (1997); Latour et al (1994) people obey rules that are socially constructed; social control theory also proposes that people's relationship, commitment, values, norms and beliefs encourage them not to break the law. So designing rules for maintenance and refurbishment (e.g. a form of planning legislation) without considering the social and cultural issues of the population would be meaningless as compliance levels would very likely be low. In support of this view Myrdal (1958) wrote that the development vicious cycle suggests that no economical development is successful without cultural development. Therefore, more effort could be put into developing social and cultural behavior in parallel with economical development and the rules/regulations required to support a maintenance and refurbishment culture.

Finally, the concept of building obsolescence is largely lacking in the Iranian culture. Whilst faulty designs and poor construction leads to poorly performing buildings, this, combined with a buoyant economic market simply reinforces the view that demolish and rebuild is preferable to maintain and refurbish. This issue needs to be addressed, not least amongst built environment professionals, who need to understand the role of maintenance and refurbishment, both as a practical means of extending the building life cycle and also as a way of protecting Iran's built environment heritage.

## 6. Conclusions

What was evident from this study is that the construction sector is economically buoyant in Tehran; however, it also revealed that Tehran lacks a maintenance industry, in that the culture doesn't support the idea of maintenance. This study argued that concerted action is needed from government and the professions to change the situation. For example, given the lack of user demand for maintenance and refurbishment of buildings, government could enact legislation to force the construction sector to adopt new rules and regulations for the operation of buildings that are socially constructed and support the idea of value, rather than cost. If this was enacted then building owners would be encouraged to view built asset maintenance as a strategic issue managed within the broader context of Tehran's strategic planning framework.

Whilst legislation could go some way to addressing Tehran's knock down and rebuild culture, attitudes of built environment professionals, including investors, must also change. Design needs to reflect a more 'value' focused approach in which whole life cycle issues are considered at the design stage and maintenance and refurbishment options are included as the norm. Such a change would support a move away from a short term investment driven model of development to a more sustainable view which encompasses social and environmental issues. In addressing this more sustainable view, building designs should be innovative and people should be made aware of the implications and hazards to the environment of replacing existing buildings with completely new one.

Finally, if legislation and changes in design philosophy are to have any impact in practice then the role of facility management, both in informing design and enacting maintenance, needs to be encouraged. At present the role of facilities manager does not exist in Tehran and this gap needs to be filled.

## References

- Altshuler, D., Gusella J., Kucherlapati, R., & Seidman, S. (2009) 'Human Genetics' Harvard University
- Arditi, D., Nawakorawit, M. (1999) 'Issues in Building Maintenance: Property Managers Perspective' J. Arch. Engrg. Volume 5, Issue 4, pp. 117-132
- Aune, M., Berker, T. & Bye, R (2008). "The missing link which was already there." *Facilities*, Volume 27 Number 1/2, pp.44-55
- Beggs, C & K. Moodley, (1997). "Facilities management for passively constructed buildings." *Facilities*, Volume 15, Number 9/10, pp. 233-240
- Cigolini, R., Fedele, L. Garetti, M. & M. Macchi (2008). "Recent advances in maintenance and facility management." *Production planning and control*. Volume 19 No. 4, pp.279-286
- Dann, N. Worthing, D. & Bond, S. (1999) Conservation maintenance management Establishing a research agenda; *Structural Survey*. volume 17 No 3, UK.
- Ekins P, & Etheridge B (2006) "The Environmental and Economic Impacts of the UK Climate change Agreements." *Energy Policy* 34: 2071-2086.
- Finch, E. (1996), in Alexander K. (Eds), *Facilities Management: Theory & Practice*, E&FN Spon, London, pp.51-6
- Hirsch, J. (1997). Some history of heredity-vs-environment, genetic inferiority at Harvard(?), and *The (incredible) Bell Curve*. *Genetica*, Volume 99, pp. 207-224

Hutcheson, J. (1994). "The life cycle economics of buildings." *Facilities*, Volume 12 Number 5, pp.11-15

Jones, K. (2002) *Best value in Construction*, Kelly, Moreledge, Wikinson (ed), Blackwell Publishing, ISBN 9 780632 056118.

Jones, K., Butt, T.E, (2010) 'Challenges to Sustainable Developments, How Facility Managers can apply Intelligent Monitoring to Maintenance' ministry of petroleum, *National Iranian oil company (NIOC) Technology Year Book*

Latour, B., Mauguin, P. & Teil, G. (1994). "A note on socio technical graphs." *Social studies of Science*. Volume 22, pp.33-58.

Madanipour, A. (2003). "Modernization and everyday life: Urban and Rural change in Iran." In, A. Madanipour, *Iran encountering globalization: problems and prospects*, London: Routledge

Myrdal, G. (1958) *Value in Social Theory*, Routledge and Kegan Paul

Thompson, P. (1994). "The maintenance factor in facilities management." *Facilities*, Volume 12, number 6, pp.13-16.

Umeadi, B & Jones, K. G (2003) *From Condition to Performance Assessment of Built Components: Proceedings of the RICS Foundation Construction and Building Research Conference*, ISBN 1-84219-148-9.

Wood, B. (2003). "Approaching the care free building." *Facilities*, Volume 21, Number ¾, pp.74-79

Yik, F, Lee, W and C. Ng. (2002). "Building energy efficiency and the remuneration of operation and maintenance personnel.", *Facilities*, Volume 12, Number 13/14, pp.406-413.

Zavadskas, E., Bezder, E. & Kaklauskas, A. (1998). "Raising the efficiency of the building lifetime with special emphasis on maintenance.", *Facilities*, Volume 16, Number 11, pp.334-340



## Risk, culture, and implementing environmental health in facilities management

**Renato Rocha Lieber**

UNESP – University Estadual Paulista, Brazil.

[lieber@feg.unesp.br](mailto:lieber@feg.unesp.br)

### Abstract

The purpose of this paper is to show how the risk concept in Environmental Health (EH) can be applied in Facilities Management (FM). The data presented are based on several critical incidents that took place in different buildings in southeastern Brazil which, whether directly or indirectly, posed threats to people's lives. The discussion focused on the Brazilian cultural context, on the perceptions of uncertainty or risk, and on the proposed solutions. To undertake this analysis, buildings were understood as micro-territories, or “places” as with EH. Buildings are subject to contingencies similar to those studied in EH. In FM, as in EH, the uncertainties derived from the contingencies in the population's health conditions and in the material and social conditions to control them, imply establishing risk relationships. Although the perception of risk may be a personal attribution resulting from many factors, both accepting or rejecting the uncertainties and the control proposals are based on shared culture, values, and priorities. Preferences and feelings, resulting from values, are aspects to be included in the risk analyses. Ignoring these subjective aspects encourages false guarantees of control. The current intense competitive conditions and resource use optimization not only worsen the known uncertainties but also drive unknown ones. The results show how the authoritarian and paternalistic relations, which result from the Brazilian culture, endanger people's health and provide precarious solutions. It is proposed that the adoption of health promotion programs in buildings, as recommended in EH, can enable more democratic relations. The conclusion is that disasters and their consequences can be minimized through precaution, by empowering people, and by means of solutions that are more compatible with the culture in transformation.

**Keywords:** Health Promotion, Crisis, Brazil, Shopping Mall, Call Center

*“First we shape our buildings, then they shape us”*

(Winston Churchill, about the destruction of the Houses of Parliament, 1943)

## 1. Introduction

Legal requirements make health and safety one of the highlights of Facility Management (FM). As is the case with security, health and safety control involves different circumstances, not all of which under control, and, thus, activities treated as objects of risk (Booty, 2009). However, what is expected of FM goes far beyond merely meeting the requirements of the laws and standards in operating buildings under conditions of uncertainty. Rather, as a support process, FM should, first and foremost, improve business competitiveness, providing primary activities with more efficiency and effectiveness. The process of economic globalization has been offering a wide spectrum of opportunities for that, but has also fueled several challenges in the service sector (Lam, 2001). The need to introduce innovations into resources and processes, bringing about new risks to operations, is associated to meeting specific cultural particularities, shared among individuals who live and work in the managed spaces. What some consider solutions, many deem as issues.

The purpose of this paper is to show that health and safety issues in FM are also environmental health problems. Environmental health, as a part of public health, has its own ways of addressing the issues. Its most recent proposals for understanding and configuring solutions also take the cultural context into account. This paper reviews the theory in order to go deeper into the problem. It then discusses a few air quality-related cases collected from different buildings in southeastern Brazil. The findings are discussed from the perspective of the Brazilian culture.

## 2. Theoretical issues

### 2.1 Risk

Facilities management (FM) involves different activities associated to non-core services. Requiring professional services of different natures for different purposes, FM requires multidisciplinary knowledge, a fact that renders it more difficult to determine its nature and attributions with precision (Tay & Ooi, 2001). In a recent review, De Toni & Nonino (2009) list at least 10 service objects in 8 management practices to describe the purposes of FM. These activities are often concurrent requirements. Barrett & Baldry (2003) suggest that FM can be understood based on its function analysis and divide it into strategic, tactical, and operational functions. While the former two operate on the management level, the operational function takes place in the routines and involve the execution of several activities. However, FM involves cost reduction and service quality improvement-related commitments in which the most diverse resources are used by people in a given place (Chotipanich, 2004). These circumstantial conditions lead to uncertainty regarding performance or even the attainment of goals and require strategic treatment (Nutt, 2000). Uncertainties reflect the condition of risk that is inherent to operation complexity and must be managed. Risk management and crisis

management (Alexander, 1992; Finch, 1992; and Barton & Hardigree, 1995), link these two FM levels and enable competitive capacity in supposedly acceptable conditions.

## 2.2 Emerging demands

FM demands have grown rapidly in recent decades, resulting not only from the number of projects to be managed, but also from the new forms of configuration these undertakings require. New patterns of demand have long been being introduced in the EU, showing the relevance of ethical, social, and moral considerations in management, particularly with regard to health and safety conditions in buildings (Facilities, 2001). Changes in the productive base, ecological demands and the urbanization of the populations have contributed to new proposals in property developments, including in developing countries. Conveniently located spaces abandoned by industrial occupation, for example, have become attractive to housing and services, not only because they save travel time and fuel, but also because they reduce environmental emissions (Winston, 2007). However, vertical or horizontal mixed-use developments, in addition to social problems, also bring about many new public health issues. Shared spaces lead to conflicts and subject people of different degrees of vulnerability to live together (Rowley, 1996; Grant, 2004, Hunt, 2008). FM, therefore, can not only protect people from diseases, but also foster healthier environments for them (Younger et al., 2008).

## 2.3 Building and health problems

Public health issues, associated with space configuration, have been a reason for concern among governmental and non-governmental organizations and have been encouraging review work such as that of Butterworth (2000), in Australia, and of Lavin et al. (2006), in Ireland. In FM, the problem has been addressed more specifically, such as by Brown (1994), who stressed the importance of environmental audits to verify legal compliance and adjustments relating to health and safety in buildings. Air quality remains the primary object of study. According to Veitch (2008), 40% of the papers of a recent seminar dealt with this topic. However, growing consideration has been given to secondary and indirect sources, such as furniture and textile products in the built environment (Cieslak, 2006). Emphasis is more often placed on worker health and safety. Fernandez (1995) showed the importance of ergonomics in the workplace, while McLennan & Bennetts (2003) studied the forms of personal transport to work in the UK and its implications for the workers' well-being. Diseases resulting from sharing environments started getting attention from FM with the emergence of the Sick Building Syndrome as of the 1990s, in work done by Tong & Leaman (1993), Rooley (1997), and Ilozor et al. (2001), among others. More recently, the issue again became a concern for FM with the outbreak of Severe Acute Respiratory Syndrome (SARS) in 2003, in China (PRC), with worldwide contamination from a doctor who was staying at a hotel in Hong Kong. The fact spurred criticism and cooperation, for example, in devising building ventilation approaches (Baldwin, 2005). In more recent work done in that city, Chan et al. (2008) related indoor environmental quality to the health conditions of housing project residents, and researched not only air quality, but also thermal, lighting, and noise comfort and even went as far as figuring subjective perceptions into the equation as well. Therefore, a broader understanding of the relationship between health and

environmental conditions is being attained, rounding up a larger amount of risk factors, as has already been being shown for hospital environments (Tarcan et al., 2004, and Codinhoto et al., 2009) and buildings in general (Veitch 2008a). However, the full understanding of the relationship between built spaces and their occupants' health conditions remains a challenge. Veitch (2008), summarizing the 1<sup>st</sup> Canadian Building and Health Sciences Workshop of Canada, concluded that:

*“There are few, if any, fully integrated models that reveal how building systems create interior conditions and how, in turn, those interior conditions influence health.”*

## 2.4 Culture as intervenient factor

Health and well being are also related to how people perceive, understand, and appraise their life experiences. Symbols and meanings are shared in the culture and set a unique vision of the world (Eckersley, 2001). Several studies have emphasized the importance of culture for different aspects of FM. Davies & Walters (1998) show the importance of the organizational culture in treating risks that can affect disaster recovery in situations of crisis. Leaman (2002) notes that the perception of the risks and hazards, as a cultural phenomenon, results from collective, geographically circumscribed life and death experiences. Based on different experiences in buildings in the EU, he also highlights the role culture plays in shaping the users' expectations:

*“Habits, needs and preferences are to some extent culturally dependent. They are affected by attitudes to health, safety, risk, and fashion as well as regulations, and organizational and social norms.”*

Therefore, understanding the shared culture in an organization is being treated as a starting point in FM (Sekula, 2004). In buildings, Fleming (2004) highlights that the perception of inappropriateness stems not only from the occupants' previous experiences, but also from the preferential use of the resources. Depending on the culture, problems and their solutions are configured in different ways, as shown by Johnson & Manser (1997) while comparing the French and British civil works management practices. Depending on the cultural context, some problems differ in importance. A few contingency situations perceived as inadequacies in the West, for example, are accepted with greater tolerance in Southeast Asian countries (Chotipanich, 2004, Kamaruzzaman & Zawawi, 2010). Innovations in the forms of work (Pitt & Bennett, 2008) and in the design of the spaces (Brown et al. 2010) should consider the fact that the users' satisfaction and performance hinges on these subjectively-constructed expectations being met.

## 2.5 Social relations and decision-making in uncertainty

Given these aspects, it is clear that the understanding of Tay & Ooi (2001), or *“The role of FM in the organization is to manage the workplace. A performing workplace is the end product of FM,”* is a particular case these days. Although buildings can be designed and built to achieve

purposes, such as, among others, work, the purposes can only be achieved by people, whose needs and expectations may or may not be met by FM with the provision of different resources (Leaman, 1991).

The space and the material resources, including the workplace, only have any meaning at all when the people and their needs are figured into them. As Bathelt & Glückler (2005) note, material resources, knowledge, power and social capital must be understood and valued in relational terms in order for their use to become essentially contingent. Buildings and their resources, while in use, will be the structures for the institutions, delimiting space for the construction of social networks (Gieryn, 2002). Without this social network having been built, or the “*constellation of network relations governed by social actors,*” the primary activities, as a company or firm, cannot perform. (Yeung, 2005).

The design and the project allow people to shape the buildings, but the possible relationships, thanks to their use, shape people, like W. Churchill said, in 1943, on the ruins of the 'Houses of Parliament' (Gieryn, 2002). Because people are immersed in social relations, shaped by the shared culture (Okuno-Fujiwara, 2002), not only does the perception of risks and hazards arise from the culture, but also the forms and preferences of management. A review made by Weber & Hsee (2000) shows that in addition to perception, preferences, judgments and decisions about risk are driven by values too. A study of decision-making processes in major accidents shows that the decisions that were made shape a story according to the shared organizational culture (Vaughan, 1996). Accordingly, executives from different countries make different decisions when faced with conditions of uncertainty or risk (Tse et al. 1988, Hsee & Weber 1999).

Since the work done by Knight (1921), the economic theory has made a clear distinction between two situations of risk. Weak uncertainties are conditions that assume situations that have already been observed in the past will repeat in the future. In this case, the probability calculation applies to configuring the risk. Strong uncertainties are situations for which there is no incident history, or situations that are entirely ignored. Situations such as these do not allow for probability calculations and are becoming more frequent with the use of new technologies. Dealing with situations of this kind involves precaution, and Environmental Health has been changing the risk assessment by introducing the "Precautionary Principle" for health protection (Antó, 2005).

## 2.6 Environmental health, social relations, and space

While the FM approach takes place in the social relationships and in their needs, arising from a limited space, Environmental Health (EH) also addresses the hazards and risks stemming from relationships observed between people and the conditions of their space. To EH, space conditions are not restricted to the living space; rather also include the work and leisure spaces. Likewise, the relationships in the space are not only those related to the use of air, water, and soil which can cause diseases, as is the case with environmental pollution. As in any shared space, there are social relations that drive consensus and foster conflict. Situations of risk or uncertainty can be better understood from this perspective than from the probability calculation

one, as Rayner & Cantor (1987) suggest for the nuclear technology context. For air pollution, for example, Day (2007) shows that it is how the space is designed and its resulting relations that determine the inequalities.

EH acknowledges a broad scope of activities when studying, researching, and proposing measures to protect and promote health. According to the World Health Organization (WHO):

*“Proper environmental management is the key to avoiding the quarter of all preventable illnesses which are directly caused by environmental factors. The environment influences our health in many ways — through exposures to physical, chemical and biological risk factors, and through related changes in our behavior in response to those factors.”* (WHO, 2010)

Under these terms, EH has several other focal points to protect health, ranging beyond the better known ones, such as climate change and indoor and outdoor air pollution. Topics of interest also include occupational health, environmental health in emergencies and impact assessment, water sanitation, chemical safety, electromagnetic fields, ionizing and ultraviolet radiation, and several others, including ways to encourage the strategy for participatory health protection and promotion. (WHO, 2010).

Promoting health assumes that the population's health stems both from specific (prevention) and from nonspecific (promotion) actions. Among the many aspects that define health promotion, the importance of controlling the determinants of health, such as the empowerment of people and communities stand out. By empowerment one should understand how people gain autonomy over the factors that can affect their health, both under individual and collective conditions (Nutbeam, 1998). The concept of Empowerment is associated with the concept of social capital, reflecting the levels of trust and integration in social networks, and enables the reinterpretation of the meaning of spaces and social relations (Hawe & Shiell, 2000). Therefore, ecological perspectives that attempt to highlight the inequities have been proposed, linking different aspects relative to the environment and to the subject (Stokols, 2000). The space goes on to be understood as shared territory, with a history and a location that provides for relationships, cultural identity and that can either compose social life or be configured by it (Paasi, 2002).

For built environments, some have been adopting this approach advocated by WHO. In a recent review, Dumont (2008) identifies at least seven determining factors for health status in buildings: Indoor air quality, Temperature, Lighting, Sound and Vibration, Electromagnetic Fields, Flora and Fauna, Social and Psychological environment. The innovation proposals in the space planning techniques were examined by Pitt & Bennett (2008). The study highlights the importance of employee satisfaction and empowerment, taking the organizational culture into account. Adler (2009) reviews the major U.S. programs aimed at improving school buildings, in which "green features" combine with "high performance." New architectural and operating designs provide better health promotion conditions to students and employees. The results are examples that involve water conservation and energy programs, nontoxic cleaning products, integrated pest management, and healthful cafeteria food, among others.

### 3. Air quality FM - Brazilian cases studies

#### 3.1 Mosquitoes, call center, and crisis

In the early evening of March 26 2008, firefighters and the municipal civil defense were called to respond to an emergency in a building in downtown Rio de Janeiro. Around 100 people crowded the sidewalks. Many of them were coughing, had difficulty breathing, and had watery eyes. A 26-year-old woman had passed out. The building housed a major call center company, employing approximately 2,000 people spread around in seven large rooms working shifts around-the-clock. Firefighters wearing breathing apparatuses evacuated the building. There were more than 400 people working at the site. Fire department vehicles and 6 ambulances were dispatched and took 51 victims to public hospitals, causing turmoil and overcrowding emergency rooms.

A dengue fever outbreak ravaged the city of Rio de Janeiro that summer. That year, 54 people had died of the disease across the state. To control the mosquito (*Aedes aegypti*), the building's tenant had hired an external cleaning service to come to the building and eliminate breeding sites. The company hired to do the job had used a concentrated chlorine (sodium hypochlorite) solution and allowed the product to leak into the air conditioning ducts. The smell was noticed between 6 PM and 7 PM that evening. The 26-year-old attendant passed out on the way to toilet. Several people started evacuating the building; however, the call center supervisor denied permission for the room to be abandoned. Around 8 PM, she herself got ill.

After the victims had been cared for, the shift was suspended and the building was cleared for use. The next day, the morning shift started. Workers again complained of nausea and headaches. A commotion started, and 25 people were treated for symptoms of intoxication. The building was locked down for 24 hours, and the afternoon and evening shifts were also suspended.

The next day, a civil defense official visited the site and detected a strong smell of chlorine. He decided to close the place down for an additional 48 hours. Several services provided by the call center, involving public utilities, a credit card, among others, were dead for more than 80 hours.

#### 3.2 Mosquitoes, luxury shopping, and crisis

The limited amount of public transportation options and the rising living standards in the city of São Paulo have spurred a surge in automobile traffic. As a result, some parts of the city have become impassable and many commercial activities have sought less traditional places, but with better access conditions. Among the several options, preference has been given to freight transport corridors, wide roads that skirt the rivers and contour the city. This has been the case of shopping malls and department stores that focus their activities on luxury consumption. Two events that took place in this region deserve consideration.

As these are new luxury real estate projects, all of them seek to have the most impact for their bold architectural design. At one of these undertakings, a decision was made to build a large internal atrium with several large trees and open to the outside air. It so happens, however, that the nearby rivers are heavily polluted and lifeless. Consequently, mosquitoes proliferate and plague the building. Moreover, in summer, the river gives off large amounts of gases, and the shops are engulfed with bad odor. To control the situation, shopkeepers started spraying air fresheners in the occupied spaces.

Seeking more comfort, other undertakings in the region have adopted air conditioning. In the early morning of June 23 2006, several attendants of a shop were beginning their work shifts at 8 AM, before the mall was opened to the public, at 10 AM. They had been preceded by maintenance workers, whose shift had begun at 6 AM, but had remained unsupervised by any manager. One of the attendants complained of a strong smell, which was soon noticed by several other employees. As the odor persisted, a senior employee called the maintenance workers and demanded that the air conditioning, usually switched on at 9 AM, be turned on immediately. He also demanded that the store be "ventilated" and that the air renewal system be activated. Without access to their supervisor and fearing reprisals, the workers obeyed. As a result, the odor increased even more. A half hour later, 3 attendants went to the infirmary complaining of nausea, while another one was rushed to a hospital emergency room. Nine more people were sent home from work that morning, and the building was evacuated. It was later found that the odor was due to leakage of t-butyl mercaptan, a fuel gas aromatizer. The night before, a truck hauling 10 drums of gas had turned over on the express lane of the road that skirts the river, losing eight cylinders. Two cylinders leaked, one of which into a stream. The accident occurred at 4:30 AM, but was only controlled at 10 AM. Several districts were affected and 116-km traffic jam formed while the road was closed to clear the accident.

### **3.3 Thermal comfort, pen cap, and overcoming the crisis**

Easy access routes skirting the rivers in the city of São Paulo until recently harbored many industries and warehouses. With the transformation that took place in the city's economic base, many of these buildings have become idle and have been attracting interest for use for new purposes. A major state-owned company used to occupy several office buildings scattered around the city, which had been leased to be used by the company's several departments. Seeking to reduce costs and improve operations, a number of these industrial buildings, located off of one of these express routes, were renovated to house the entire staff. After two years of design and need assessments and adjustments, the renovation was completed and 1,200 people were transferred to the new buildings.

As soon as occupation began, there were widespread complaints of thermal discomfort involving both excess cold and excess heat. A consultancy firm was hired and found that, in some cases, less than 60% of users were satisfied. People felt very cold when they were close to the ceiling diffusers, and very hot when near the windows. Satisfaction also varied according to time of day and, in some places, temperatures oscillated up or down by 3.0°C on the same day. As a result, some occupants obstructed the ceiling diffusers with paper, while others opened the



windows. It was also found that there was a localized thermal load and that the thermostats had been installed at an improper height, near the ceiling. The study recommended greater attention be paid to layout and to how the space was occupied.

With the report's findings, FM positioned thermostats 1.5 m above the ground, enclosed in a metal casing to prevent public access. It then issued announcements with explanations and recommendations. The windows should not be opened. The comfort complaints stemmed from the variation in individual tolerance to heat or from the diversity of clothing worn at the workplace. Many problems still remain, resulting from the successive changes made to the occupation of the space as required by the different departments. FM expects changes in user attitude in order for the system to operate properly.

Therefore, like every summer, many men continue wearing jackets and ties, as required by their jobs. Likewise, many women continue wearing spaghetti strap blouses because the outside temperature is 32°C and they do not have air-conditioned cars. But now anyone can change the temperature in the rooms. People insert pen caps into the hole of the thermostat's metal casing.

## 4. Discussion and concluding notes

*“Those who can, give orders; those who are wise, obey.”*

(Old Brazilian adage)

At first glance, the three cases presented here could be seen merely as an indoor air quality issues. However, the situations also suggest problems involving ergonomics, occupational health, and emergency assessment and management. From the EH standpoint, it is about environmental risks. People relate to the environment, but also interact with each other. Circumstances are experienced in buildings, some of which unusual. With the growing outsourcing practices, such as for cleaning services, new variables are introduced and the operation's risks change (Downey, 1995). Risk assessment can not ignore these changes. New problems arise with facility use, and systems become fragile when redundancies or surplus resources are missing, as was the case of the thermal discomfort. Since the primary activities must be done, one way or another operations go on and precariousness increases the health risks even more.

It is evident that incidents such as those described herein demand contingency plans and crisis management, as has been proposed in FM (Barton & Hardigree, 1995). However, more than the lack of plans in the cases presented here, it is surprising to realize how health risks are ignored. When dealing with chemical risks, prevention, such as hiring a qualified company in the call center case, does not suffice. Toxic exposure requires precaution. Therefore, the building should not be occupied while maintenance is being carried out, or at the very least parts if it should be isolated. Chemical cleaning agents and air fresheners may be hazardous materials, some of

which known carcinogens and reproductive toxicants (Nazaroff & Weschler, 2004). A national population study carried out in the U.S. showed that over 30% of the population has adverse reactions when exposed to air fresheners (Caress & Steinemann, 2003). With the free use of these products, such as in the shopping mall case, not only are new risks taken on, but the practice also masks the perception of other issues, as was the case with the odor in the department store in the same region. Avoid using air fresheners is advisable, not only to prevent disease but also as a precaution in the event of serious accidents.

Selden (1989) describes a chemical emergency involving a group of young women, and shows that panic can often lead to disastrous results. The magnitude of the crisis that was seen at the call center is, therefore, not at all surprising. However, risk analysis, ignoring these subjective aspects, encourages false guarantees of control; presupposing people will reproduce behaviors in an absolutely unchangeable environment assumed in statistic relationships.

Without a clear perspective of protecting and fostering health, the situations described herein reveal strategic failures. The tactical consequence is a paralyzed, ineffective FM. A reflex of this are the contexts in which the ability those involved had to control their own risk exposure, or empowerment, is reduced or simply nonexistent.

Leaman (2002) suggests that the users' control of the environmental conditions in the workplace is positively related to well being and performance. Although the modern organizational proposals do not necessarily provide empowerment to workers (Harley, 1999), the fact is that call center operator autonomy is particularly limited in different ways (Taylor & Bain, 1999). On the other hand, it is also known that individuals, including managers, avoid decisions by postponing them. Anderson (2003), reviewing findings made in different areas, argues that this behavior of accepting the status quo, as observed in the cases, involves not only the consideration of objective aspects, rather also the subjective aspects of the decision. In US chemical plants, the research done by Meszaros (1999) showed that for control in situations of risk, “(managers) found comfort in accountability rather than in analysis” and “appealed upward in their hierarchies to check whether their choices were consistent with organizational preferences.” Understanding the risk-related behavior in the cases that were analyzed should, therefore, take the local organizational culture into account, in this case, the Brazilian culture.

First of all, it should be emphasized that there is no such thing as a "Brazilian culture." Brazil, like the U.S., is not racially and culturally homogeneous. It is a continental country. Over 500 years, there were different forms of occupation and colonization. This intense immigration over the centuries led not only to regional differences, but also to a unit resulting from the incorporation and sharing of common values ("melting pot"). Thus, although there is little difference in language and religion, there are striking regional differences. Depending on the geographic location, the Indian, African or European culture may dominate. These differences play an important role in management preferences, according to a study done by Hofstede et al. (2010). Risks and hazards are perceived differently among the inhabitants of the biggest Brazilian cities such as Rio de Janeiro and São Paulo, for example (Perez-Floriano & Gonzalez, 2007).

As management depends on the organizational culture, the performance of foreign multinational companies in Brazil depends on the understanding of the values Brazilians share at work (De Hilal et al., 2009). Differences in business behavior between Brazil and the US were studied by O'Keefe & O'Keefe (2004). Risks and hazards are perceived differently among the inhabitants of the biggest Brazilian cities and the capital of Argentina, Buenos Aires (Perez-Floriano & Gonzalez, 2007). In similar terms, Brazilian multinational companies also share their own values, even when based in other countries. Ambiguous or contradictory behaviors and double-edged ethics, characteristic of Brazilian culture, were found in the operation of different branches in different countries, covered by a Brazilian multinational (De Hilal, 2006).

These cultural traits, among others, reflect a long history of oppression in the shaping of the country. Bethell (2000) summarizes the history of Brazil and shows how the different circumstances of colonization produced a country that is still undemocratic and unequal. The asymmetry of power, the geographical distances and the inability to understand the circumstances of the colony showed Brazilians the advantages of avoiding confrontation and of contextualizing the problems and solutions. To foreigners, the result is apparently illogical behavior. Novinger (2003) highlights that in Brazil people “say ‘yes’ to almost any request, even when they actually mean ‘no’.” Meanwhile, in companies, De Hilal et al. (2009) show the relationships are authoritarian and paternalistic. Managers seek privileges and postpone decisions that conflict with other interests, as in the cases presented. In the absence of empowerment, all that is left to people is passive resistance, minor violations and improvisation, putting their own health at risk.

To many, the Brazilian culture has been better understood as “*neither traditional nor fully modern*” (Tavolaro, 2008). But the fact is that, in a live society, culture is constantly renewed, drawing unexpected routes. In Brazil, the new Constitution, enacted in 1988, fostered new empowerment. Health has become a right, the State took on obligations, and people organize themselves to seek improvement in their life and work conditions.

In conclusion, buildings are not only material resources brought together. They can also be understood as a “place” or micro-territories. A “place” has a history and a culture that shapes the relations of individuals between themselves and with the environment. To EH, health is the outcome of these possible relationships, although not all imaginable. Therefore, making the most common needs in buildings feasible, thus minimizing disasters, depends on attitudes of precaution and on keeping the shared culture that defines problems and solutions in mind.

FM in Brazilian buildings must seek to achieve improved competitiveness and to provide good working and living conditions to people, improving operations. Therefore, EH has much to contribute. One cannot expect more productivity without promoting health in the workplace, as Goetzel et al. (2008) suggest for occupational health. Nor can one expect that, without democracy, the risks and their damage can be mitigated, as EH does in the different circumstances. Brazil is not a rich country, but as Kahn (2005) showed for natural disasters, the survival rate in crises does not stem from the wealth of each country affected, rather from the political conditions that promote and ensure democratic participation.

## References

- Adler T (2009) Putting Healthy School Principles into Practice. *Environmental Health Perspectives*, 117 (10):A 448-A453.
- Alexander K (1992) Facilities Risk Management. *Facilities*, 10(4):14-18.
- Anderson CJ (2003) The Psychology of Doing Nothing: Forms of Decision Avoidance Result from Reason and Emotion. *Psychological Bulletin*, 129(1):139-166.
- Antó JM (2005) The Precautionary Approach: From Birth to childhood Epidemiology for Risk Assessment: Losing the Beginner's Confidence. *The European Journal of Public Health*, 15(5):443-446.
- Baldwin AN (2005) Solutions Implementation for Healthy Buildings in Hong Kong – A Summary of the Research and Findings. IN: Chan EHW, Ho DCW (ed) *Proceedings of the CII-HK Conference Healthy Building Community Health and The Built Environment*, 30 November 2005, Hong Kong, PRC. (Available online [http://bsun02.bre.polyu.edu.hk/~bsedchan/ciikh2005\\_proceeding.pdf](http://bsun02.bre.polyu.edu.hk/~bsedchan/ciikh2005_proceeding.pdf). [Accessed on 28/05/10])
- Barrett P, Baldry D (2003) Facilities Management Systems. IN: Barrett P, Baldry D *Facilities Management: Towards Best Practise*. London, Wiley-Blackwell, pp45-51.
- Barton L, Hardigree D (1995) Risk and Crisis Management in Facilities: Emerging Paradigms in Assessing Critical Incidents. *Facilities*, 13(9,10):11-14.
- Bathelt H, Glückler J (2005) Resources in Economic Geography: From Substantive Concepts Towards a Relational Perspective. *Environment and Planning A*, 37(9): 1545-1563.
- Bethell L (2000) Politics in Brazil: From Elections without Democracy to Democracy without Citizenship. *Daedalus*, 129(2):1-27.
- Booty F *Facilities Management Handbook*. 4ed, Oxford, Butterworth-Heinemann, 2009.
- Brown D (1994) Your Environmental Auditing Obligation. *Facilities*, 12(11):16-19.
- Brown Z, Cole RJ, Robinson J, Dowlatabadi H (2010) Evaluating User Experience in Green Buildings in Relation to Workplace Culture and Context. *Facilities*, 28(3/4):225-238.
- Butterworth I (2000) The Relationship Between the Built Environment and Wellbeing: A Literature Review. *Victorian Health Promotion Foundation*, Melbourne, Australia. (Available online <http://planning.org.au/vic/images/stories/health/butterworth.pdf>. [Accessed on 28/05/10]).

Caress SM, Steinemann AC (2003) A National Population Study of the Prevalence of Multiple Chemical Sensitivity. *Archives of Environmental Health: An International Journal*, 58(6):300-305.

Chan EHW, Lam KS, Wong WS (2008) Evaluation on Indoor Environment Quality of Dense Urban Residential Buildings. *Journal of Facilities Management*, 6 (4): 245-265.

Chotipanich S (2004) Positioning Facility Management *Facilities*, 22(13/14):364-372.

Cieślak M (2006) New Approach to Environmental Tobacco Smoke Exposure and Its Relation to Reemission Processes. *International Journal of Occupational Medicine and Environmental Health*, 19(2): 92-98.

Codinhoto R, Tzortzopoulos P, Kagioglou M, Aouad G, Cooper R (2009) The Impacts of the Built Environment on Health Outcomes. *Facilities*, 27(3/4): 138-151.

Davies H, Walters M (1998) Do All Crises Have to Become Disasters? Risk and Risk Mitigation. *Property Management*, 16(1):5-9.

Day R (2007) Place and the Experience of Air Quality. *Health & Place*, 13(1):249-260.

De Hilal AVG (2006) Brazilian National Culture, Organizational Culture and Cultural Agreement Findings from a Multinational Company. *International Journal of Cross Cultural Management*, 6(2):139-167.

De Hilal AVG, Wetzel U, Ferreira V (2009) Organizational culture and Performance: a Brazilian Case. *Management Research News*, 32 (2):99-119.

De Toni AF, Nonino F (2009) The Facility Management: Non core services definitions and taxonomy. In: De Toni AF, Ferri A, Montagner M (Eds.) *Open Facility Management: A New Paradigm for Outsourced Service Management*. Milano, International Facility Management Association (IFMA), pp. 3-28.

Downey JM (1995) Risk of Outsourcing – Applying Risk Management Techniques to Staffing Methods. *Facilities*, 13(9/10):38-44.

Dumont R (2008) The Effect of the Indoor Environment in Buildings on Human Health: A Review. In: Veitch JA (ed) *Proceedings First Canadian Building and Health Sciences Workshop*, November 3 – 4, 2008, National Research Council Canada, Montreal, Canada.

Eckersley R (2001) Culture, Health and Well-being. IN: Eckersley R, Dixon J, Douglas B *The Social Origins of Health and Well-being*. Published/Created: Cambridge, UK, Cambridge University Press, 2001. pp 51-70.

- Facilities (2001) Promoting a Safety and Health Culture through Marketing and Procurement. *Facilities*, 19(11/12): Developments.
- Fernandez JE (1995) Ergonomics in the Workplace. *Facilities*, 13(4):20-27.
- Finch E (1992) Risk and the Facilities Manager. *Facilities*, 10(4):10-13.
- Fleming D (2004) Facilities Management: A Behavioural Approach. *Facilities*, 22(1/2):35-43.
- Gieryn TF (2002) What Buildings Do. *Theory and Society*, 31(1)35-74.
- Goetzel RZ, Ozminkowski RJ, Bowen J, Tabrizi MJ (2008) Employer Integration of Health Promotion and Health Protection Programs. *International Journal of Workplace Health Management*, 1(2):109-122.
- Grant J (2004) Encouraging Mixed Use in Practice. *International Planning Symposium on Incentives, Regulations, and Plans – The Role of States and Nation-States in Smart Growth Planning*. September 30 – October 1, 2004, National Center for Smart Growth Research and Education, University of Maryland. (Available online [http://eddyburg.it/filemanager/download/668/Mixed\\_Use\\_Jill\\_Grant.pdf](http://eddyburg.it/filemanager/download/668/Mixed_Use_Jill_Grant.pdf). [Accessed on 28/05/10]).
- Harley B (1999) The Myth of Empowerment: Work Organisation, Hierarchy and Employee Autonomy in Contemporary Australian Workplaces. *Work, Employment and Society*, 13: 41-66.
- Hawe P, Shiell A (2000) Social Capital and Health Promotion: A Review. *Social Science & Medicine*, 51(6): 871-885.
- Hofstede G, De Hilal AVG, Malvezzi S, Tanure B, Vinken H (2010) Comparing Regional Cultures Within a Country: Lessons From Brazil. *Journal of Cross-Cultural Psychology*, 41 (3):336-352.
- Hsee C, Weber EU (1999) Cross-national Differences in Risk Preference and Lay Predictions. *Journal of Behavioral Decision Making*, 12(2):165-179.
- Hunt WP (2008) Analysis of Mixed-use Occupancy Target Hazards in Uptown Shelby North Carolina. *Shelby Fire & Rescue Department*, Shelby, North Carolina. (Available online <http://www.usfa.dhs.gov/pdf/efop/efo41714.pdf> [accessed on 28/05/10]).
- Ilozor BD, Treloar GJ, Olomolaiye PO, Okoroh MI (2001) FM Puzzle: Sick Building and Sydney's Open-plan Offices. *Facilities*, 19(13/14):484 – 493.
- Johnson A, Manser J (1997) French Studies: Compare and Contrast. *Facilities*, 15(1/2):18-21.

- Kahn ME (2005) The Death Toll from Natural Disasters: The Role of Income, Geography, and Institutions. *Review of Economics and Statistics*, 87(2): 271-284.
- Kamaruzzaman SN, Zawawi EMA (2010) Development of Facilities Management in Malaysia. *Journal of Facilities Management*, 8(1):75-81.
- Knight FH (1921) *Risk, Uncertainty and Profit*. Boston, MA, Hart, Schaffner & Marx; Houghton Mifflin Co., 1921. (Available online <http://www.econlib.org/library/Knight/knRUP.html> [accessed on 28/05/10]).
- Lam AK (2001) Business Transformation and Facility Management. IN: Teicholz, E. (ed) *Facility Design and Management Handbook*, NY, McGraw-Hill Professional. pp. 4.1-4.16
- Lavin T, Higgins C, Metcalfe O, Jordan A (2006) Health Impacts of the Built Environment: A Review. *The Institute of Public Health in Ireland*, Dublin. (Available online [http://www.oxha.org/knowledge/publications/ireland\\_builtenvironment.pdf](http://www.oxha.org/knowledge/publications/ireland_builtenvironment.pdf) [Accessed on 28/05/10]).
- Leaman A (1991) What is a Building for?: Part I. *Facilities*, 9(10):13-16.
- Leaman A (2002) User Needs and Expectations. In: Cole R, Lorch R (eds) *Buildings, Culture & Environment*, Oxford, Blackwell Publishing.
- McLennan P, Bennetts M (2003) The journey to Work: A Descriptive UK Case Study. *Facilities*, 21(7/8):180-187.
- Meszaros JR (1999) Preventive Choices: Organizations' Heuristics, Decision Processes and Catastrophic Risks. *Journal of Management Studies*, 36(7): 977-998.
- Nazaroff WW, Weschler CJ (2004) Cleaning Products and Air Fresheners: Exposure to Primary and Secondary Air Pollutants. *Atmospheric Environment*, 38(18): 2841-2865.
- Novinger T (2003) *Communicating with Brazilians: When "Yes" Means "No"*. Austin, University of Texas Press.
- Nutbeam D (1986) Health Promotion Glossary. *Health Promot.*, 1(1):113-27.
- Nutt B (2000) Four Competing Futures for Facility Management. *Facilities*, 18(3/4):124-132.
- O'Keefe H, O'Keefe WM (2004) Business Behaviors in Brazil and the USA: Understanding the Gaps. *International Journal of Social Economics*, 31(5/6):614-622.
- Okuno-Fujiwara M (2002) Social Relations and Endogenous Culture. *Japanese Economic Review*, 53(1):1-24.

- Paasi A (2002) Place and Region: Regional Worlds and Words. *Prog. Hum. Geogr.*, 26: 802-811.
- Perez-Floriano LR, Gonzalez JA (2007) Risk, Safety and Culture in Brazil and Argentina: The Case of TransInc Corporation. *International Journal of Manpower*, 28(5):403-417.
- Pitt M, Bennett J (2008) Workforce Ownership of Space in a Space Sharing Environment. *Journal of Facilities Management*, 6(4):290-302.
- Rayner S, Cantor R (1987) How Fair Is Safe Enough? The Cultural Approach to Societal Technology Choice. *Risk Analysis*, 7(1):3-9.
- Rooley R (1997) Sick Building Syndrome - The Real Facts: what is Known, what can be Done. *Facilities*, 15(1/2):29-33.
- Rowley A (1996) Mixed-Use Development: Concept and Realities. *Cutting edge, Royal Institution of Chartered Surveyors (RICS) Research*. (Available online: [http://www.rics.org/site/download\\_feed.aspx?fileID=2196&fileExtension=PDF](http://www.rics.org/site/download_feed.aspx?fileID=2196&fileExtension=PDF). [Accessed on 28/05/10]).
- Sekula MR (2004) Your First 60 Days as Head of Facilities. *Facilities*, 22(9/10):228-232.
- Selden BS (1989) Adolescent Epidemic Hysteria Presenting as a Mass Casualty, Toxic Exposure Incident. *Ann. Emerg. Med.*, 18(8):892-5.
- Stokols D (2000) Creating Health-Promotive Environments: Implications of Theory and Research. IN: Jamner MS, Stokols D (eds) *Promoting Human Wellness: New Frontiers for Research, Practice, and Policy*. Berkeley, University of California Press. p.135-162. (available online <http://ark.cdlib.org/ark:/13030/kt4r29q2tg/> [accessed on 28/05/10])
- Tarcan E, Varol ES, Ates M (2004) A Qualitative Study of Facilities and Their Environmental Performance. *Management of Environmental Quality: An International Journal*, 15(2):154-173.
- Tavolaro SBF (2008) "Neither Traditional nor Fully Modern..." Two Classic Sociological Approaches on Contemporary Brazil. *International Journal of Politics, Culture, and Society*, 19(3-4):109-128.
- Tay L, Ooi JTL (2001) Facilities Management: a "Jack of all Trades"? *Facilities*, 19(10):357-363.
- Taylor P, Bain P (1999) An Assembly Line in the Head': Work and Employee Relations in the Call Centre *Industrial Relations Journal*, 30(2):101-117.



- Tong D, Leaman A (1993) Sick Building Syndrome: Strategies and Tactics for Managers. *Facilities*, 11(4):19 -23.
- Tse DK, Lee K, Vertinsky I, Wehrung DA (1988) Does Culture Matter? A Cross-Cultural Study of Executives' Choice, Decisiveness, and Risk Adjustment in International Marketing. *The Journal of Marketing*, 52(4):81-95.
- Vaughan D (1996) *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA*. Chicago, University of Chicago Press.
- Veitch JA (2008) Connecting the Building Sciences and Health Sciences in Canada: Research Gaps (Conclusions). IN: Veitch JA (ed) *Proceedings First Canadian Building and Health Sciences Workshop*, November 3-4, 2008, National Research Council Canada, Montreal, Canada. (Available online <https://www.nrc-cnrc.gc.ca/obj/irc/doc/pubs/nrcc51222/nrcc51222.pdf#page=101> [accessed on 28/05/10])
- Veitch JA (2008a) Investigating and Influencing How Buildings Affect Health: Interdisciplinary Endeavours. *Canadian Psychology*, 49(4):281-288.
- Weber E, Hsee C (2000) Culture and Individual Judgment and Decision Making. *Applied Psychology An International Review*, 49(1):32-61.
- WHO (2010) World Health Organization. Environmental health. (Available online [http://www.who.int/topics/environmental\\_health/en/](http://www.who.int/topics/environmental_health/en/) [accessed on 28/05/10])
- Winston RD (2007) Achieving Vertical and Horizontal Integration - Challenges of Mixed-use Development. *Probate & Property*, 21(2):38-43. (Available online <http://www.abanet.org/rppt/publications/magazine/2007/ma/winston.shtml> [accessed on 28/05/10])
- Yeung HW (2005) The Firm as Social Networks: An Organisational Perspective. *Growth and Change*, 36(3):307-328.
- Younger M, Morrow-Almeida HR, Vindigni SM, Dannenberg AL (2008) The Built Environment, Climate Change, and Health Opportunities for Co-Benefits. *Am. J. Prev. Med.*, 35(5):517-526.



## Session C - Key Notes

**Prof. Danny Shiem-Shin Then**

The Hong-Kong Polytechnic University - Hong Kong/China

**The Experience Economy Approach in the Real Estate Market**

477

Prof. Dr. João da Rocha Lima

Escola Politécnica - University of São Paulo

**Facilities Management - Coming of Age: What are the expectations?**

479

Professor Danny Shien Then

The Hong-Kong Polytechnic University, China



## **The Experience Economy Approach in the Real Estate Market (\*)**

Prof. Dr. João da Rocha Lima Jr.



Professor Rocha Lima has graduation in Civil Engineering, Masters and Ph.D. in Civil Engineering-Real Estate, all from the Polytechnic School of the São Paulo University. He obtained the Associate Professor title in 1997 and since 2005 he is Full Professor at EPUSP. As head of the Center for Real Estate of the Polytechnic School, prof. Rocha Lima coordinates research and consultancy services in Real Estate with emphasis in Planning and Evaluation of Projects and Project Finance Structures and Securitization, acting on the following topics: planning and economy of the real estate sector, valuation of companies and enterprises, securitization, investment analysis, real estate funds and other means of sharing the investment in Real Estate. Under his leadership, the Center for Real Estate received the 'Sector Initiative Award' in 2008, highlighting the high-quality linkage between academic knowledge and the real estate market. Creator and coordinator of the MBA-USP program in Real Estate, prof. Rocha Lima teaches on under-graduation and graduation levels. He has authored several texts and articles, published in Brazil and abroad.

(\*)Presentations are available for download in <http://www.fmresearch.co.uk/events.html>



## Facilities Management - Coming of Age: What are the expectations? (\*)

Professor Danny Shiem-Shin Then, Bsc, MSc, PhD



Prof. Dr. Danny Then is fortunate to have an academic career that spans from Edinburgh to Brisbane and for the last 9 years in Hong Kong, in three universities that in some respect, pioneered facilities management training at the postgraduate level. Through research, consultancies and interactions with postgraduate students, he has had opportunities to reflect on research, curriculum development, current practices in real estate and facilities management.

Dr. Then involvement with Working Commission, CIB070 started in the late 1970s. He was appointed Coordinator for CIBW70 in 2000 and nowadays he is Joint Coordinator with Professor Edward Finch from University of Salford in England.

Dr. Then current position is Programme Leader of the Graduate Programme in Facility Management at The Hong Kong Polytechnic University since 2003. The PolyU Graduate Programme in Facility Management is the oldest in Asia with a 15 year history, and is internationally accredited by IFMA, BIFM and RICS in UK, HKIFM in Hong Kong.

Dr. Then joined the Department of Building Services Engineering of the Polytechnic University of Hong Kong (PolyU) in November 2001 from Queensland University of Technology, Australia where he was Associate Professor on a 5-year fixed term sponsored position (1997-2001), funded by the Department of Public Works, Queensland Government. The position was one of the funded chairs in Strategic Asset Management and Facilities Management. Previous to that he was a lecturer at Heriot-Watt University in Edinburgh, Scotland where he obtained his higher degrees.

In all the three universities, Danny had pioneered the development of facilities and real estate management as a viable post graduate programme, both in departments with a construction and property management focus, as well as building services engineering focus.

Dr. Then was presented the Faculty Award for Outstanding Achievement in Teaching due to his highly successful contribution towards the Graduate Program in Facility Management for 2007-08. In the same year Dr. Then won the Performance Award for Outstanding Performance in his Department. The International Facility Management Association granted him an award in 2007 for outstanding contribution in promoting the facility management profession. Dr. Then has published and presented more than 70 papers internationally and is co-author of a Butterworth-Heinemann, (UK) publication: Facilities Management and the Business of Space. Dr. Then consultancy experiences include projects in UK, Australia, Singapore and Hong Kong.

(\*)Presentations are available for download in <http://www.fmresearch.co.uk/events.html>





## Session 7 - Urban Facilities Management

Dr. Sarel Lavy<sup>1</sup> & Prof. Dr. Gilda Collet Bruna<sup>2</sup>

<sup>1</sup>Texas A&M University - College Station-Texas/USA

<sup>2</sup>FAUUSP Faculdade de Arquitetura e Urbanismo, University of São Paulo - São Paulo/Brazil

### Trends in Retail Centres Recycling Initiatives

483

BAHARUM, Mohamad Rizal<sup>1,2</sup>; PITT, Michael<sup>1</sup>; RILEY, Michael<sup>1</sup>

<sup>1</sup>School of Built Environment, Liverpool John Moores University

<sup>2</sup>University Malaya

### Heritage and management in the transformation of industrial canal zones: the case of B5 in The Netherlands

495

CURULLI, Irene<sup>1</sup>; KOOLEN, Gertjan<sup>2</sup>

<sup>1</sup>Eindhoven University of Technology, The Netherlands

<sup>2</sup>Province Northern-Brabant, Department of Strategic Planning, The Netherlands

### Inclusive Tourism and Barrier free Istanbul European Capital of Culture

511

INALHAN, Goksenin<sup>1</sup>; SUNGUR ERGENEOGLU, Asli<sup>2</sup>

<sup>1</sup>Istanbul Technical University

<sup>2</sup>Yildiz Technical University

### Gentrification and city improvement districts: a case study of residents' perceptions in Claremont, South Africa

525

CATTELL, Keith; MICHELL, Kathy; BOWEN, Paul; FLORENCE, Tim

University of Cape Town

### The effects of studentification on the residential neighbourhood of a university suburb: A study of the University of Cape Town in Rondebosch

543

ORDOR, Uche; CATTELL, Keith; MICHELL, Kathy; BOWEN, Paul

University of Cape Town



## Trends in Retail Centres Recycling Initiatives

**Mohamad R Baharum**

School of Built Environment, Liverpool John Moores University and University Malaya  
[M.R.Baharum@2008.ljmu.ac.uk](mailto:M.R.Baharum@2008.ljmu.ac.uk)

**Michael R Pitt**

School of Built Environment, Liverpool John Moores University  
[M.R.Pitt@ljmu.ac.uk](mailto:M.R.Pitt@ljmu.ac.uk)

**Michael L Riley**

School of Built Environment, Liverpool John Moores University  
[M.L.Riley@ljmu.ac.uk](mailto:M.L.Riley@ljmu.ac.uk)

### Abstract

The paper intended to examine recycling initiatives of a group of UK retail centre in regards to the waste production and recycling initiatives over periods of two years. Method adopted in the study is the collection of primary data obtained from individual shopping centres throughout UK. Review of nine shopping centres merely represents the recycling trends of UK shopping centres, as few shopping centers have only just started their recycling programs. Findings of the study revealed that the sector did show an overall decreasing level of waste production, and waste minimisations were achieved through a variety of recycling initiatives. As a result, the more proficient approach to recycling, the better were the results. The paper also shows that shopping centre recycling does produce positive results. Although the effect of the landfill tax is uncertain but additional incentives and facilities management innovation to shopping centre recycling may be essential to drive the sector wide improvement.

**Keywords:** Waste management, Recycling, Shopping centres, United Kingdom

## 1. Research background

There is nothing new about recycling as an objective, but there are new and growing pressures on shopping centre business as property investment to act responsibly and comprehensively to manage their waste. Apparently, recycling has become a central component of many retail centres operations, and valued for the cost-savings associated with some programs as well as its general environment-friendly aspects. However, sustainability in retail shopping centre through recycling is ultimately a creative act that involves thought and dedication to extend the life and usefulness of retail centre waste stream. Although, most of previous research on waste minimisation through recycling relates to the municipals, commercial office building, medical, hotel, educational and industrial. This paper attempts to observe the UK retail centres sector waste production and recycling trends. Also, the present study extends the work by Fuller's (1994) and Pitt's (2005) studies concerned with retail shopping centres waste management which requires further investigation.

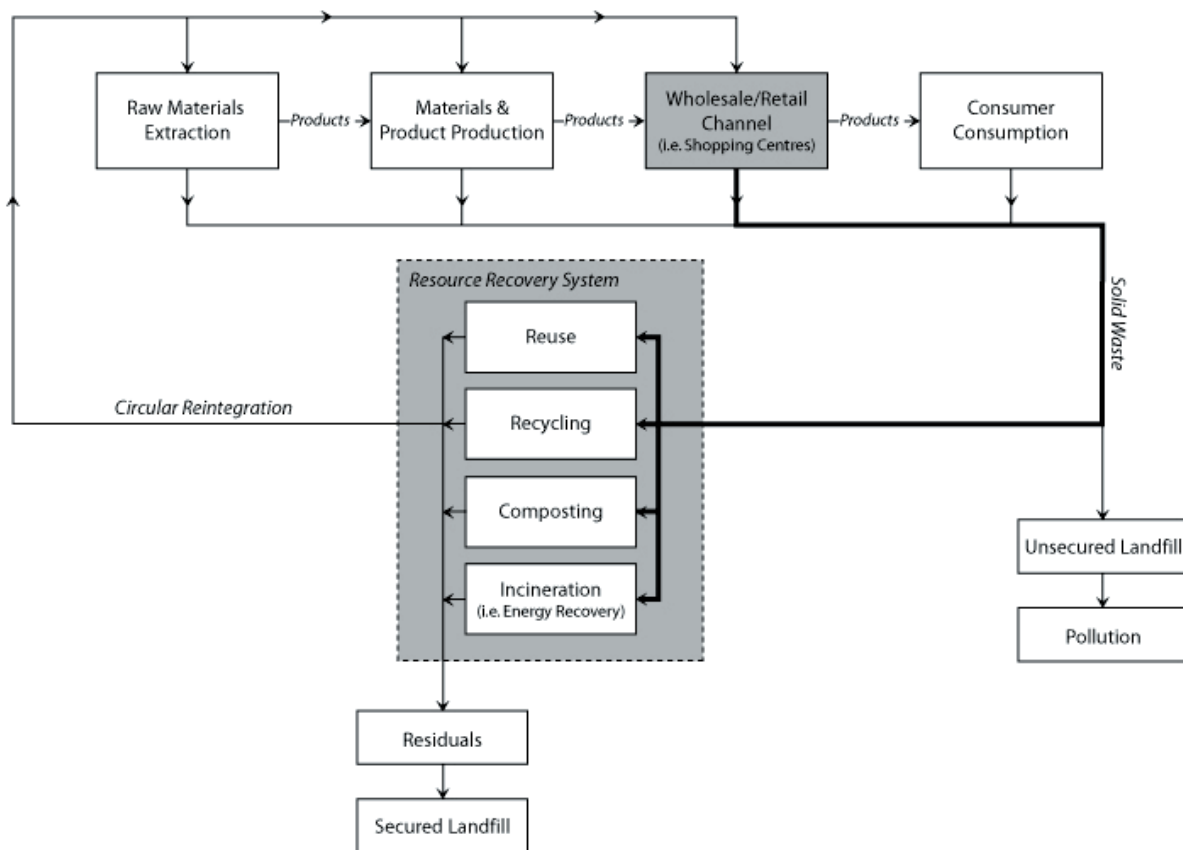
This paper starts with the theoretical discussion about shopping centre waste management and recycling. After this research directions by means of pilot studies are presented. The last part of this paper discusses about the results and gives implications to shopping centre management.

## 2. Integrated waste management: resource recovery system

It is argued that a large waste assimilation capacity in the environment is outcome from the generation of waste begins from every production process (i.e. water, energy, materials) from supply-chain networks (Turner and Powell 1991; Phillips et al. 2001). Within the broader waste management strategy of resource recovery system, materials recycling can be differentiated from the other subsystems by the fact that it creates a marketable physical product that is essentially a substitute for virgin source raw materials in primary production processes. Therefore, recycling is distinguished as re-introduction of residual materials into production processes so that they may be re-formulated into new products (United Nations 2003). Those materials are refined back to essentially its virgin specification; or it may subsequently be used for any purpose appropriate to that material specification. By this means, recycling clearly demonstrates that the goal is to reverse this result by achieving a circular flow (as illustrated in figure 1) that effects a reintegration of materials with markets. Nevertheless, in order for recycling to be sustainable, there needs to be accessible markets for recycled materials at the end of the cycle.

Otherwise, materials reuse and incineration subsystems have as their respective objectives the development of returnable (reuse) systems (Korzum et al, 1990), composting and the reduction of waste by energy recovery. When these used together, materials recycling, reuse, composting, and incineration represent the major elements of an integrated solid waste management program (United Nations 2003; UNEP 2007). However, the least favorable alternative is the traditional approach to product disposition, which several authors described as a linear flow (Neace, 1990; Phillips et al. 2006), in which waste materials are interred in landfills or indiscriminately dumped.

Presently, waste management is appeared to view recycling-collection as a cost reducing alternative. Recycling also becomes a central component of many shopping centre operations. Fuller (1994) described the shopping centre occupies a position as “down-stream”, in product extended channel. This position places it at the point where bulk breaking associated with product assortments takes place. The measures to prevent waste generation and to re-incorporate waste in the economic cycle or “closing the materials loop”, i.e. recycling, are therefore an important element of a comprehensive approach to resource management (Fuller and Allen 1997). This proposition can be further illustrated in Figure 1, the circular flow which applies to waste generated at different levels in a hypothetical production consumption cycle overtime. Within this, marketing intermediaries also produce waste that follows this same routing, and that the overall effect of the diversion of materials through resource recovery is not only to converse resources but to eliminate additional, on-going pollution from unsecured landfilling. Thereby shopping centres has important roles that help to close the loop, thus, creating supply from the materials recovered.



*Figure 1: Shopping centre position in materials system life-cycle  
(Adapted from Fuller and Allen 1997)*

### 3. Shopping centre position in resource recovery systems

For that reason, shopping centre recycling is one of the basic subsystems of waste management (or resource recovery) that collects, processes, and return former waste materials to productive use. It is also perceived as a logical waste management strategy through which shopping centre management can achieve its waste reduction objectives. The collection of these waste places the shopping centre at the head of forward retailer or wholesaler within the product materials circular reintegration, and predictable solid waste streams composed of packaging materials are associated with the shopping centre operations. As a unique form of materials recycling, shopping centre recycling can be distinguished by the nature of the waste they generates and types of material sought.

Normally shopping centres produce much larger quantities of relatively homogeneous wastes which are by products of their operations. Corrugated cardboard is the largest amount produced in shopping centre waste stream, as a normal part of the business routine compared to other material components of the waste, most of which derives from various forms of product packaging. This also includes plastics, glass, metals, furniture, oil and foods, electronic waste, hangers, etc. These wastes are then collected individually through shopping centre waste contractors. However, Pitt (2005) studies revealed the increasing waste trend in shopping centres were due to having no recycling plan, layout infrastructure, using alternative disposal methods (e.g. incineration) or having exceptionally high customer flows. This setback occurs due to the way shopping centre waste have been operated and managed.

### 4. UK commercial waste issues

The concerns related to resource depletion and environmental degradation are reflected in the concept of sustainable development (World Commission on Environment and Development, 1987). Beforehand, the over reliance on landfill has also caused many countries to face shortages of landfill sites. Throughout Europe and the USA, a strong reliance on disposing of waste in landfills is currently practiced. Yet, in many developing countries, conditions for waste disposal are still rudimentary (World Resource Foundation 1997).

Many authors acknowledged sustainable business is one which considers being environmentally and socially aware to be good business practice (Bates and Philips 1999; Castka 2004; Walker et al. 2007; Baharum and Pitt 2009). The etiquette towards managing a sustainable solid waste disposal and recycling becomes a necessary part in every commercial business (United Nations 1992; DETR 1999; DETR 2000; DEFRA 2008). For that reasons, companies are also being asked to respond to the concept of social responsibility (Castka 2004; Idowu and Towler 2004; Walker et al. 2007; Baharum and Pitt 2009), hence, sustainability thorough recycling has emerged as central component in many business operations.

#### 4.1 Waste from retail sector

Waste trends from various sectors in the UK have previously been explored DEFRA 2006; DEFRA 2007). According DEFRA, the overall UK waste sent at landfill sites registered for the

tax fell from around 96 million tonnes in 1997/98 to around 72 million tonnes in 2005/06, a reduction of around 25 per cent. This improvement further highlights the effects of the policies instrument which revealed some success. Although, the EU Environment Agency recognised the UK waste management trends is among the group with low recovery materials and incineration, with around 25 per cent recovery rates, alongside Portugal, Greece and Slovenia (European Environment Agency 2007). DEFRA (2007) also identified the UK commercial sector produces around 25 million tonnes of waste every year. Although approximately one-third of this waste is recycled, about half still goes to landfill. The individual sector that generated the most of the waste is retailing sector, which produced nearly 13 million tonnes of waste, with paper and corrugated cardboard account for 20 per cent, and over half of the waste being classified as general mixed commercial waste in its waste stream.

Despite the need for extraction of recyclables from this sector, it was also acknowledged that the sector has been slow to initiate waste reduction strategy. Pitt (2005) described the set back of retail centre waste in the UK was due to poor leadership, commitment from top management, awareness and waste management skills are some of the reasons why this sectors are slow to response. Besides, few scholars (Cant 2005; Musa and Pitt 2009) also emphasised the failure on the part of facilities management discipline to effectively involve in this sector of operations. In effects, poor procurement skills and efficient management of waste disposal and recycling solutions might add to a high cost of operation into the sector.

## 4.2 Legislation

UK waste management policy apparently originated from Environmental Protection Act 1990 and EU Waste Framework Directive in 1975. The revised waste directive (Directive 2008/98/EC) provides a good opportunity to create new European targets and processes to minimise waste and maximise recycling (European Commission 2008). The directive also lays down waste management principles such as the "polluter pays principle", and promotes Europeans a recycling society.

At the start, positive signs of recycling promotion in the UK started in 1987, initiated by the National Council for Voluntary Organisations, with a project called Waste Watch (Waste Online 2004). Managing waste in a sustainable way, optimising recycling, as well as limiting the generation of waste materials, forms a core part of UK government policy to protect the environment. The Environmental Protection (Duty of Care) Regulation 1991 also affects every business in the UK to responsibly produce or handles their waste. By this means, companies need to make sure their waste is collected and disposed of in accordance with the relevant legislation, instead of a linear "cradle to grave" model; companies now have a cyclical "cradle to cradle" model based approach.

The foremost policy instruments that influence UK commercial waste sector are the landfill tax, landfill tax credit scheme and landfill allowance trading scheme (DEFRA 2004). The combined effect of these policies are to reduce the use of landfill and put pressure on retailing sector the

certainty of materials recovery and recycling options. For the meantime, a further landfill tax escalator of £8 per tonne each year taking the current UK landfill tax for active waste to £48 per tonne, and will increase by £8 per tonne each year until April 2013 (HM Treasury 2010). For business, this relative change in costs could tip the balance between recycling and landfill disposal, making their recycling attempt the most cost effective option in their business. Unaware of the consequences of these issues, lack of proper waste management may cost companies heavily, not only in terms of monetary losses, but also in environmental impacts (Envirowise 1998; Phillips et al. 2006). The legislative framework on commercial waste embraces financial penalty as the key driver that drive companies to effectively manage their waste management in a sustainable way.

With this, shopping centre direction and scope for recycling strategy requires certain configuration of its resources in order to meet the area of focus, formalises the necessary organisational structures for successful implementation. To achieve recycling goals and promoting other means of waste reduction, therefore, requires a creative act and dedication to reverse shopping centre waste streams into meaningful resources. Without such a strategy, progress on recycling and waste minimisation will have to depend on its organisational experience and ingenuity.

## 5.0 Research directions

The difficulty to quantify commercial waste data is due to the fact that it is collected individually by businesses through waste contractors. This also causes lack of data transparency to enabling efficient monitoring of waste from commercial sector in the UK. Unlike municipal waste, local authorities are much in control to gather municipal waste data centrally to enable resourceful monitoring. It is also expressed (Pitt, 2005) that the lack of waste decision making in this sector probably due the fact that the nature of each industry or sector varies, hence, the suitability of each disposal method varies accordingly.

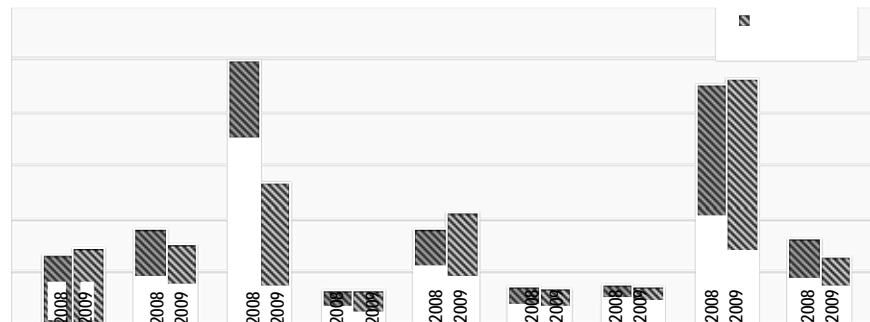
Thereby the aim of this pilot study was to identify waste production and recycling trends among the shopping centres across the UK. Although not all centres to fully participate in the interview as they were unable to provide a precise breakdown of their waste on quarterly or yearly basis incorporating with recycling initiatives. However, only 9 shopping centres, ranging between 21,816 square meters to 150,500 square meters of lease area, participated in this study. Thus far the series of data collated is acceptable to take on analytical work. Hence, wastes produced and recycled by these shopping centres over a period of 2 years (2008-2009) were examined.

### 5.1 Research findings

The data represents the average tonnage of waste produced by these centres for year 2008 is 0.020 tonnes per sqm, and 0.017 tonnes per sqm for the consecutive year. In 2008, six centres have their average weights for the two years below average tonnage while the rest are above average. Figure 2 illustrates that shopping centres C and H produce the highest amount of waste.



The reason of for high production is not known. Although it is possible their results might be due to economy of scale; exceptionally high numbers of shoppers; as these two centres size are among the largest in the study. It is also believes that the declining waste production is somewhat due to economic recession which sent retailers sales sliding in this period. However, waste production from three shopping centres (A, E and H) portrays small growth despite the recession.



**Figure 2: Waste (tonnes) produced and recycled per sqm (Year 2008-2009)**

All shopping centres drawn in the study have their recycling strategy implemented with 2 to 10 years of experience. Presently, every individual centre in the study has baler and compactor facilities on-site to facilitate recycling for materials such corrugated cardboard, paper, glass, aluminium cans, wooden pallets, soft and hard plastics, etc. In addition, special management provisions to facilitate recyclable materials such fluorescent tubes, toner cartridges and electrical goods, hangers, are evident. Few have resource recovery facility and only one centre has incinerator for an alternative option to landfill. However, none of the centres in the study has initiated anaerobic digestion facility for food waste disposal.

From the figure, it can be seen that performances of the shopping centre recycling are consistent. Generally, all the centres’ recycling performance quantitatively improved despite the increase of waste produced. The data presented shows the average tonnage of waste recycled by these centres for year 2008 was 0.010 tonnes per sqm, and marginal raise up to 0.011 tonnes per sqm for year 2009. It is revealed that shopping centres A, C and H have their recycling weights above average tonnage in both years. Recycling weights for shopping centre E also increased to 0.012 tonnes per sqm in year 2009. Even though centres F, G and I recycling rates decrease, waste minimisation was apparent.

Shopping centre A is the only centre equipped with baler, compactor, resource recovery facility and incinerator on-site, thereby facilitates 100% recycling of its waste stream throughout the two years observation. Rest of its residual is sent for energy recovery, as alternative to landfill. According to the centre management, some of the cost saving to landfill is reinvested in additional recycling initiatives and some of it is passed on to retailers. However, community involvement and local investment in regional initiatives are imperative for the technological advancement to be in place.

Other data indicates that since 2006, the centre C has located its baler and compactor on-site, together with resource recovery facility off-site achieved the largest decrease of waste, with 43% leap of recycling rate for the consecutive year. Interview with centre manager and environmental manager at centre C revealed the space limitation has previously prevented this from easily being overcome. For that reason, initiative such provision of retailers' door-to-door collection service appears essential, and together providing privilege service to retailers.

From the observation, it is also acknowledged that shopping centre E is currently acquiring full ISO 14001 certification. Only shopping centres A, B, H and I have implemented environmental management systems as part of their focusing strategy. In this regard, the importance in managing waste data relative to performance indicators also been highlighted. Such waste auditing and segregation could allow shopping centres to see more clearly where their waste is produced and how it could be reduced (Pitt 2005). Discussion with the centre managements from these centres revealed, waste and cleaning contractors also essential to the ongoing effective management of waste on site. So as to ensure full co-operation and participation by these contractors, therefore, appropriate performance indicators to meet centre recycling policy were included in the service contracts.

In addition, retailers' staffs on sites can greatly reduce material contamination and increase material. Centre managements from centres D, F, G and H relate one obstacle to recycling was caused by retailers' pressure with staffing levels, therefore, not having buy in to centres recycling strategy. Although tenant lease has specified the voluntary measures and centre recycling requirements, further awareness raising; training and re-training programs for retailers staffs may play a part in focusing strategy.

With the analysis for two years, there are some trends and alternatives for procuring waste disposal and recycling services that currently in practice. Only few large shopping centres have invested in resource recovery facility to handle large quantity of waste they produced.

## **5.2 FM implications**

Recycling initiatives among the 9 shopping centres that affect the development of retailing waste stream is presented. Indeed, such practices appear to be becoming increasingly mainstream. Somehow, the successes of the centres waste stream to be recycled are greatly dependent on facilities management at shopping centre establishment to innovatively procure their recycling

services together with other relevant initiatives. Although the facilities management discipline in shopping centre is relatively infancy in UK (Cant 2005; Musa and Pitt 2009), yet, the agility of facilities management knowledge to react swiftly with companies environmental criteria is expected (Baharum and Pitt, 2009). Certainly facilities management has important position to recover and recycle shopping centre solid waste at every opportunity in order to reduce the risk, cost and amount of waste being sent to landfill.

## 6. Conclusions

Investigation from the primary data suggests that the UK shopping centres recycling trends are consistent throughout the two years analysis. Among the nine shopping centres participated in this study, it signifies that recycling improvements are being made visible at the current time despite minor decrease of waste produce in the consecutive year. However, such support from local investment in regional initiatives, the current economic conditions, technology advancements, taxation on alternative to landfill apparently have an effect on the existing trends. As a result, this pilot studies conclude that the sector did show an overall decreasing level of waste production, and waste minimisation were achieved. The study also revealed the primary influences on shopping centres recycling are to reduce waste management costs, compliance with legal requirements, corporate environmental conscience, and desire to reflect consumer's their values.

With regards to financial-economic constraints; the existing situation; regulation; and organisational; environment; and technical issues, shopping centre management need to consider appropriate options and organising and managing their waste stream in cost-effective way possible. Facilities management from this sector will have to accept the concept of recycling as basic to the maintenance of present and future business trends. For this reason, facilities management should be proactive in matters relating to the environment, rather than reactive and responding only to government or regulatory pressure. In doing so, facilities management discipline would be demonstrating a credible, sincere long-term commitment to the environment.

## References

- Baharum, M. R. and Pitt, M.,(2009). "Determining a conceptual framework for green FM", *Journal of Facilities Management*.7 (3): 267 – 282.
- Bates, M. P. and Philips, P. S., (1999). "Sustainable waste management in food and drink industry." *British Food Journal*. 101(8): 580-589.
- Cant, M. (2005). "Collaboration in infrastructure services in regional retail centres: Value-added contribution of facilities management at the Birmingham Bullring." *Journal of Facilities Management*. 3(3): 215 - 225.

Castka, P., Bamber, C., Bamber, D. and Sharp, J (2004). "Integrating corporate social responsibility (CSR) into ISO management systems - in search of a feasible CSR management system framework." *The TQM Magazine*. **16**(3): 216-224.

Department for Environment, Food and Rural Affairs (DEFRA) (2004). Municipal waste, commercial waste and the Landfill Allowances Trading Scheme, (available online <http://www.defra.gov.uk/ENVIRONMENT/waste/localauth/lats/pdf/lats-unicipalwastedefine.pdf> [accessed on 3/4/2008])

Department for Environment, Food and Rural Affairs (DEFRA) (2008). Business Resource Efficiency and Waste (BREW) Programme: Metrics Results for 2005/06. (available online <http://www.defra.gov.uk/environment/business/.../0506-metrics-results-paper.pdf> [accessed on 3/11/2008])

The Department of Environment, Transport and the Regions (DETR) (1999). A better quality of life: a strategy for sustainable development in the UK, The Department of Environment, Transport and the Regions. London, UK; (available online <http://www.berr.gov.uk/files/file13547.pdf> [accessed on 3/5/2008])

The Department of Environment, Transport and the Regions (DETR) (2000). Waste Strategy 2000 for England and Wales: Part 1 & 2. Stationary Office, London.

European Environment Agency (EEA)(2007). Packaging waste generation per capita and by EU country.

Envirowise (1998). "Waste minimisation pays: five business reasons for reducing waste." (available online <http://www.envirowise.gov.uk> [accessed on 1/5/2008])

European Commission (EC)(2008). Directive 2008/98/EC on waste (Waste Framework Directive), The European Parliament And of The Council. (available online <http://eur-lex.europa.eu> [accessed on 3/4/2009])

HM Treasury (2010). "Budget 2010: Securing the recovery " (available online <http://www.hm-treasury.gov.uk/budget2010.htm>. [accessed on 3/5/2010])

Idowu, S. O. and Towler, B. A. (2004). "A comparative study of the contents of corporate social responsibility reports of UK companies." *Management of Environmental Quality: An International Journal* **15**(4): pp. 420-437.

Korzum E., Duyar M.T., and Villaneuva J. (1990) *The Recycling of Energy Values in Municipal Solid Waste: Current Practices and Future Trends*, Florida Center for Solid and Hazardous Waste Management State University System of Florida Type I Center Gainesville, Florida

Musa, Z. N. and Pitt, M. (2009). "Defining facilities management service delivery in UK shopping centres." *Journal of Retail and Leisure Property* **8**(3): 193-205p.

Neace, M.B (1990) Consumer Products Packaging and Disposal: A Normative Model, Progress in Marketing Thought, *Proceeding of the Southern Marketing Association*, 201-211.

Phillips P S, Barnes R, Bates M P, and Coskeran, T., (2006). "A critical appraisal of an UK county waste minimisation programme: The requirement for regional facilitated development of industrial symbiosis/ecology." *Resources, Conservation and Recycling* **46**(3): 242–264.

Phillips P. S., Pratt R.M., and Pike, K. (2001). "An analysis of UK waste minimization clubs: key requirements for future cost effective developments." *Waste Management* **21**(4): 389-404.

Pitt, M. (2005). "Trends in shopping centre waste management." *Facilities* **23**(11/12): 522-533.

Turner, R. K. and Powell, J., (1991). "Towards an Integrated Waste Management Strategy." *Environmental Management and Health* **2**(1).6-12.

United Nation Environmental Program (UNEP) (2007). UNEP Annual Report 2007, (available online <http://www.unep.org> [accessed on 21/6/2008])

United Nations (1992). "Agenda 21". *United Nations Conference on Environment and Development, Geneva*, UN. (available online <http://www.un.org/esa/dsd/agenda21.html> [accessed on 22/6/2009])

United Nations (2003). *Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003*, United Nations. New York, United Nations.

Walker D, Pitt M., and Thakur U.J., (2007). "Environmental management systems: Information management and corporate responsibility." *Journal of Facilities Management*. **5**(1): 49 - 61.

World Commission on Environment and Development (1987) Our Common Future, (available online <http://www.un-documents.net/wced-ocf.htm> [accessed on 11/7/2008])

Waste Online. (2004). "History of waste and recycling information sheet." (available online <http://www.wasteonline.org.uk> [accessed on 14/3/2008])

World Resource Foundation (1997). "Landfill Information Sheet" *Warmer Bulletin: Journal of the World Resource Foundation (WRF)*, 56.



## Heritage and management in the transformation of industrial canal zones: the case of B5 in The Netherlands.

**Irene G. Curulli**

TU/e, Eindhoven University of Technology, Department of Architecture, Building and Planning, The Netherlands

[g.i.curulli@bwk.tue.nl](mailto:g.i.curulli@bwk.tue.nl)

**Gertjan A. Koolen**

Province Northern-Brabant, Department of Strategic Spatial Planning, The Netherlands

[gkoolen@brabant.nl](mailto:gkoolen@brabant.nl)

### Abstract

The main aim of this article is to investigate the management process in the transformation of industrial canal zones. This term is referred to those abandoned factory areas along watercourses that have made many areas at the edge of a consolidated urban structure quite distinctive. In the long-term process of transformation, managers from several parties participate in it with different titles and roles and have a very influential role. This article will investigate the efficiency level in the management processes and methods used in the transformation of such abandoned areas. Furthermore, it will explore the level of exchange between experimentation and practice so as to enhance and protect the qualities of these sites.

The author will refer to B5 canal zones in The Netherlands as a case study. B5 or BrabantStad is the metropolitan area including the 5 cities (Eindhoven, Breda, Tilburg, s'Hertogenbosch and Helmond) and the towns in-between, located in the southern area of the country, named Brabant. Former industrial zones located along specific canal-courses/shipways characterize all 5 Municipalities. Originally located at the edge of the historical urban structure of each city, these areas are characterized by industrial buildings of different scale and architectural styles. Furthermore, a system of navigable canals connects the 5 canal areas (and cities) in a circuit with a high potential.

Methodologically, this paper will first discuss the meaning and heritage value of abandoned industrial canal zones, explaining the necessity to keep them standing and to protect their integrity. Secondly, it will illustrate the methods adopted in the management process of canal zone areas and will discuss the relationship between research and practice, focusing on the involvement and collaboration with Province, local authorities and University.

**Keywords:** industrial canal zones, management process, research and practice, experimentation, 'research-through-design'.

## 1. Introduction

Since the beginning of 70's many industrial areas in Europe have been closed and large productive areas have fallen into disuse.

In the Netherlands, like elsewhere, the process of de-centralization, that is the transformation of the productive system and the crisis of some industrial sectors, have made large urban areas available. As a result, it has been sparked off a debate on the future of dismissed sites, the unrivalled opportunity that these areas might represent in re-launching and acquiring strategic areas for future urban development.

In terms of *urban sustainability*, the rehabilitation of dismissed industrial areas fulfils two needs: 'necessity' and 'resource'.

'Necessity' refers to the reclamation of polluted lands, which represent a contamination threat against the surrounding areas. The threat is often due to the central location of these sites and their vicinity to densely inhabited areas. This is basically an engineering approach to the site.

'Resource' is referred to the potential benefit, both environmental and social, that a well-advised reuse of such large portions of territory can be for the macro and micro scale of the city. It refers to design strategies able to suggest a different idea of urbanity. Urbanity will arise from an unexpected and complex network of old and new; urbanity is meant as the coexistence of both official and un-official developments, i.e. a mixture of large and small scale.

What about the *heritage* value of abandoned industrial sites?

According to the definition of industrial heritage by The Nizhny Tagil Charter of 2003, as "the evidence of activities which had and continue to have profound historical consequences", the remains of dismissed industrial areas record historical and social events, technological and architectural experimentation, whose investigation would contribute to the understanding of our industrial past and present.

Therefore, they are not empty sites, valueless and ordinary locations. On the contrary, they are rich areas with in-built forces, energies and patterns that the passing of time has set and moulded. In most cases, the regions identity is tied to industrial sites. The industry bred towns and cities and even if they are no longer in use, that identity source still has not faded. For example, port cities retain their character long after their harbour has gone.

Therefore, this definition discloses how much abandoned areas are vital and confirm that the heritage they represent is not to be neglected (Powell, K., King, L., 2005).

Focusing on industrial canal zones, this paper will first investigate the characteristics of such heritage; secondly, the complexity of these areas and the multidisciplinary approach in the



process of transformation; finally, the management processes and methods used in the transformation of these abandoned areas.

The canal zone along the Zuid-Willemsvaart in B5 area, The Netherlands, will be the study case of reference.

## 2. Industrial canal zones: a multidisciplinary approach

Historically, industrial canal zones were intensively used in the ninetieth century and were the staging points for the import and export of goods. The water as infrastructure gave them a competitive advantage to industrial enterprises and they have been the major source of wealth for many cities. Nowadays, such wealth has resulted in environmental degradation and toxicity.

Similarly to those industrial waterfront areas along the seaside, canal zones are incredible opportunities for cities to be reconnected to their water's edge, in order to recapture economic investments and to attract people towards deserted and isolated areas.

Dictated by principles of mobility and efficiency, the morphological structure of canal zones is based on regular footprints. A canal imparts order to the territory and it is comparable to a 'street', which offers architecture and public spaces multiple ways of presenting its aesthetical and functional capacities. Sober buildings with a distinguishing character (and valuable expressions) often stand next to new ones, built on budget. Fragments of memory appear here and there. Streets are plain transportation routes whose width optimize machineries' needs and rapidity of connection. Peers and quays are sharp edges to the water. Water is no longer a dynamic force but has now turned into a stagnant one.

However, they stimulate our imagination, perception and inspire our memory. We should not forget that local and regional identities are tied to these sites.

Under attentive observation of canal zones, it is evident that they are articulated urban organisms where several features are in play; they do co-exist and are marked by interesting characteristics that imply *complexity*.

From the morphological viewpoint, we can distinguish two types of complexity in the canal zones: an internal one, based on the physical characteristics and logistics of the sites; an external one, which is based on the relationship that these sites have with their context.

Physically, the requirement for functional buildings (moving, storing and delivery of goods, such as the warehouses in Rotterdam) leads to unique architectural expressions (especially in the design of facades) and construction systems that turn the need into a highly creative virtue (in technical and aesthetical terms). Therefore, an attentive observation of the architecture of these buildings proves that they are not so ordinary and plain as they are commonly perceived.

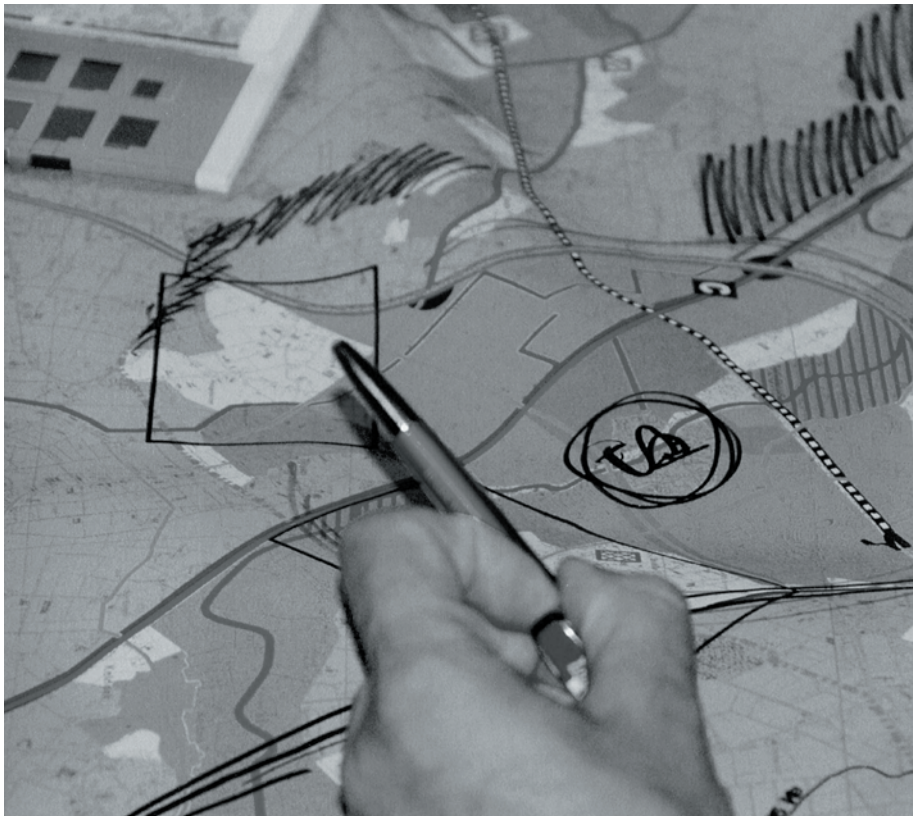
On the other hand, the scale of these buildings is often in contrast with the fine grain of the city to which they relate; this disruptive zone is very often the focus of transformation designs.

Last but not least, the presence of several land-ownership of these sites make the dialogue among the parties a very interesting piece in the process of reuse.

In the end, if we add to the aspects briefly mentioned above, the heritage values of industrial canal zones, we can understand the stratified layers and intertwining complexity that compose dismissed industrial canal sites. Therefore, interventions in these areas require an interactive presence of diverse competencies, from the ‘analysis of the problem’, along with the ‘concept of design’ and throughout the entire process of development. Design should be identified as a collective action, instead of individual product, so to respond to an explicit request by the ‘formal client’ and to optimize time in the formulation of the design answer. (Ciamarra M.P., 2009).

We should then ask ourselves how we can handle this complexity; which methods we should adopt and how we can monitor the level of efficiency in these processes.

The following project will attempt to answer these questions by employing the exchange between practice and experimentation as an operative method.



*Figure 1: Exchange between practice and experimentation as the management process.*

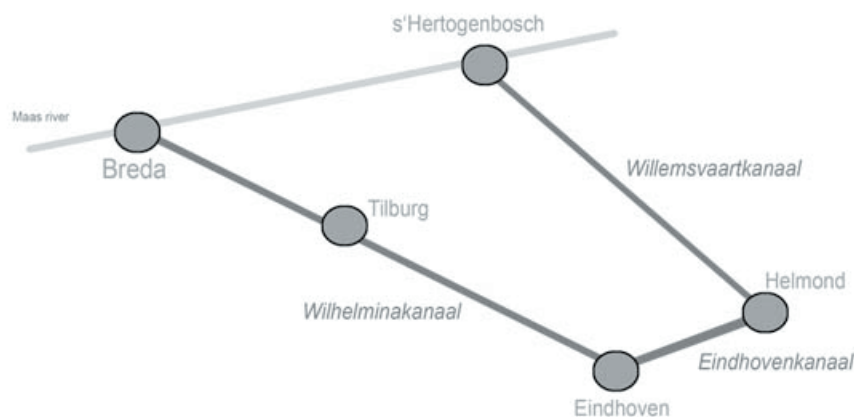
### 3. B5 and Zuid-Willemsvaart: site and problem field

#### 3.1. BrabantStad or B5 and canal zones

BrabantStad or B5 as commonly named, is the metropolitan area formed by the five Dutch cities of Eindhoven, Helmond, 's Hertogenbosch, Tilburg and Breda, which are located in the southern part of The Netherlands, the Brabant region.

In the past, Brabant was the leading industrial area of the country and economically able to provide one of the main sources of income. The industrial activity was primarily related to textile manufactures and the production of peat; goods were transported out through the large net of canals present in the area. Their construction started at the beginning of 1800 and canals were efficiently used and implemented until the 60's. At the end of this period, the decline of the area started. Large companies moved to new industrial areas that offered more facilities, such as larger harbours and better connections with railway and road infrastructures.

Nowadays, these cities strongly cooperate with each other; and infrastructures, cultural activities, design and innovations are some of the elements that promote the network among them. We can call it 'light' cooperation, driven by mutual goals that respect the diversity of each city, not with (political) pressure but rather with a stimulating competitiveness. B5 still remains a centre for industrial production. The increasing production by Philips (technological products) and competitiveness of the low-cost manufacture in India and China has offered a challenging opportunity to B5: how to renew the positioning of the five cities within the European/Global context?



*Figure 2: The 5 cities of BrabantStad (or B5) and the connecting canals*

From the urban and architectural point of view, these cities are connected to each other by two systems of canal: an outer one, a ring-like canal, that connects the five cities, while cutting through the open landscape formed by numerous heritage villages; an inner one, dead-end waterways, formed by dismissed canals characterized by notable buildings (some of them are listed monuments) on a different scale and architectural style. These dead-end canals were originally located at the edge of the historical urban structure, but nowadays have an internal location into the city fabric since the new urban development has absorbed them.



*Figure 3: Former industrial canal zones within the urban fabric of the 5 cities.*

### 3.2 Problem field

Every four years the five Brabant cities discuss a common program that establishes the actions on the territory through projects and finances. BrabantStad 2008-2012 is our planning period of reference. The experiment undertaken by the Province North-Brabant, named 'Atelier BrabantStad', that I will discuss in this paper, represents the first step in the process of negotiation of the common program.

The reuse of the canal zones is an important aspect in the political agenda' of the BrabantStad. The reasons are several: firstly, the canals are potential places of future urban development; secondly, their remains (buildings, in particular) are visible expressions of the regional industrial past and they are strong reminder of the identity of the area; thirdly, dismissed terrains (canal areas in our case) should be considered within the 'economy' of land in the Dutch territory, where not even a square centimetre of land can be left unproductive.

As a matter of fact, all five municipalities have ambitious programs and long for new design plans for their industrial waterfront areas. Some of them would like to focus on the revitalization of specific portions of the former industrial canal-zones; others envision a transformation of the old buildings towards new uses; all of them need a mixed program able to 'rejuvenate' these forgotten sites.

The approaches and questions concerning the enhancement of the historical value of the canal zones are very important in the transformation of these areas. Policies aiming at the maintenance of the industrial heritage should form the common background of interventions.

Indeed, all municipalities struggle with the pressure of economical issues and the power of investors and developers. Therefore, good intentions towards the industrial legacies are very likely to fall through. So, what should we keep of the existing heritage? Beside the ‘standard rules’ of evaluation, can other aspects influence the choice of keeping them? why and how should we demolish them?

The general trend is to transform ‘fragments’ of the larger area of development according to market needs and economical availability. The program of implementation appears to be poor when it comes to keeping an eye on complementarity among the five cities, or the identity of the sites. Standardization of open spaces seems to be the dominant rule.

The initiatives undertaken by the Province, in 2006 with the Atelier BrabantStad and the current research managed/developed by the University of Eindhoven, Department of Architecture, aims to engage all parties involved in the process of transformation so as to formulate a strategic common plan able to fulfil all demands within a short time. The enhancement of the heritage values has become a target at last.

Important notice: by ‘heritage’ we mean both those values embedded in buildings along the canal areas, the canals themselves and the landscape which the canal zones encounter through their course. To their ‘intrinsic values’ we should also add the ‘instrumental’ and ‘institutional’ ones so as to obtain a complete definition of the heritage value.

Nowadays, development is becoming more and more difficult due to the economical crisis. Nevertheless, the reuse of the former canal zones is a strong aim. Commitments by authorities, and concerns by citizens and investors on the future of these areas are exponentially increasing.

## 4. Four actions

The work undertaken by the Province North-Brabant and by the University of Technology of Eindhoven indicate a *modus operandi* whose aims are the following:

1. to investigate a full-scale dialogue on concepts and architectural quality in the canal development among stakeholders in this process.
2. to understand and enhance the industrial values of the existing canals
3. to illustrate how different design-based methods can serve as tools in the process.

In order to reach these aims, the actions undertaken explore the management system on two specific and interrelated scales: planning issues and building design strategies. This setup defines also the amount of actions, numbers of people involved and time frame for each activity.

We can single out four actions: Atelier BrabantStad 1, Atelier BrabantStad 2, Kanaalzones Atelier and Public Seminar.

### **Action 1: Atelier BrabantStad-1 (heritage management at regional level)**

Atelier BrabantStad aimed at understanding the space qualities and potentials of BrabantStad. It was a one year project (2006) started as an experiment of collaboration between national, regional and local governmental institutions. In fact, the parties involved were representatives of the 5 Municipalities of BrabantStad, of the Province Noord-Brabant and of the Ministry of VROM (Ministry of Housing, Spatial Planning and the Environment).

The atelier was located in Tilburg, one of the 5 cities of Brabantstad, in a 'neutral' zone and intentionally far away from central government. The activity was organized in 2 sessions whose aim was the integration of three specific topics: environments, connections and icons.

Combining research and practice, the atelier used the 'research-through-design' as operative methodology. The planning horizon was the year 2036.



*Figure 4: 'research-through-design' as operative methodology (Atelier BrabantStad1, 2006).*

### *Work activity*

The first session involved urban designers, landscape architects and architects. The focus was the relationship city-land and the individualization of potential areas between highly urbanized (red points) and low-density zones/villages (green points). These elements follow the advice of the Memorandum issued by the Ministry of Spatial Planning of The Netherlands (VROM, Nota Ruimte, 2006).

The second session involved representatives from those 'red' and 'green' points, investors, developers and experts from the cultural field (historian, anthropologist, etc.).

### *Result*

In design terms, the first result of the atelier was the definition of the spatial coherence of B5 cities, named 'mozaiek BrabantStad'. As a metaphor, the word 'mosaic' emphasized the strength of the 'tesserae', which lies in the differences of heritage values and cultural-history of built-up areas. Their colours and tones were used to suggest diversity, intensification of programs and their location.

Among the ten lessons (golden chances) we learned from the atelier, the canal zones had a special importance. They were regarded as the big secrets of B5 cities, to be enhanced in their heritage qualities and individuality and their reuse is indicated as a *must*. On a larger scale, canal zones were identified as an infrastructural network for transportation and recreational use; they were considered the backbone of B5, which allows circumscribed areas to grow and may sustain them.

The atelier indicated the necessity of reusing the canal zones and pointed out specific areas of interventions to operate on; but it did not highlight a common policy of reuse of the industrial heritage, which was referred to the municipalities.

In economical terms, the one-year atelier defined an investing program of € 1.000.000 for the period of four years.

Definitely, the intense collaboration between regional government and municipalities and the limited time span for the work, efficiently contributed to reach the collaborative investment (Samen Investeren): timing was perfect; the commitment by B5 and Province was high (the mindset was on cooperation). It is hard to measure the direct influence of the study on the different investments. What was new about the 'Samen Investeren' was the conceptual switch by the Province concerning the definition of heritage sites. It moved from 'traditional' rural areas to 'urban areas'.

### *Evaluation*

Reflecting on the process of the atelier, some considerations should be taken into account: first of all, the experimentation phase should have started earlier in the process; secondly, the discussion towards a common agreement on reuse of the built-up heritage could have been more specific in the agenda of the atelier; lastly, the formula ‘discussion and design’ (talking and drawing) generated enthusiasm, and this was an excellent ingredient for the success of the experiment.

The action towards the enhancement of the heritage values has to be seen within the framework of its ‘institutional value’, that is about the process and techniques used to create organizational legitimacy, public trust, accountability and organizational process.

### **Action 2: Atelier Brabantstad-2 (heritage management at urban level)**

Atelier BrabantStad 2 was a two-day workshop organized by the province, as an in-depth analysis of the previous action.



***Figure 5: Management through ‘discussion and design’ (talking and drawing), Atelier BrabantStad2, 2008.***



Compared to the Atelier BrabantStad 1 the brief of this new action limited the field of research to one specific canal area: the Zuid- Willemsvaart<sup>1</sup>, one of the 3 canals forming the outer ring of B5 and connecting the two main cities of 's Hertogenbosch and Helmond. The future of the canal was the goal and it was investigated according to its space potential, heritage meaning and programmatic transformation. The planned transformation of the existing provincial street, which is parallel to the canal, was an interesting combination of causes and prospective effects.

As in action 1, the workshop was held away from the governmental institution, in a neutral zone (on a boat) and it was attended by a higher number of participants. In fact, beside the representatives of the 2 cities of Helmond and 's Hertogenbosch, the province and government, an important role was played by the members from the industrial field, water management, different associations (from transport to engineering, etc.) and guest experts.

Once again, the formula research-by-design was adopted.

#### *Work activity*

It included a physical experience of the canal (walking) and a creative one (design). The six sluices, three of which were in the heritage list, were regarded as essential action points;

---

<sup>1</sup> In a brief history, this canal is dated 1822 and it was conceived as part of the 'Grand canal du Nord' (never realized and aiming at military purposes as in the wish of Napoleon Bonaparte). It is a long incision into the historical landscape of sand plateaus, turf pits and physically it connects the city of 's Hertogenbosch to Maastricht.

As a chain of bottlenecks, six sluices puncture the course of the canal and form complex architectural and engineering points for the navigation and the crossing from each other side of the waterway. Three sluices are actually listed monuments.

Economically, the canal was an important incentive to the development of industry due to its strategic relationship with the city of Liege in Belgium, where was located a large a flourishing centre of industries.

The 'heads' of the canal (within the B5) are two industrial zones from the 19<sup>th</sup> century, respectively on the northern and southern part of it. The first one is the industrial area of 'kop van 't Zand' related to the city of 's Hertogenbosch. Here are located the well-known buildings of 'sigarenfabriek Willem II' and de Verkadefabriek, respectively for the production of cigars and chocolate.

The south 'head' of the canal is the Kanaaldijk Noord-West area, related to the city of Helmond. Here are located the large footprints of the historical buildings of Vlisco's factory, a textile company dated 1846 involved in the production and exportation of wax-prints to the Dutch East Indies (the actual Indonesia).

furthermore, the sequential diversity of historical elements (buildings and landscape) and new implementations was considered a strong element of the area identity.

### Result

Three scenarios were developed. They were focused on: 1. the dynamic relationship between big cities and historical villages (bourgondisch scenario); 2. reuse of the canal zones within the inner fabric of the two main cities through the transformation of the existing industrial buildings for cultural purposes (bruisend scenario); 3. intensification of the areas for a new development.

The second scenario is of our interest as it clearly reveals the policy of reuse of historical industrial areas aimed at a high level of public use.



**Figure 6: creative discussion into operative process (Scenario 2) (Atelier BrabantStad 2,2008)**

Compared to the previous atelier, we can define this action with relation to the ‘instrumental value’ of heritage, which focuses on the benefit at a community level, mainly economic and environmental.

### **Action 3: Atelier Canaalzones (heritage management at architecture level)**

This ‘action’ is part of a research concerning architectural qualities at the Department of Architecture, TU/e Eindhoven. The “actions” include workshops, seminars and possibly development projects.

Scope is the intrinsic value of the heritage; the benefit derived from the built-up elements and its existence value.

Therefore, Atelier Canaalzones focuses on the transformation of the industrial canal zones located within each of the five cities. The architectural scale of the existing buildings, their influence on the close surrounding and the awareness about their role as a source of local identity are the core elements of the action.

Representatives from Province, Municipalities, students and guest advisors are involved in the activity.

#### *Work activity*

It consists of parallel design studios and seminars every academic semester. In this period the dialogue between students and members from the involved parties allows the exploration of different approaches to the heritage value, thus bringing a new and fresh perspective on the matter. Through the inventiveness of young designers and the experience of professionals and academics, theory and practice find their invaluable combination.



**Figure 7: Enhancing heritage values through the combination of theory (university) and practice (professionals) (TU/e, 2010)**

#### *Result*

The action is under way and it will last one more year. Step by step, the design results of each semester are synthesized in guidelines for a design brief addressed to professional designers.

### *Evaluation*

Although action 3 was not concerted together with the previous activities, it can be envisaged as their follow-up. This action adds to the quantitative and qualitative targets emphasized by the Atelier BrabantStad 1 and 2. They represent new outcomes aimed at increasing cultural awareness, skills and identity of the built-up elements and mean to prove the impact of the heritage.

#### **Action 4: Kanaalzone public seminar (to disseminate knowledge and awareness about the built heritage)**

This action is to come. It is conceived as the conclusion of the Kanaalzone atelier: representative of the five municipalities have requested it as a platform to compare and exchange strategies for the five canal zones.

The enthusiasm fired by the collaboration between University and official Institutions has inspired it.

## **5. Conclusion**

The above-mentioned actions adopt an open-end approach with dynamic development plans as its result. Design choices and strategies are adapted to the specific and evolving situation. This is also regarded as a challenge for the project itself. Interventions on heritage buildings are then projects that call for individuality and an original solution for each case. The experiences undertaken in the canal zones of B5 should not be expected to provide universal answers. They illustrate an approach in the management of the built heritage in a context of de-industrialization whose aim is to keep the spirit and evidence of the industrial past as wealth for the future.

It is a complex process, where the management has a key role in as much as it achieves successful results. The public management has a tactful and strategic position here. In fact, the representatives are figureheads responsible for perpetuating the focus in a long-term vision (2040) and success relies on the commitment of a few key players in the process. It is their concern to manage the balance between a long-term vision and short-term results. We should not forget that eventually the vision for 2040 has to be translated into investments for the near future. The participatory actions undertaken through the ateliers are instruments to achieve this goal.

An effectual management cannot disregard some essential ingredients. Firstly, it requires *openness*, both of mind and process. An open mind and attitude of the participating management should prove to be receptive/available to contribution and sharing while offering their professional competencies. The process of setting up the collaboration between University and Institutions as for the Canal zone atelier should be open in that it allows for experimentation and hence for research into unconventional solutions. It requires *creativity* in the way of

capturing the attention of potential important parties, as in the workshops of Brabantstd 1 and 2; and is able to raise the level of interest of the community (for example, the public seminar planned in action 3). It *enhances heritage values* through the combination of theory (university) and practice (professionals). Finally, it is *efficient* in saving time thanks to the presence of many experts under one roof who generate *enthusiasm* while working together for a common purpose.

The actions illustrated in this paper are a work-in-progress activity, and projects of implementations are only at their initial phase. Only the future can test the overall management process. Instead, what we have noticed so far is the increasing enthusiasm for the described activities. This adds to quality and ambitions in the development of our environment. An ever-growing number of professionals and students may be driven by the interest in acquiring and disseminating knowledge and research as they might be the prospective ‘managers’ of problem-areas of heritage value. Finally, realism and professionalism always generate enthusiasm into designing plans of the B5 urban growth in a 2040 perspective.

## References

- B5-Ruimtelijk Ordening (2007) BrabantStad Mozaiek metropool, NPN drukkers, NL
- Bosch Slabbers (2008) “Werksessie N279/Zuid-Willemsvaart”, Summary of the work session 10-11/9/2008.
- Ciamarra, M.P. (2009). Costruire nel costruito: un’azione multidisciplinare. In Bondonio A., Callegari G., Franco C., Gibello L., *Stop & Go. Il riuso delle aree dismesse in Italia. Trenta casi studio*, (pp.226-228). Firenze: Alinea Editrice.
- Powell, K., King, L. (2005). Introduction. In Powell, K., King, L., *Architecture reborn: the conversion and reconstruction of old buildings*, (pp. 6-18). London: New Line Books.
- TICCIH (2003, July 17). *The Nizhny Tagil Charter for the Industrial Heritage*. Moscow: The International Committee For The Conservation of the Industrial Heritage (TICCIH). Available online [http://www.mnactec.cat/ticcih/industrial\\_heritage.htm](http://www.mnactec.cat/ticcih/industrial_heritage.htm) [accessed on 10/08/ 2008]
- VROM (2006) Nota Ruimte (Memorandum by the Ministry of Housing, Spatial Planning and the Environment on the Future development of The Netherlands).



## **Inclusive Tourism and Barrier free Istanbul European Capital of Culture**

**Goksenin Inalhan**

Istanbul Technical University  
inalhang@itu.edu.tr

**Ash Sungur Ergeneoglu**

Yıldız Technical University  
asungur@gmail.com

### **Abstract**

Tourism is a rapidly growing industry in the Asian and Pacific region (ESCAP, 2001). This development has been fueled in part by the growing trend in the west for people to consider tourism and travel to be the social rights of all citizens (Darcy, 2006). Within the larger group of travelers and tourists, there is also a growing group of people with disabilities and older people who are also consumers of travel, sports, and other leisure-oriented services. Yet many of this group encounter obstacles that block their access to a significant number of existing tourism sites. This year, Istanbul, a popular tourism destination city in Euro-Asia, has been designated as the European Union's "European Capital of Culture," which gives it a chance to showcase its cultural life and cultural development. The choice of European Capital of Culture has traditionally served as a catalyst for the cultural development and the transformation of the honored city; therefore, Istanbul has found an opportunity to reassess the needs of the city and use this information as a tool to transform the city for good. Provision of accessible facilities is by far the most important area of concern for achieving barrier-free tourism for people with disabilities in Istanbul. To this end, Yıldız Technical University and Istanbul Technical University submitted a project proposal to 2010 Istanbul: The European Capital of Culture Committee to investigate the accessibility issues of the heritage sites in Istanbul. This study includes both a document on accessibility in the Historical Peninsula and route maps to be implemented within the scope of 2010-The Capital of Culture. The project has determined accessibility to the heritage sites, by classifying the Historic Peninsula into areas each covering a specific historical building/place or a landmark. Transportation routes have then been assessed and evaluated for the accessibility of each area. Guidance and alternative accessibility maps have been determined in order to make those routes accessible. The tourism market potential of disabled people is currently considerable and is likely to increase as the population ages, generating increasing demand for facilities and services. Any efforts for making heritage sites inclusive and accessible will provide guidance for those involved in the provision (designers, developers and owners of buildings) and management (facilities managers, local authorities) of environments and spaces.

## Introduction

Tourism is a rapidly growing industry in the Asian and Pacific region (UNESCAP, 2000; ESCAP, 2001). The global marketplace for tourists who are disabled is recognized as a niche market that is continuing to grow and develop (Prager, 1999; Ozturk et al., 2008; Freeman and Selmi, 2009). People with disabilities and older people are becoming a growing group of consumers of travel, sports, and other leisure-oriented services. Travel and tourism has also increasingly becoming a social right that concerns all European citizens (Darcy, 2006). Yet for many, some form of disability is considered to be the main obstacle blocking their access to many of the existing tourism sites.

The relationship between disability and aging is recognized as a challenge for the global tourism industry. This has been acknowledged in Europe and America and the tourism industries have been seeking ways to ensure that its infrastructure and products are accessible (Darcy, 2006). The availability of sufficient facilities and qualified human resources are preconditions to serving this market (Ozturk et al., 2008). Design, planning and any service operation that address the disability and seniors markets can benefit from the principles of universal design. Effectively, the majority of people will benefit from these provisions including the aging population, parents with strollers and employees, as it incorporates good design for a range of occupational health and safety requirements (Darcy, 2006).

The European Network for Accessible Tourism (ENAT) estimates that the potential market for accessible tourism in Europe is around 130 million people, with an annual spending power that exceeds 68 billion Euros. This number is made up of tourists with disabilities, older people, and pregnant women, families with small children and people with chronic health conditions or a temporary disability. All these people, and those with whom they travel, require accessible tourism. Because the world's aging population is increasing, that market will continue to grow and expand.

Lack of general accessibility has a direct and negative effect on tourist numbers; without good access many people can not travel, and the potential income they represent to business and communities is lost. Better access in tourism can lead to better quality, comfort and safety for everyone. Upgrading access is the means to achieving quality for all customers and new business opportunities for those who are prepared to take up the challenge (ENAT, 2010)

Helping the disabled obtain better service and greater protection of their rights when they travel by ensuring that their trips are barrier-free also encourages the enhancement of social welfare and community (Williams et al., 2006; Wu and Cheng, 2008). Provision of accessible facilities is by far the most important area of concern for achieving a barrier-free tourism for people with disabilities. The purpose of this study is to propose a barrier-less, or "accessible," tourism platform in the Historic Peninsula of Istanbul. It makes suggestions to facilitate the current travel information for the disabled persons that are willing to visit The European Capital of Culture 2010 Istanbul.



The key objectives of the study are:

- providing a framework for assessing access-related considerations for all visitors to the urban environments /heritage sites in Historical Peninsula of Istanbul
- utilizing the framework to audit key urban attractions in the Historical Peninsula of Istanbul
- evaluating the existing way-finding (route) systems to consider whether they create barriers to movement in and around Historical Peninsula of Istanbul
- suggesting alternative solutions to make existing way-finding system accessible
- making recommendations on accessible tourism to key stakeholders.

This article includes the following sections. Following the introduction as the underlying basis of our study, the subsequent section details the previous studies on accessible tourism and its market size along with its economic contribution. Having examined the literature and identified the key areas of concern of our study, the following section introduces the project design that was submitted to 2010 Istanbul: The European Capital of Culture Committee by Yildiz Technical University and Istanbul Technical University to access the accessibility issues of the heritage sites in Istanbul. The final section presents implications for research, design and managerial actions.

## 2. Literature Review: Disability, Aging and Tourism

According to the UK Disability Discrimination Act, a disabled person is someone who “has a physical or mental impairment that has a substantial and long-term adverse effect on his/her ability to carry out normal day-to-day activities” (Ozturk et al., 2008). There is also a significant relationship between aging and disability. Disabilities are strongly linked with age, and global societies are facing a growing number of people aged 75 and more, who are more likely to have impairments or disabilities. A person is 14 times more likely to have a disability by the time they reach age 65 than they were as a four year old. (Darcy et al., 2008)

The relationship between people with disabilities and tourism started to receive increasing academic and government attention during the last decade in Europe, the Americas and the Asia-Pacific (Darcy 2005). In his comprehensive literature review on accessible tourism, Darcy (2006) concluded that disability and tourism were largely an under-researched phenomenon. Since the World Tourism Organization (1991) resolution for Creating Opportunities for Handicapped People in the Nineties, a number of other international bodies have called for a coordinated approach to dealing with issues of disability and access in the travel and tourism industries (International Bureau of Social Tourism 1997; Community Based Rehabilitation Development and Training Centre 2000; United Nations Committee on Transport,

Communications, Tourism and Infrastructure Development 2000; International Congress on Inclusion by Design 2001; Vignuda 2001; United Nations Economic and Social Commission for Asia and the Pacific 2002; Walsh 2004; U.S. Architectural and Transportation Barriers and Compliance Board (Access Board) 2005).

At present, although the disabled customer's market is an important niche market for the tourism industry, Ozturk et al. (2008) concludes that academic research regarding the travel of disabled people has been limited (Burnett and Bender, 2001; Darcy, 1998, 2002; Israeli, 2002; Ray and Ryder, 2003). He points out that the earlier studies concerning disabled people and travel were carried out at the end of the 1980s and in the middle of the 1990s (Cavinato and Cuckovich, 1992; Driedger, 1987; Gleeson, 1997; Muloin, 1992; Murray and Sproats, 1990; Smith, 1987). There have been a few additional studies carried out more recently (Aitchison, 2003; Daniels, Rodgers, and Wiggins, 2005; McKercher, Packer, Yau, and Lam, 2003; Ray and Ryder, 2003; Yau, McKercher, and Packer, 2004, Ozturk et al., 2008). This indicates the need to develop a sound research base on which to make decisions about disability and tourism. Other people such as parents with strollers, people with injuries, and tourists with heavy luggage may also benefit from improved accessibility in tourism (Westcott, 2004; Ozturk et al., 2008).

## 2.1 Market size and economic contribution

There are more than 500 million disabled people in the world, a number that constitutes around 8% of the world population (UNESCAP, 2000). The disabled customers' market is becoming an increasingly important developing market in the tourism industry worldwide (Ozturk et al., 2008).

As cited in the works of Ozturk et al. (2008) according to research carried out by Touche Ross (1993), 8 million disabled people in Europe take a trip abroad at least once per year. In addition, 15 million European disabled people travel within their own country and an additional 22 million European disabled people participate in daily excursions in their own country. If the companions of disabled people are taken into account, the potential demand for travel will exceed these figures. According to Pfenning (2002), this phenomenon would continue in the future and an estimated 96 billion would have been spent on travel by people with disabilities by 2005. It cannot be denied that disabled people are a potentially important customer component for the tourism sector as more are reclaiming their right to travel around the world. Opening up this market could generate billions of euros for the travel industry (Arellano, 2003). It is essential that countries that wish to expand their incoming travel markets should have the necessary facilities in place and an understanding of how to service the special needs of tourists with disabilities (Shaw- Lawrence, 1999; Ozturk et al., 2008).

## 2.2 Disability access and built environment/disabled tourism legislation

Traveling for any purpose can, and should be, regarded as a human right throughout the world and depriving anyone of this right should be regarded as discrimination. Governments have to take measures to provide ease of travel for all people.

The Law for Americans with the Disabilities Act (ADA) enacted in the USA in 1990, and the Law of the Disability Discrimination Act (DDA), which was passed in England in 1995, both play an important role in the tourism industry. These laws require some obligations from hotel administrations in terms of usage of services by disabled people (Miller and Kirk, 2002).

In Turkey, the ‘Law for Disabled People’ drawn up in July 2005, aims to help disabled people by alleviating problems in relation to health, education, rehabilitation, employment, care and social security. The law also aims to assist their development in every aspect by taking measures to remove any obstacles and making the relevant arrangements for the coordination of these services (Item I). According to this law, within seven years of the implementation of the act, facilities for disabled people must be put in place, in terms of them being able to access buildings that belong to public institutions, roads, sidewalks, pavements and public places. Another law, the Code of Practice (18/c) of Law 2634 states that arrangements must be made for disabled people to use tourism enterprises (Ozturk et al., 2008).

Access to tourism is a right for everyone that has been assured by the UN Convention on Rights of Persons with Disabilities (Table 1). Over 140 countries have signed the Convention, including the European Union and the USA. Despite this, the European Network for Accessible Tourism claims that the work of implementing the Convention’s aims and targets still remains to be done.

The American with Disabilities Act (ADA) states in section 4.3.2 under the title of “Accessibility Guidelines for Buildings and Facilities” the following:

“At least one accessible route within the boundary of the site shall be provided from public transportation stops, accessible parking, and accessible passenger loading zones, and public streets or sidewalks to the accessible building entrance they serve. The accessible route shall, to the maximum extent feasible, coincide with the route for the general public.”

Accessibility is determined by the spatial distribution of potential destinations, the ease of reaching each destination, and the magnitude, quality, and character of the activities found there (Handy and Niemeier 1997; Nicholls, 2001). The greater the number of potential destinations within some defined time or distance range, the greater the accessibility.

Table 1: UN Convention on the rights of persons with disabilities, Article 30 (excerpt)

<b>UN CONVENTION ON THE RIGHTS OF PERSONS WITH DISABILITIES</b>
Article 30 : Participation in cultural life, recreation, leisure and sport (Excerpt)
1. States Parties recognize the right of persons with disabilities to take part on an equal basis with others in cultural life, and shall take all appropriate measures to ensure that persons with disabilities: (a) Enjoy access to cultural materials in accessible formats; (b) Enjoy access to television programs, films, theater and other cultural activities, in accessible formats; (c) Enjoy access to places for cultural performances or services, such as theaters, museums, cinemas, libraries and tourism services, and, as far as possible, enjoy access to monuments and sites of national cultural importance.
2. States Parties shall take appropriate measures to enable persons with disabilities to have the opportunity to develop and utilize their creative, artistic and intellectual potential, not only for their own benefit, but also for the enrichment of society.
3. States Parties shall take all appropriate steps, in accordance with international law, to ensure that laws protecting intellectual property rights do not constitute an unreasonable or discriminatory barrier to access by persons with disabilities to cultural materials.
4. Persons with disabilities shall be entitled, on an equal basis with others, to recognition and support of their specific cultural and linguistic identity, including sign languages and deaf culture.
5. With a view to enabling persons with disabilities to participate on an equal basis with others in recreational, leisure and sporting activities, States Parties shall take appropriate measures:  (a) To encourage and promote the participation, to the fullest extent possible, of persons with disabilities in mainstream sporting activities at all levels; (b) To ensure that persons with disabilities have an opportunity to organize, develop and participate in disability-specific sporting and recreational activities and, to this end, encourage the provision, on an equal basis with others, of appropriate instruction, training and resources; (c) To ensure that persons with disabilities have access to sporting, recreational and tourism venues; (d) To ensure that children with disabilities have equal access with other children to participation in play, recreation and leisure and sporting activities, including those activities in the school system; (e) To ensure that persons with disabilities have access to services from those involved in the organization of recreational, tourism, leisure and sporting activities.

## 2.3 Accessible Tourism- A Europe Accessible for All

Darcy (2006) defines accessible tourism as a process of enabling people with disabilities and seniors to function independently and with equity and dignity through the delivery of universal tourism products, services and environments (adapted from Olympic Co-ordination Authority 1999). The definition is inclusive of the mobility, vision, hearing and cognitive dimensions of access.

Though accessible tourism is not defined in any of the government documents, accessibility has been high on the political agenda for a long time now, at EU as well as at global levels. Many commitments have been made over the years, which have helped deliver an extensive body of political declarations, technical standards and guidelines. Most recently, there has been a call for the tourism industry to adopt universal design principles as a foundation to achieving greater social sustainability (Rains 2004).

In 2003, the European Commission and the disability movement organized the European Year of People with Disabilities to underline barriers and discrimination faced by disabled people. Travel and tourism has increasingly become a social right that encompasses all European citizens. However, it has been estimated that over 40 million Europeans still do not take holidays. For many, some form of disability is considered to be the main obstacle blocking their access to many of the existing tourism offers.

Promoting accessibility for all will also contribute to the success of the European strategy of "economic and social renewal" launched at the Lisbon European Council. The European Union has committed itself to modernizing and reinforcing social cohesion and social protection as a key to deliver more and better growth by 2010 and to making Europe a better place to live. To this end, it established the the "Lisbon strategy," which is based on four strategic goals: raising competitiveness, achieving full employment, strengthening social cohesion and promoting sustainable development.

The European Year has created a momentum throughout Europe behind a rights-based, inclusive approach to disabilities. In this context, the next section introduces the proposal to make the city of Istanbul, which has been designated by The Council of European Union as European Capital of Culture for 2010, barrier free for tourism.

## 3. Case Study: Istanbul European Capital of Culture 2010

The European Capital of Culture is a city designated by the European Union for a period of one calendar year during which it is given a chance to showcase its cultural life and cultural development. The Culture program aims to achieve three main objectives: to promote cross-border mobility of those working in the cultural sector; to encourage the transnational circulation of cultural and artistic output; and to foster intercultural dialogue.

This year, Istanbul which is popular tourism destination city in Euro-Asia, has been designated The European Capital of Culture by the European Union.

As a city that has been home to countless civilizations and cultures throughout history, today Istanbul has a meaning and importance for significant amount of people of various historical, cultural and religious backgrounds. Having been designated by The Council of European Union as European Capital of Culture for 2010, together with Essen and Pecs, Istanbul is now in the midst of totally new developments. . As Artistic Director of the Berlin European Capital of Culture Nele Hertling stated, “Knowing the needs of our city and using this formation as a ‘tool’ is needed to have good results in the process. Throughout its history the choice of European Capital of Culture has served as a catalyst for the cultural development and the transformation of the city. Therefore an opportunity has arisen to reassess the needs of the city and use this information as a tool to transform the city for good.”

Provision of accessible facilities is by far the most important area of concern for achieving a barrier-free tourism for people with disabilities in Europe, and in Istanbul as well. With this in mind, Yildiz Technical University and Istanbul Technical University submitted a project proposal to 2010 Istanbul: The European Capital of Culture Committee aimed at evaluating the accessibility issues of the heritage sites in Istanbul. In the framework of this project, a document on accessibility in the Historical Peninsula and route maps are being prepared to be implemented within the scope of 2010- The Capital of Culture.

Architecture students of these two collaborating universities are participating in the survey of the historic sites in Historic Peninsula of Istanbul. As an approach, in order to access the heritage sites, The Historic Peninsula has been classified into areas that each encompass a historical building/place/ landmark or of a place of interest of another kind. Each designated part of the area is distributed to a team of students.

The accessible site design process is divided up into four sections; research phase, analysis phase, synthesis phase, and implementation phase.

### **Research Phase:**

An understanding of the site and its environment is an integral part of making it accessible by all. The first step is to define the site and its historical background. Having done the research on existing and potential conditions of the historic site, students have started to analyze each area from the accessibility point of view. In each area, two or three routes are determined so that the routes lead to the particular historical building/place, landmark or the place of interest, starting from a point of a bus landing area, a car park, etc. Within this phase a framework for assessing access related considerations for all visitors to urban environments /heritage sites in Historical Peninsula of Istanbul is provided and utilized.

**Analysis phase:**

This stage involves deciphering opportunities and constraints within the proposed site. SWOT analysis as a strategic planning method is used to evaluate the Strengths (to maintain, build and leverage), Weaknesses (to remedy or exit), Opportunities (to priorities and optimize), and Threats (to counter) involved in the site's for making it accessible. An inventory of the site factors and forces, and how they coexist and interact is prepared. The purpose of the analysis is to provide thorough information about the site assets and liabilities prior to starting the design process. Only in this way can concepts be developed that incorporate meaningful responses to the external conditions of the site to make it accessible.

Numerous site analyses are done to evaluate the elements of site including heritage conservation area, location, neighbourhood context, site boundary and zoning, legal elements, natural physical features (existing vegetation), man-made features, circulation (pedestrian movement/vehicular movement), utilities, sensory, human and cultural components. At the end of this phase the evaluation of existing way-finding (route) systems is considered and a determination as to whether they create barriers to movement in and around Historical Peninsula of Istanbul is made.

**Synthesis phase:**

By taking account the site's existing/future problems and capabilities a program is developed to make the site accessible. As the main concentration point was to maintain accessible routes for all, leading to areas and buildings of an ultimate importance like Hagia Sophia, the current situation of those routes is determined and suggestions are developed for every aspect of the route by means of accessibility for all. By the end of this phase alternative solutions are suggested to make the existing way-finding system accessible in the Historical Peninsula of Istanbul. Drawings, sketches and photographs of the probable solutions are all prepared in the design process of this phase.

**Implementation phase:**

The last part of the project, a document on accessibility in Historical Peninsula is prepared. The divided areas of the historic peninsula are then all integrated. Several design solutions coming from each group are compared and contrasted. The accessible route maps for the whole Historical Peninsula are prepared to be implemented within the scope of 2010- The Capital of Culture. Not all the accessibility issues addressed in Historical Peninsula can be solved by design. Legislation and management issues of making the heritage sites are also very important; so, the document also provides recommendations on accessible tourism to the different levels of key stakeholders.

## 4. Conclusion

The tourism market potential of disabled people is currently considerable and is likely to increase as the population ages, generating increasing demand for facilities and services. In view of this changing consumer demand, tourism for all is an increasingly important sales argument in a competitive market. However, taking advantage of this potential niche market will depend on how the tourism sector as a whole and the tourism industry in particular will address the issue of tourism accessibility for people with disabilities. This can also serve as an effective tool in furthering the human rights of people with disabilities in destination communities (UNESCAP, 2000).

Although the number of tourists who would benefit from accessible facilities and services is on the increase, most tourism services providers have still not yet recognized the importance of taking action on this issue. Most facilities and tourist sites are not physically accessible for many people with disabilities and older persons.

It is recognized in the literature that there are three key issues that require immediate attention to make tourism barrier-free for people with disabilities (UNESCAP, 2000; ESCAP, 2001),

- (a) The formulation and implementation of related legislation in order to protect the right of persons with disabilities to accessible facilities and environment;
- (b) Education and training on awareness and sensitivity to disability issues; and
- (c) Provision of accessible facilities in the tourism sector.

At the EU level, although the Commission has launched a debate on the sustainability of cities, including their accessibility, much remains to be done as far as a global approach is concerned. We must recognize that, despite these longstanding commitments to achieving accessibility, concrete improvements were not made at all levels concerned. Regulations and standards, where they exist at all, are not implemented and enforced properly everywhere (EU Commission Report 1996, 2003). That is because accessibility is often dealt with on a technical basis, which implies a division between various areas of expertise. However, accessibility for all can only be dealt with as an inclusive process through an integrated and coordinated approach. Such a shift in policy requires the involvement of many actors and the definition of an agenda based on many instruments, ranging from legislation to financial support, to be affected through public authorities and the private sector.

Facility managers can play a key role in facilitating an integrated and coordinated approach in making the environments barrier free and accessible. They can provide guidance on developing strategies to ensure that the opportunities and services available to users are inclusive and, importantly, how they can be maintained in coordination with all the actors involved in the provision (designers, developers and owners of buildings) and management (facilities managers, local authorities) of environments and spaces.



## References

- Aitchison C (2003) From leisure and disability to disability leisure: Developing data definitions and discourses, *Disability and Society*, 18(7), 955–969.
- Arellano L (2003) Broadening horizons, *Travel Agent*, 311(10):21–22.
- Burnett J and Bender B H (2001) Assessing the travel-related behaviors of the mobility-disabled consumer, *Journal of Travel Research*, 40: 4–11.
- Cavinato J L and Cuckovich M L (1992) Transportation and tourism for the disabled: An assessment, *Transportation Journal*, 31(3): 46–53.
- Church R L and Marston J R (2003) Measuring Accessibility for People with a Disability, *Geographical Analysis*, Vol. 35, No. 1, The Ohio State University
- Daniels M J, Rodgers E B D and Wiggins B P (2005) Travel tales: An interpretive analysis of constraints and negotiations to pleasure travel as experienced by persons with physical disabilities, *Tourism Management*, 26(6): 919–930.
- Darcy S (1998) *Anxiety to access: Tourism patterns and experiences of disabled New South Wales people with physical disability tourism*, Sydney, New South Wales.
- Darcy S (2000) *Tourism Industry Perspectives of Providing Facilities and Services for People with Disabilities: A Scoping Study of the Accommodation Sector*. Sydney, New South Wales, Australia: NSW Department of Aging and Disability.
- Darcy S (2002) Marginalized participation: Physical disability, high support needs and tourism. *Journal of Hospitality and Tourism Management*, (9): 61–72.
- Darcy S (2004) 'Disabling Journeys: the Social Relations of Tourism for People with Impairments in Australia - an analysis of government tourism authorities and accommodation sector practices and discourses', Unpublished PhD thesis, Faculty of Business, University of Technology, Sydney.
- Darcy S (2005) *Disability and Tourism Online Bibliography*, viewed 19 May 2010, [www.business.uts.edu.au/leisure/research/disability.html](http://www.business.uts.edu.au/leisure/research/disability.html)
- Darcy S (2006) *Setting a Research Agenda for Accessible Tourism*. Gold Coast: Sustainable Tourism for Cooperative Research Centre.
- Darcy S, Cameron B, Dwyer L, Taylor T, Wong E and Thomson A (2008) *Visitor accessibility in urban centres*, Cooperative Research Centre for Sustainable Tourism.

Driedger D (1987) Disabled people and international air travel, *Journal of Leisurability*, (14)13–19.

ESCAP Report (2001) Promotion of barrier- free tourism for people with disabilities in the Asian and Pacific Region, Seminar on Sustainable Development of Ecotourism in Pasific Island Countries.Suva, Fiji: Economic And Social Commission For Asia And The Pacific, Tourism Unit,Transport, Communication,Tourism and Infrustructure Development Division.

European Commission (1996) Making Europe accessible for tourists with disabilities: Handbook for the tourist industry. Luxemburg: European Communities.

European Commission (2003) 2010: A Europe Accessible For All. Report from expert group set up by European Commission, Luxemburg: European Communities.

Freeman I and Selmi N (2009) French versus Canadian Tourism: Response to the Disabled *Journal of Travel Research*, OnlineFirst, (published on October 27).

Gleeson B J (1997) Disability studies: A historical materialist view, *Disability and Society*,12(2): 197–202.

Guerra L S (2003) Tourism For All: Organising Trips For Physically Disabled Customers, Unpublished MA Thesis, European Tourism Management, Bournemouth University, UK.

Handy S L and Niemeier D A (1997) Measuring Accessibility, An Exploration of Issues and Alternatives. *Environment and PlanningA*, (29):1175–1194.

Israeli A A (2002) A preliminary investigation of the importance of site accessibility factors for disabled tourists. *Journal of Travel Research*, 41(1):101–104.

McKercher B, Packer T, Yau M and Lam P (2003) Travel agents: Facilitators or inhibitors of travel for people with disabilities. *Tourism Management*, (24):465–474.

Miller G A and Kirk E (2002) The disability discrimination act: Time for the stick? *Journal of Sustainable Tourism*, 10(1): 82–88.

Muloin S (1992) Wilderness access for persons with a disability. In G. Harper, & B. Weiler (Eds.), *Ecotourism* (pp. 20–25). Canberra: Australian Bureau of Tourism Research.

Murray M and Sproats J (1990) The disabled traveler: Tourism and disability in Australia. *Journal of Tourism Studies*, (1) 9–14.

Newell A F and Gregor P (2002) Design for older and disabled people – where do we go from here?, *Universal Access in the Information Society*, (2): 3– 7.

Nicholls S (2001), Measuring the accessibility and equity of public parks: a case study using GIS, *Managing Leisure*, (6):201–219.

Ozturk Y, Yayli A, and Yesiltas M (2008) “Is the Turkish Tourism Industry Ready for a Disabled Customer’s Market?” *Tourism Management*, 29 (2): 382-89.

Pfenning A (2002) Hospitality and travel needs of the disabled. *Travel Weekly*, 61(33): 10.

Prager J H (1999) “People with Disabilities Are Next Consumer Niche.” *Wall Street Journal*, pp. B1-B2 (published on December 15).

Ray N M and Ryder M E (2003) Abilities tourism: An exploratory discussion of the travel needs and motivations of the mobility-disabled, *Tourism Management*, (24): 57–72.

Rains S (2004) Universal Design and the International Travel & Hospitality Industry. Paper presented at the Designing for the 21st Century III, Rio de Janeiro, Brazil, 7-12 December.

Shaw-Lawrence P (1999) Enabling the disabled. *Travel Weekly*, 59(91): 8.

Touche Ross and Co. (1993) *Tourism for all in Europe: Profiting from opportunities, A new market for tourism*. London: Touche Ross and Co.

Turco D M, Stumbo N and Garnearz J (1998) Tourism constraints for people with disabilities, *Parks and Recreation*, 33(9): 78–84.

UNESCAP Report (2000) Conditions to promote barrier-free tourism for people with disabilities and older persons. Presentation at the national workshop on sustainable tourism development in China. Tianjin, China: Economic and Social Commission for Asia and the Pacific (ESCAP).

Westcott J (2004) Improving information on accessible tourism for disabled people, The European Commission. [http://ec.europa.eu/enterprise/services/tourism/policy-areas/doc/improving\\_accessibility\\_en.pdf](http://ec.europa.eu/enterprise/services/tourism/policy-areas/doc/improving_accessibility_en.pdf) [Accessed 19.05.2010].

Wu Yen-Chun J and Cheng Ming J (2008) "Accessible Tourism for the Disabled: Long Tail Theory ", Proceedings of the 1st World Summit on the Knowledge Society (WSKS'2008), M.D. Lytras et al. (Eds.), *Communications in Computer and Information Science (CCIS) Vol. 5288*, Springer-Verlag, Berlin, pp. 565-572.

Yau M K, McKercher B and Packer T L (2004) Traveling with a disability: More than an access issue. *Annals of Tourism Research*, 31(4): 946–960.



# Gentrification and city improvement districts: a case study of residents' perceptions in Claremont, South Africa

**Cattell, Keith**

University of Cape Town, Department of Construction Economics and Management  
keith.cattell@uct.ac.za

**Michell, Kathy**

University of Cape Town, Department of Construction Economics and Management  
kathy.michell@uct.ac.za

**Bowen, Paul**

University of Cape Town, Department of Construction Economics and Management  
paul.bowem@uct.ac.za

**Florence, Tim**

University of Cape Town, Department of Construction Economics and Management

## Abstract

City Improvement Districts (CID) have emerged as an effective form of urban facilities management. The issues that surround the handing over of the governance of public urban spaces to private enterprise are not yet fully understood. This paper presents case study research on the residents living in the Claremont CBD, South Africa and its surrounding neighbourhoods. It explores the link between the work done by a CID organisation and gentrification, and how the changes brought about by this gentrification impacts on the residents. The paper provides greater insight into how the residents of the area perceive the CID organisation in light of the changes taking place. The research establishes that the gentrification of Claremont has been significantly influenced by the work done by the Claremont Improvement District Company (CIDC). Furthermore, through the analysis of survey data collected from the residents living in a defined area surrounding the Claremont CBD, the study finds that these residents regard the changes brought about as a result of this gentrification to be (largely) positive.

**Keywords:** Urban Facilities Management, City Improvement Districts, Gentrification

# 1. Introduction

## 1.1 Background to the research

City Improvement Districts (CIDs) emerged as an effective form of urban governance in New York City during the 1980s (Ward, 2006). Over one thousand cities across the USA and Europe have adopted CIDs as a strategy to develop the local economy and revitalise urban space (Miraftab, 2007). CIDs are also found in developing countries, with over 40 in South Africa alone (Hoyt, 2005). CIDs have achieved clear successes - reduced crime, cleaner streets, improved services, increased investment and successful marketing campaigns are reported in the literature – which are attributed to the freedom, autonomy and self-interest with which these CID organisations operate (Hoyt, 2005). But at what costs have these successes been achieved? Hoyt (2005:26) points out that the handing over the governance of public urban spaces from “general-purpose representative governments to special-purpose commercial clubs (i.e. CIDs)” could have some significant consequences for the area concerned. She encourages these consequences to be explored, stating that the “systematic impacts (of CIDs) should be the subject of ongoing research and evaluation” (Hoyt, 2005:26). The study reported in this paper is a response to this prompt, and specifically investigated gentrification in the residential neighbourhoods surrounding a CID.

## 1.2 Research design and method

CIDs provide clear benefits for businesses in the area, and in the context of residential areas, neighbourhood watches and the like, function similarly. However, the changes that come about as a result of their introduction are described in the literature on gentrification as being potentially positive or negative, depending on who evaluates them. Since the case study area of Claremont Central Business District (CBD) has a CID that is exclusively supported by businesses and managed by the Claremont Improvement District Company (CIDC), it is unclear what the effect on residents in the immediate and surrounding areas has been. What impact has the Claremont Improvement District Company had on the residential neighbourhoods surrounding the CIDC’s area of jurisdiction? The aim of the research was to establish whether or not gentrification is occurring in the neighbourhoods surrounding the Claremont CBD - and to determine whether the CIDC has caused this gentrification - by analysing residents’ perceptions of the changes occurring in their neighbourhood. Gentrification is occurring in the neighbourhoods surrounding the Claremont CBD due to the influence of the CIDC and the residents living in these neighbourhoods perceive this to be a negative change process. Since the research investigates a “contemporary phenomenon in a real-life context” (Yin, 2003), a single case study was undertaken. Two chief sources of evidence were used, namely a postal questionnaire survey and telephone interviews of residents. The survey was limited to those residents living within or in close proximity (1-2 km) to the boundary of the CIDC’s area of direct control. Only residents were surveyed. Other interested parties such as business owners

and informal traders within Claremont were excluded from the research. The response rate for the postal questionnaire survey (7.6%) could possibly be considered too small for valid conclusions to be drawn. Further, given that participation in the survey was voluntary, there is a possibility that the views expressed by the respondents do not necessarily reflect those of the population that did not respond. The number of interviewees in the follow-up survey (14) may be also be unrepresentative of the entire residential population.

### 1.3 Context of this study

Claremont is a suburb of the City of Cape Town, but had previously been a separate municipality. It thus has a commercial district, situated on the main road that runs through all of Cape Town's Southern Suburbs. Following many years of degradation and disinvestment, initial attempts at rejuvenating the Claremont CBD began in the early 1990s under an informal body called the Claremont Business Forum. Then, in 2000, after the City Improvement District by-law was promulgated by the City of Cape Town, this body developed into an official legal entity known as the Claremont Improvement District Company (CIDC) (Claremont Central, 2008). The CIDC's area of jurisdiction includes all of the commercial properties in the area, and excludes residential properties. The CIDC's vision is to make Claremont the premier retail, commercial and professional destination in the Cape Peninsula (Claremont Central, 2008). There is abundant evidence to suggest that the CIDC has delivered on this mission - the Claremont CBD has undergone a dramatic facelift over recent years, attracting major capital investment in commercial and residential apartment projects (Claremont Clarion, 2006). Previous studies conducted by Sandes (2006) and Vorster (2007) concluded that gentrification was taking place in the CIDC's area of jurisdiction and the surrounding neighbourhoods and that this was having a negative impact on the various stakeholders in the area (*i.e.* businesses, informal traders and residents). The sample sizes of residents used in these two studies were arguably too small to produce reliable conclusions. This study thus focused exclusively on the impact that the gentrification in Claremont is having on the residents living in the area, with the aim of improving the findings of these previous studies with an increased sample size.

## 2. Literature review

A city improvement district (CID) is a zone within a city that receives additional privately funded services for security, cleaning and marketing. CIDs are also referred to as "Business Improvement Districts", "Business Improvement Areas" and "Municipal Improvement Districts" (Hoyt, 2005). Businesses within the CID pay additional fees to their municipal bills in the form of a tax or levy (Miraftab, 2007). These services do not replace those provided by the local authorities, nor do they result in a reduction of these services, they merely top up gaps between what municipalities provide and what businesses desire (Hoyt, 2005). The CID model of governance was adopted due to "declining urban economies and failing city government responses (to the problem)" (Ward, 2006:70). CIDs are managed by non-profit, private partnerships between local government and businesses, which oversee services provided by

both the municipality and private contractors within the CIDs (Miraftab, 2007). The main aim of CIDs is to improve the economic conditions of a business area and all of the projects undertaken by CID management should aim to make the area more prosperous (Dawkins and Grail, 2007). There has been a global movement towards CIDs since the practice first emerged in Toronto in the early 1970s. However, they were brought to the public's attention during the 1980s when the then Mayor of New York, Rudi Giuliani, adopted them as a way to combat urban economic decline (Miraftab, 2007). Ward (2006) notes that this was the first time that CIDs were seen to privatise previously 'public' spaces. They did this by "redefining the ways in which urban areas were policed, involving itself in the transformation of New York's midtown into one big theme park and removing those whose activities/behaviour/look did not fit in with the image-building exercises at work" (Ward, 2006:63). New York was able to reduce crime and to attract new investment through the private and public sectors working together. The success stories of New York's CIDs meant that they, and their policies, became the model for other countries looking to adopt the same form of urban management (Ward, 2006). CIDs now exist in over one thousand cities in sixteen countries across four continents. CIDs can be viewed (Ward, 2006; Peck, 2003) as 'policies in motion' representing a new wave of neo-liberal urbanisation: "a new mode of governance rules, regulations, programs, and policies to resuscitate cities as sites for capital accumulation" (Wilson, 2004:771).

CIDs differ with regard to policies and objectives from one city to another, as well as from CID to CID within cities (Hochleutner, 2003). Hoyt's (2005) study on CIDs in the USA, Canada, New Zealand and South Africa confirms this. She found that CIDs in the USA, Canada and New Zealand focussed on consumer marketing as a tool to attract visitors and investors from surrounding areas in order to combat the attractions provided by suburban shopping centres, while in South Africa they concentrate more on safety and security. Uniquely, South African CIDs were also found to supplement social services, confronting issues such as homelessness and drug abuse among children. In her research on the implementation of CIDs in Cape Town, Miraftab (2007) reflects on the Cape Town Partnership's (CTP) objective – working through the CIDs (of which the CIDC is one) – of creating a world class, globally competitive city. This objective, she argues, is "fundamental to the CTP's elitist practices in establishing CIDs" (Miraftab, 2007:606). She supports this view by describing how the CTP partnered with major real estate development companies in bringing about a real estate boom in the downtown CIDs, and how it is seeking to emulate New York and London downtown living and their privileged lifestyles by developing upmarket apartment complexes. Further, Miraftab (2007:608) claims that "the CTP uses regulatory practices that socially sanitize public space in the city's CIDs", giving examples of the treatment of informal traders and homeless people, amongst others, to validate this point. In the case of informal traders, Miraftab (2007) found that the CTP is trying to remove them from all CID sidewalks to designated market spaces, commenting "while this may suit big businesses and look orderly to visitors, they are not the busy markets that serve the local low-income clientele" (Miraftab, 2007:610). Furthermore, Miraftab's (2007) research found that bylaws in Cape Town, unchanged from the years of Apartheid, make homelessness and poverty offences under the law. She claims that such bylaws are ignored in the city as a whole, but are expected to be enforced within the CIDs and have resulted in countless homeless people being displaced from CID areas in Cape Town since their inception in 2000. While



homelessness can be regarded as an undesirable characteristic of an urban area, these people also have a right to public space, a view by Miraftab (2007). Finally, Miraftab (2007:613) warns: "...the city centre's real estate boom and the pressing gentrification of adjacent neighbourhoods are aggressively displacing residents with middle and lower incomes." Kotze and van der Merwe (2000) studied six inner city neighbourhoods within 4km of the CTP's area of operation and concluded that the urban renewal processes taking place in two of them could be defined as gentrification, in terms of the gentrification profile they compiled for Cape Town. However, they found that the urban renewal process in the other four areas was not sufficiently advanced for this conclusion to be drawn. Despite Miraftab's (2007) negative observations, CIDs in Cape Town have achieved a number of successes. The Cape Town Partnership (2008) claims that the Central City CID has made a definite impact, which includes successes in the areas of: *Urban regeneration* (crime reduced, new building construction, old building renovation and quality urban management); *Investment* (restored investor confidence in the central city - capital value of current leases, new developments, investment purchases, upgrades and renewals is R11bn<sup>1</sup>); *Economic growth* (CBD has experienced phenomenal economic growth since the introduction of the new urban management scheme, many businesses thriving); *Pedestrian routes and public space upgrades* (upgrade of public spaces and pedestrian areas resulting in increased use); *Poverty reduction and social development* (homeless placed in shelters and offered job opportunities by the CTP). The Claremont CID can also claim some significant successes. Capital investment – worth an estimated R1.8bn (Claremont Clarion, 2006) – in retail, commercial and residential developments mirrors the investment going into the Central City CID. A significant feature of this wave of investment was the R48 million CIDC-City of Cape Town joint venture Claremont Boulevard bypass and taxi/bus interchange, part of which had been on the City's agenda for over 40 years, but had never been implemented due to budgetary constraints (Koblitz, 2007).

The negative proposition adopted for this study was prompted by Hoyt's (2005) suggestion that the property and business owners who initiate and oversee CID organisations are motivated by self-interest and not by the needs of the wider community. Accordingly, their work in revitalising urban commercial areas is for the purpose of protecting or increasing the returns on their investments. They do this by improving "the physical, economic and social conditions within their geographical jurisdiction in a way that serves their own interest and those of their customers" (Hoyt, 2005:26). Lloyd *et al.* (2003) see this as a threat to local government accountability as well as strategic planning institutions, which seek to benefit all groups in society, not merely businesses. Furthermore, because one of a CID's main tasks is to improve service delivery, their establishment is an admission on the part of local government that traditional public service provision has effectively failed (Ward, 2006). Although an increase in land and property values within a CID is considered an advantage to property owners, Catalano (2000) points out that this is indeed a disadvantage for certain groups. One such group are

---

<sup>1</sup> 1 South African rand = 0.130061 U.S. dollars

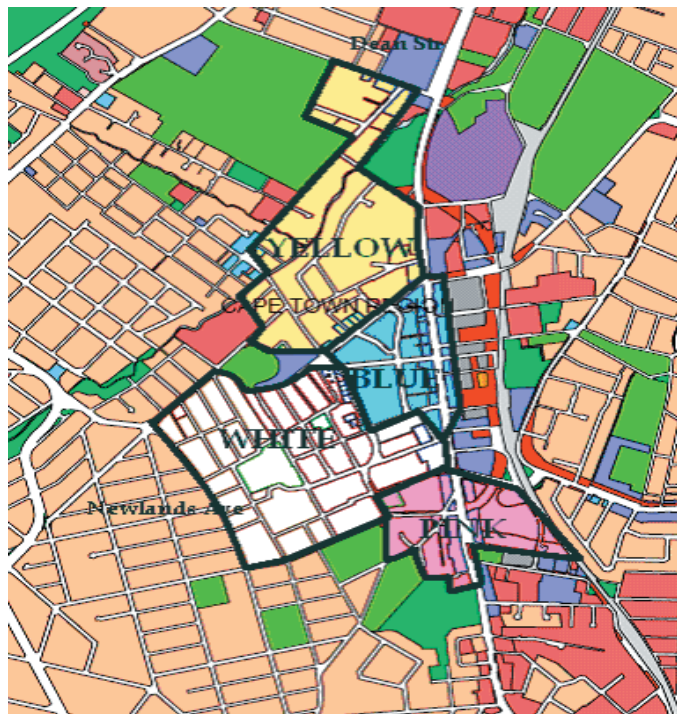
tenants, who are forced to pay higher rentals as a result of urban regeneration. This may lead to their displacement. Linked to this, CIDs are also known to adversely affect homeless people, as the removal of such people is often high on the agenda of CID organizations (Lloyd *et al.*, 2003). Lloyd *et al.* (2003) explain that while CIDs may be effective in removing homeless people from their district, they merely shift them into surrounding areas. Lloyd *et al.* (2003) also suggest that CIDs may be seen as creating an image that is too exclusive for their own good. They argue that the utopian style cleanliness and order that they try to instil may be seen by some as “leading to a degree of sterility and homogeneity”, thus taking away any character or charm that an area may have possessed before the CID was established.

Placing the establishment of CIDs in a theoretical framework, the study views this as gentrification. First coined by Glass (1964), the term referred to the London middle classes moving into working class quarters, upgrading properties, effectively displacing the original occupiers and bringing about a change in the social character of the neighbourhood. Gentrification is not only defined in this restrictive sense, but has also been defined more inclusively to refer to situations where the displacement of the working class has not occurred (Kotze and van der Merwe, 2000, *citing* Bourne, 1993). The definition adopted for this study is the former, more restrictive definition, described by Savannah Metropolitan Planning Commission (2004:2) as “the process whereby relatively affluent homebuyers, renters, and investors move into a neighbourhood thus increasing property values, rents, or taxes resulting in an involuntary displacement of long-term residents and business owners, the loss of neighbourhood diversity, or a change in the overall character of the area.” The ‘rent gap’ theory, introduced by urban economist Neil Smith during the 1980s explains gentrification as the product of investment and disinvestment in the inner-city. Over time, urban development and expansion creates a disparity between ‘capitalised ground rent’ – the value of a property given its current use – and ‘potential ground rent’, the return that could be earned on the land if it were put to its highest and best use. As the gap between the two widens, so does the incentive for land use change and development. The ‘rent gap’ is closed by land developers, landlords and ‘occupier developers’ (people who renovate homes before moving into them) when they reinvest in run down inner-city properties in the hope of achieving healthy profits. This is coupled with a return of professionals to urban areas and their surrounding neighbourhoods to satisfy financial corporations’ need for employees ‘spatial proximity’ to the workplace in order to ‘reduce decision times’. In short, Smith's argument was that gentrification takes place because capital returns to the inner-city, setting up opportunities for residential relocation and profit (Lees *et. al.*, 2007; Slater, 2002). Gentrification can be defined in positive terms (such as revitalisation and redevelopment) or negative terms (such as displacement and dislocation) (Savannah Metropolitan Planning Commission, 2004). Sandes (2006) conducted initial research into the Claremont CID and the influence it was having on the gentrification occurring in the area. Semi-structured interviews were undertaken with residents, businesses and informal traders in the area (Sandes, 2006). Follow-up research was undertaken in 2007 by Vorster (2007) to see how the perceptions of the stakeholders had changed over the one year period. Both Sandes (2006) and Vorster (2007) concluded that gentrification was indeed taking place in the neighbourhoods surrounding the Claremont CBD and that the overall perceptions of the

various stakeholders towards the CIDC were negative - despite both studies finding that residents felt the CIDC had had a positive effect on the area.

### 3. The Survey

Previous research on the Claremont CID area by Sandes (2006) and Vorster (2007) involved relatively small samples of 15 and 34 residents, respectively, using purposive sampling. The current study sought to improve the representivity of these by sampling the entire residential population of the immediate CBD area and the neighbourhood within 2km of it. A pre-stamped postcard survey was hand-delivered to the post boxes of 1765 residents in Claremont between 2-9 August 2008. This postcard survey was designed to gain both demographic data pertaining to residents (*i.e.* age, duration living in the area, level of personal income, etc.) as well as information regarding perceptions of gentrification indicators such as displacement of residents and change in the character and diversity of the area. Further, respondents were asked their opinion on whether any changes had been brought about due to the influence of the CIDC and whether they perceived such changes to be positive or negative. The postcard contained a definition of gentrification. An option of providing a telephone number was given for those willing to take part in a follow-up survey. The postcard survey obtained 134 responses (N=1765; n=134) (7.6%), of which 42 provided telephone numbers. Fourteen of these 42 were selected for the follow-up telephonic survey, selected on the basis of nature of their responses to the postcard survey. The sub-zones of the Claremont area are characteristically quite different. Figure 1 below shows these, coded by colour.



*Figure 1: Map of the defined area displaying the different zones*

The Blue zone is the CBD, which has undergone major rejuvenation in recent years. It contains the original 45000m<sup>2</sup> Cavendish Square shopping centre and its new extension Cavendish Connect and three new apartment complexes. The White zone to the west of the CBD contains 667 residential units and is characterised by large blocks of flats and double-storey houses as well as several residential to business conversions. The Yellow zone to the north contains three large blocks of flats, several medium sized blocks of flats as well as single residential units. There is evidence in this zone of business creep and a proliferation of bed and breakfast establishments. The Pink zone, to the south, is dominated by blocks of flats (341 units), with only 25 single residential units, and there is little evidence of new development or redevelopment occurring. Since the residential component of the whole area comprises both single residences and flats, postcards delivered to flats were marked to make them separately identifiable. The breakdown of the postcards distributed in each zone is shown in Table 1 and the number of responses within each zone in Table 2 below.

*Table 1: Breakdown of postcards distributed by unit type*

Unit type	White	Yellow	Pink	Blue	Total
Flats	452	258	341	356	1407
Houses	215	118	25	n/a	358
Total	667	376	366	356	1765

*Table 2: Breakdown of cards distributed by geographical zone*

Zone	Number administered	Number participating	%
White	667	61	9.1
Yellow	376	46	12.2
Pink	366	19	5.2
Blue	356	8	2.2
All	1765	134	7.6

The overall response rate of 7.6% was low, but it does provide an indication of perceptions amongst residents. It is interesting to note the response rates over the four different zones. The highest response rate came from the Yellow zone. This zone was subject to the most aggressive rejuvenation activity of the four zones, with renovations and business creep being particularly noticeable. The Blue zone, on the other hand, attracted the lowest response. This is not surprising as it consists of new upmarket apartment blocks in the heart of the CBD that had only been occupied for two years. The people living in this zone are unlikely to have witnessed all of the changes that have occurred since the establishment of the CIDC, unless they had previously lived elsewhere in Claremont. It is also interesting to note the breakdown of responses between flats and single residential units. It is clearly noticeable from Table 3 that

the response rate was markedly higher from those living in a house. This could be because these people are more affected by the changes than those living in a flat apartment. The research found that 98% of the house dwellers owned their dwelling.

*Table 3: Response rate by type of residence*

Zone	Flats	Response Rate	House	Response Rate	Total	Response Rate
White	30	6.6	31	14.4	61	9.1
Yellow	24	9.3	22	18.6	46	12.2
Pink	16	4.7	3	12.0	19	5.2
Blue	8	2.2	n/a	n/a	8	2.2
Total	78	5.5	56	15.6	134	7.6

### 3.1 Findings and analysis

Questions 1 - 6 were designed to gather personal information in order to profile the population. The average age (55 years) of respondents for the entire area was high. Thirty-two percent (32%) of the respondents were older than 65, with the oldest being 89 years. Eighteen percent (18%) were over the age of 75 and only 18 (14%) of the respondents were under the age of 30, with the youngest being 18. It is noticeable that the Blue zone's average age is significantly younger than the others. On average, respondents had been living in the area for 12 years. Fifty-two percent (52%) had lived in the area for more than 8 years, the duration for which the CIDC had been in existence at the time of the survey. Thus, it is believed that the majority of the respondents were well positioned to comment on the changes taking place. Again, it is clear that those living in the Blue zone were new to the area.

*Table 4: Form of tenure*

Zone	Own	%	Rent	%
White	44	72.1	17	28.3
Yellow	41	89.1	5	10.9
Pink	16	84.2	3	15.8
Blue	0	0.0	8	100.0
All	101	75.4	33	24.6

It is clear from Table 4 that the bulk of the responses were from property owners. A possible reason for this is owners have a vested interest in what affects their property's value, whereas

tenants do not. Interestingly, 100% of the respondents from the Blue zone were tenants. Although the number of respondents from this zone was small, this is probably an indication that there are a limited number of owner-occupiers in the apartment complexes in the Blue zone. Question 4 asked if the property was a residence, or business premises. When the surveys were delivered, business premises were deliberately avoided since the focus of this study was on residents only. However, this question was deemed necessary as it is suspected that many businesses operate illegally in the area, without signage or any other indication of the location being business premises. The intention of the question was to identify and eliminate any data pertaining to business premises. Only one respondent indicated that the premises were used for business purposes. The definition of gentrification used in this study refers to “relatively affluent homebuyers, renters, and investors” (Savannah Metropolitan Planning Commission, 2004:2). Judging from the data in the Table 5, Claremont does not appear to fit this definition, because roughly a third of the respondents (27.6%) were from a relatively lower income bracket. However, closer inspection of the data revealed that 38% of the lower income bracket had moved into the area since the CIDC was established, which is still a relatively high percentage for a gentrifying area. Secondly, 66% of those earning in the highest income bracket and 59% of those in the middle-income bracket had moved into the area since the establishment of the CIDC. Therefore, on the whole, this does represent an influx of wealthier residents into the area.

Table 5: Annual income of respondents

Zone	>R500k	%	R150k- R500k	%	<R150k	%	No entry	%
White	12	19.7	22	36.1	15	24.6	12	19.7
Yellow	15	32.6	12	26.1	14	30.4	5	10.9
Pink	5	26.3	3	15.8	7	36.8	4	21.1
Blue	0	0.0	7	87.5	1	12.5	0	0.0
All	32	23.9	44	32.8	37	27.6	21	15.7

Note: 1 South African rand = 0.130061 U.S. dollars

In the literature review, the theory was introduced that those residing in urban areas choose locations close to their workplace. The table below suggests that this is not the case in Claremont. However, 36% of the respondents who answered that they do not work in Claremont were over the retirement age of 65. Twenty-eight percent (28%) of pre-retirement age respondents were found to work in Claremont. Considering that displacement is one of the major characteristics of a gentrifying area, it is interesting to note that 76.7% of respondents report not noticing the displacement of original residents during their residence in the area. However, the duration of their residence in the area is the key factor in determining displacement caused by gentrification.

Table 6: Do you work in Claremont?

Zone	Yes	%	No	%	No entry	%
White	16	26.2	45	73.8	0	0.0
Yellow	6	13.0	38	82.6	2	4.4
Pink	4	21.1	14	73.7	1	5.2
Blue	3	37.5	5	62.5	0	0.0
All	29	21.6	102	76.1	3	2.2

Table 7: Displacement of original residents

Zone	Yes	%	No	%	No entry	%
White	16	26.2	44	72.1	1	1.6
Yellow	10	21.7	36	78.3	0	0.0
Pink	4	21.1	15	78.9	0	0.0
Blue	0	0.0	7	87.5	1	12.5
All	29	22.4	102	76.1	2	1.5

Of the 70 respondents who have been living in the area for more than 8 years, 47% indicated that they had noticed a displacement of original residents. On the other hand, of the 64 respondents who have been living in the area for less than 8 years, only 25% of them reported noticing the displacement of original residents. These findings are open to interpretation, but almost half of the long-term residents perceive displacement to have occurred. An overwhelming majority of owners (97%) indicated that there has been an increase in their property value during their time living there. This may be misleading, because the vast majority of property owners in Cape Town experienced growth in their property’s value during the recent boom in property prices.

Table 8: Have property rents increased?

Zone	Yes	%	No	%	Blank	%
White	7	58.3	4	33.3	1	8.3
Yellow	2	66.7	1	33.3	0	0.0
Pink	2	66.7	1	33.3	0	0.0
Blue	1	16.7	5	83.3	0	0.0
All	12	50.0	11	45.8	1	4.2

Despite the low number of tenants, it appears that rentals have increased. Only 50% of respondents indicated that they had experienced an increase in rental. However, this is somewhat distorted by the fact that 70% of those who indicated that they had not experienced an increase in rental had been living there for less than a year and would not have experienced a rent review yet. Seventy-nine percent (79%) of those who have been living in their place of residence for more than a year have experienced an increase in their rental. In response to a question on whether or not their municipal rates had increased, a large majority (82.1%) of the respondents indicated that there had been an increase in their municipal rates. Rates are derived from property values, so it is expected that this finding would closely follow that in Table 8 above.

*Table 9: Conversion from residential to business units*

Zone	Yes	%	No	%	No entry	%
White	40	65.6	19	31.1	2	3.3
Yellow	30	65.2	15	32.6	1	2.2
Pink	10	52.6	9	47.4	0	0.0
Blue	2	25.0	6	75.0	0	0.0
All	82	61.2	49	36.6	3	2.2

The majority of respondents (61.2%) indicated that they have noticed an increase in the conversion of residential units to business premises. Much of this majority was made up of respondents from the White and Yellow zones (immediately adjacent to the Blue CBD zone). Of the 107 respondents living in these two zones, 65% of them answered that they have noticed such an increase. This is not surprising, given the proximity of these zones to the CBD. The subject of conversions from residential to business units has recently received attention in the local media. Wiese (2008) describes how residents living in proximity to Kildare and Colinton Roads (within the Yellow zone) are becoming increasingly annoyed by the proliferation of businesses in their area and the negative consequences thereof. Residents are concerned about the legality of some of these businesses, claiming that they have not been granted the necessary planning permission to convert their units from residential to business zoning, or that the re-zoning was granted under false pretences. The follow-up interviews provided further evidence of residents' annoyance with the growing number of businesses in the area.

The vast majority of respondents (70.9%) indicated that they were aware of the CIDC's work. Interestingly, 28.4% of the respondents were unaware of it. This is possibly explained by the fact that the Yellow and White zones (where the highest number of negative responses were recorded) are larger and thus contain properties further away from the CBD where the CIDC's presence and activities are probably less evident.



Table 10: Awareness of the work done by the Claremont CIDC.

Zone	Yes	%	No	%	Blank	%
White	45	73.8	16	26.2	0	0.0
Yellow	27	58.7	18	39.1	1	2.2
Pink	16	84.2	3	15.8	0	0.0
Blue	7	87.5	1	12.5	0	0.0
All	95	70.9	38	28.4	1	0.7

Table 11: Change in the character or diversity of the area

Zone	Yes	%	No	%
White	46	75.4	15	24.6
Yellow	31	67.4	15	32.6
Pink	18	94.7	1	5.3
Blue	5	62.5	3	37.5
All	100	74.6	34	25.4

A significantly high 74.6% of respondents indicated that they had noticed a change to the character or diversity of the area. This is in keeping with the definition of a gentrifying area. Of the 100 respondents who felt there has been a change in the character or diversity of the area, 59% felt that this change was due to the influence of the CIDC. This is significant because it confirms that the CIDC, in the eyes of the residents of the area, has been a catalyst for change in Claremont. A few of the respondents indicated that the investor driven market, and not the CIDC, was the catalyst for change. However, it is clearly a goal of the CIDC to attract such investment. To assist the respondents in answering question 9, a list of positive and negative factors were given as prompts.

Table 12: Influence of the CIDC on change

Zone	Positive	%	Negative	%	Both	%	No entry	%
White	24	52.2	18	39.1	4	8.7	0	0.0
Yellow	13	41.9	12	38.7	5	16.1	1	3.2
Pink	10	55.6	4	22.2	4	22.2	0	0.0
Blue	4	80.0	0	0.0	1	20.0	0	0.0
All	51	51.0	34	34.0	14	14.0	1	1.0

The positive factors included revitalisation of the area, cleaner, safer, a better aesthetical environment, more vibrant, and a better shopping experience; the negative factors included displacement of old residents, increased traffic/parking congestion, a loss of the neighbourhood's diversity, and constant redevelopment of the area.

More respondents considered the changes to be positive, but large percentages in the White and Yellow zones perceived the changes to be negative. In summary, the above analysis of the postcard survey indicates that the neighbourhoods surrounding the Claremont CBD fit the definition for gentrification in that relatively affluent homebuyers, renters and investors have moved into the area in recent years, leading to an increase in property values, rents and taxes and resulting in an involuntary displacement of residents (over recent years), the loss of neighbourhood diversity, or a change in the overall character in the area. The majority of respondents attributed the change of neighbourhood character and diversity to the influence of the CIDC. This confirms the perception that the CIDC is having an impact on the residential neighbourhood in and around Claremont CBD. Further, the respondents perceive this change to be positive. The 14 follow-up telephonic interviews provided further insight into residents' perceptions of the changes occurring in Claremont and its surrounding neighbourhoods, their feelings regarding the future of the area, as well as their opinions towards the CIDC and its projects. The composition of these 14 participants was in proportion to the overall response of the particular zones to the postal questionnaire survey (*i.e.* roughly 1 in every 10 respondents from each zone was interviewed). This resulted in 6 participants from the White Zone; 5 from the Yellow Zone; 2 from the Pink Zone and 1 from the Blue Zone. For the purposes of the study, only those respondents who answered in the initial survey that they had noticed a change in the character and diversity of the area and/or whether or not the changes occurring in the area were positive or negative were selected to participate in the telephone interviews. Each interview followed a semi-structured format whereby participants were allowed to answer the questions, without any prompts or options. Respondents were asked to elaborate on the changes they had noticed and what they regarded as positive and negative about them. An increase in cleanliness and visible security, improvements made to shopping facilities and a more pedestrian-friendly infrastructure were mentioned as positive changes. The lack of off-street parking, traffic congestion, business creep and demolitions/renovations were regarded as negative changes. Another complaint was that some owners had obtained zoning rights under false pretences by claiming to be living and operating a business from the premises. Reportedly, some of these premises stand empty at night, making residential neighbours uncomfortable and detracting from their lifestyle. Unhappiness with the extent of demolitions and renovations occurring in the area was also reported, with one respondent claiming that an estimated "20 new houses have gone up around me over the past 5 years." An interesting issue raised by one respondent in the Yellow zone was that she felt that there were more tenants than homeowners in the area and that consequently properties were being neglected. She believed this to be the result of owners leaving the area and letting their properties because they were disenchanted with the results of gentrification, such as lack of parking and an increase in business units.

## 4. Conclusion

The research objective of this study was to establish whether or not gentrification is occurring in the neighbourhoods surrounding the Claremont CBD, and what level of influence the CIDC has had on this gentrification. The analysis above supports the conclusion that gentrification is indeed occurring in the area and that the CIDC has had a significant influence in bringing about this gentrification. This conclusion is based on (i) the reported influx of relatively wealthier residents into the area since the establishment of the CIDC in 2000, (ii) the increases in property values, rentals and municipal rates, (iii) the increase in the conversion from residential units to business units in recent years, (iv) residents' perceptions of a change in the character or diversity of the area. All these factors are signs that gentrification is occurring in an area, as established in the literature review. However, there are certain aspects that contradict the gentrification literature, such as the displacement of long-term residents. The majority of the respondents indicated that they have not noticed a displacement of residents during their time living in the area, although there is evidence to suggest that those who had lived in Claremont prior to the establishment of the CIDC had noticed a degree of displacement. Other interesting findings were the low number of respondents who also work in Claremont, the relatively high percentage of people earning in the relatively lower income bracket still living in Claremont, as well as the high percentage of post-retirement age people living in the area. The overall majority of respondents see the changes occurring in the area as positive. This contradicts the literature that regards gentrification and its consequences as largely negative. This finding also contradicts the research proposition, which stated, "residents living in the neighbourhoods perceive gentrification to be a negative change process." This is not, however, to say that negative aspects (with regard to the changes occurring in these neighbourhoods) do not exist. The follow-up telephone interviews established that there are serious issues affecting the residents of the area (conversions from residential units to business premises resulting in traffic congestion, parking problems and empty premises at night, influx of people, noise and dust). The conclusions drawn above do not allow either for the outright acceptance or rejection of the proposition. This is possibly attributable to several factors. Firstly, the proposition assumed that those respondents still living in the area might representatively comment on the negative aspects of gentrification, where it is more likely that those who no longer live there because they were negatively affected would do so. Secondly, the case study method adopted opens the possibility that the residents of this particular area answered as they did, where those in another area might not have. Finally, the low response rate (7.6%) of the 1765 residences surveyed provides little comfort as to the representivity of the findings.

## References

- Bourne, L.S. (1993) "The demise of gentrification? A commentary and prospective view". *Urban Geography*, **14**(1), 95-107.
- Cape Town Partnership (2008) 'Adding value to our city' [online]. Available from [www.capetownpartnership.co.za](http://www.capetownpartnership.co.za) [accessed: 15 July 2008].
- Catalano, A. (2000) "Brighter prospects". *Estates Gazette*, 5 February, 60-66.

Claremont Central (2008) 'About the CIDC' [online]. Available from <http://www.claremontcentral.co.za/cidc-vision.html> [accessed: 15 July 2008]

Claremont Clarion (2006), "Claremont Renaissance Picks Up Pace" [online]. Available from <http://www.claremontcentral.co.za/clarion/clarion-october.html>

Dawkins, G. & Grail, J. (2007) *Business Improvement Districts: Past, Present, Future*, Institute of Economic Affairs, Blackwell Publishing, Oxford.

Glass, R. (1964) "Aspects of change". In Centre for Urban Studies (Ed.). *London: Aspects of Change*, London, McGibbon & Kee.

Hochleutner, B. (2003) "BIDs fare well: the democratic accountability of business improvement districts". *New York University Law Review* **78** (April), 374–404.

Hoyt, L. (2005) *Planning Through Compulsory Commercial Clubs: Business Improvement Districts*, Institute of Economic Affairs, Blackwell Publishing, Oxford.

Koblitz, C. (2007) 'Neighbourhood Watch: Claremont' [online]. Available from <http://thepropertymag.co.za/pages/452774491/articles/2007/February> [accessed: 6 June 2008].

Kotze, N.J. and van der Merwe, I.J. (2000) "Neighbourhood renewal in Cape Town's inner city: Is it gentrification". *Journal of Family Ecology and Consumer Sciences*, **28**, 39–46.

Lees, L., Slater, T., & Wyly, E. (2008) *Gentrification*, New York, Routledge.

Lloyd, M.G., McCarthy, J., McGreal, S., & Berry, J. (2003) "Business Improvement Districts, Planning and Urban Regeneration". *International Planning Studies*, **8**(4): 295–321.

Miraftab, F. (2007) "Governing Post Apartheid Spatiality: Implementing City Improvement Districts in Cape Town". *Antipode* **39**(4): 602–626.

Peck, J. (2003) "Geography and public policy: mapping the penal state". *Progress in Human Geography* **27**(2): 222–232.

Sandes, R. (2006). "A Case Study of the City Improvement District in Claremont: Negative Gentrification?", Unpublished honours Thesis, University of Cape Town.

Savannah Metropolitan Planning Commission (2004) "One Savannah: Report of the Gentrification Task Force". Savannah. [online]. Available from <http://www.thempc.org/Planning/Publications/Revised%20Final%20Gentrification%20Task%20Force%20Report.pdf> [ Accessed: 10 September 2008]

Slater, T. (2002) "What is Gentrification?" [online]. Available from [www.gentrificationweb.com](http://www.gentrificationweb.com) [Accessed: 11 July 2008]

Vorster, A. (2007) “A detailed analysis of the change in perceptions of stakeholders towards the Claremont CID changed over the 2006-2007 period as a result of negative gentrification”. Unpublished honours Thesis, University of Cape Town.

Ward, K. (2006) “‘Policies in Motion’, Urban Management and State Restructuring: The Trans-Local Expansion of Business Improvement Districts”. *International Journal of Urban and Regional Research*, **30**(1): 54-75.

Wiese, C. (2008) ‘Newlands’ Illegal Business Creep’, *The People’s Post* (Claremont/Rondebosch Edition), 19 August 2008, Front Page.

Wilson, D. (2004) “Towards a contingent urban neoliberalism”. *Urban Geography* **25**(8): 771–783.

Yin, R. (2003) *Case Study Research: Design and Methods* (3rd Edition), Sage Publications, Thousand Oaks.



# The effects of studentification on the residential neighbourhood of a university suburb: A study of the University of Cape Town in Rondebosch

**Ordor, Uche**

University of Cape Town, Department of Construction Economics and Management  
uche.ordor@uct.ac.za

**Cattell, Keith**

University of Cape Town, Department of Construction Economics and Management  
keith.cattell@uct.ac.za

**Michell, Kathy**

University of Cape Town, Department of Construction Economics and Management  
kathy.michell@uct.ac.za

**Bowen, Paul**

University of Cape Town, Department of Construction Economics and Management  
paul.bowen@uct.ac.za

## Abstract

Universities and other higher education institutions are generally acknowledged as valuable contributors to the economy. At the local level they are known for having a steady presence in a locale, for attracting revenue from within and outside their host community, providing jobs on different levels and relatively resistant to business fluctuation cycles. A university town is described as a town or in some cases a suburb of a city which is dominated socially, economically and culturally by its university population. One of the most prominent influences of a university on its host community is the phenomena termed 'studentification'. This paper investigates the effects of studentification on the residential neighbourhood and businesses of a university suburb and how the social, cultural, economic and environmental impacts of the studentification affect the residential neighbourhood and businesses in the suburb. The case study was focused on the University of Cape Town (UCT) in Rondebosch, Rosebank and Mowbray. The research revealed the existence of a unique student housing market and opens new areas of research into the patterns, distribution and implications for the formation of student areas. Moreover, it raises the issue of the trade-off between the apparent profitability of the student market and the implications for urban facilities management and the demographic balance in these areas.

**Keywords:** Urban Facilities Management, Studentification

# 1. Introduction

## 1.1 Background and context

**Situational information:** The University of Cape Town (UCT) has grown in the scope of studies it offers and the calibre of its graduates, attracting considerable human capital in the form of students, staff and other employees. This growth is in line with government's desire to drive a modern economy underpinned by a knowledge-driven and knowledge-dependent society (Republic of South Africa, 1997: 1). The government's strategy towards achieving these objectives involves agreed phased increase of higher education (HE) student enrolment to predetermined targets. These targets differ in the various higher education institutions. The UCT student enrolment has increased at an average annual rate of 1.4%, reaching a total of 23,600 students in the 2009 academic year (Republic of South Africa, 1997; University of Cape Town, 2008). The target student population for the UCT is 24,000 students by the year 2010 (University of Cape Town, 2008). This expansion in the HE programme has impacted on the host communities of Rondebosch, Rosebank and Mowbray precincts economically. This research explores these impacts, their effects, and implications on the residential neighbourhood and businesses in the area which the study defines as UCT's host communities.

## 1.2 The research study

Universities and other Higher Education Institutions (HEI) are generally known to be valuable contributors to the economy in many ways. At the local level, universities are known to have a steady presence in their locale, attracting revenue from within and outside their host communities, providing jobs at different levels and are fairly resistant to business fluctuation cycles (Steinacker, 2005). The presence of the university or HEI pervades the economic and social life of the host community, with far reaching consequences. Arguably the most prominent influence of a university or HEI on its host community is the phenomenon of "studentification" (Smith, 2005). While a number of studies (see, for example, Smith, 2002; Hubbard, 2008) have been done on the subject of studentification globally, very little research has been done on its prevalence or otherwise, its causes, effects and implications in the South African context. The effect of studentification, which is often seen as the primary influence of the HEI on the university suburb, results in a form of urban restructuring, socially, economically, culturally and environmentally; which negatively distorts the local residential property market (Smith, 2005).

## 1.3 Research questions

(a) How has the University of Cape Town (UCT) influenced studentification in the Rondebosch – Rosebank – Mowbray areas?



(b) How have the effects of studentification affected the Rondebosch–Rosebank – Mowbray residential neighbourhoods and businesses socially, culturally, economically and physically?

## 1.2 Research proposition and method

The proposition for the study was that the University of Cape Town (UCT) causes studentification in its host communities, *negatively* impacting on the social, economic, cultural and environmental attributes of the associated residential neighbourhoods and businesses areas. A single case study was undertaken, using semi-structured interviews with UCT officials, local property letting agents, landlords, local business owners, Rondebosch-Rosebank-Mowbray community and neighbourhood leaders, as well as the Local Authority and Ward Councillor in the area.

## 1.3 Research objectives

The purpose of the study was to explore the phenomenon of studentification, its effects, and the implications of these effects on the university precincts of Rondebosch, Rosebank and Mowbray. The objectives of the study were to:

- i) establish whether there is an imbalance between the size of the student population and the UCT-provided accommodation available to them.
- ii) establish the dependence of the overflow of students not catered for by university-provided accommodation on the private rented sector (PRS) in the study area, and how widespread this is.
- iii) establish whether the factors which define studentification exist in the study area.
- iv) substantiate the influence UCT has in the studentification of the area, and
- v) examine the effects of studentification on the residential neighbourhood and businesses in the study area.

## 2. Literature review

The strict meaning of the concept of gentrification has evolved since it was first revealed in the late 1960s. Scholars, in the late 1970s and 1980s, gave a broader conceptualisation to its meaning and process, which tried to accommodate the complexities and diversities of the phenomenon (see Atkinson and Bridge, 2005; Smith, 2005; Sabri and Ludin, 2009). Over the years, new definitions of gentrification have emerged from research, which introduce gentrifiers, as well as explain its occurrence in parts of cities and towns, which probably would

not have fitted earlier strict definitions of the phenomenon. Smith and Holt (2007:153) assert that “*the ethos of gentrification is being stimulated and nurtured by networks of institutional actors in different places*”. It has therefore been suggested that gentrification should be labelled by the processes that define it. Studentification, a term first established by Smith (2002), is one of such unique processes of urban transformation influenced by the effects of the overbearing presence of an HEI on its host community. Hubbard (2008:323) describes it as “*the process by which specific neighbourhoods become dominated by student residential occupation*”. The literature review first establishes the conceptual definition of studentification and then examines the causes and drivers of the phenomenon in different parts of the world, albeit in different contexts. Finally, literature review discusses the effects of studentification, as well as the impact and implications of these effects on the residential property sector in university towns.

## 2.1 Studentification

The term ‘studentification’ is associated with the seasonal, in-migration of HE students, and explains the growth of high concentrations of such students around the neighbourhoods of HEIs. The process of studentification signifies urban changes, which bring about distinct social, cultural, economic and physical transformations within university towns (see Smith, 2005; Smith and Denholm, 2006). In terms of the strict conceptual definition of the process of studentification, these dimensions of urban transformation are linked to the recommodification of ‘single-family’ or re-modelling of existing private rented housing to create houses in multiple occupation (HMO) for HE students (Smith, 2005). In recent times, the concept of studentification has also embraced the provision of purpose-built off-campus, usually high density, accommodation for HE students, within the existing neighbourhoods of the university suburbs (Smith and Holt, 2007; Hubbard, 2009). Research has revealed that there are several causes and drivers, with many parties like government, HEIs, students, landlords and local communities, bearing at least part of the responsibility for its development (Sabri and Ludin, 2009). The expansion of the HE sector by the national government, without providing the resources and the powers required to manage the impact on student accommodation, is identified as one of the contributing factors to the occurrence of studentification (Shelter, 2002; Smith and Denholm, 2006). Research has shown that studentification occurs in stages over time (Kenyon, 1997; Smith, 2002; Smith, 2005; National HMO Lobby, 2005; “Studentification: discussion”, 2005). Studentification is inadvertently caused by such wider and often unrelated events as economic and social trends in a country, as well as government policies (Smith and Denholm, 2006). The desire to achieve social and economic competitiveness in the global arena has ensured that the development of most major countries of the world is hinged on knowledge-based economies and societies. These imperatives of economic competitiveness have inevitably ensured the rapid growth of the idea of knowledge-based economies and societies in most developed countries (Sabri and Ludin, 2009). The unavoidable implication of these developments for such countries is the rapid expansion of the HEI sector, which is usually state-sponsored, and consequently the rapid increase in the number of HE students (see Rugg *et al.*, 2000; Smith and Denholm, 2006; Sabri and Ludin, 2009). Consequently, the rate of

increase of the number of HE students greatly surpassed the rate at which the institutions are able to provide institutionalised accommodation for them, resulting in the commodification of HE student spaces and lifestyles, which are components of (see, for example, Chatterton, 1999; Smith, 2005; University of Brighton, 2007; Benn, 2009; Doward, 2009; Sabri and Ludin, 2009; Smith, 2009). Researchers argue that finance instruments such as the buy-to-let instrument in the UK for example, which makes finance more accessible, has invariably influenced the rise in investment culture (Crook, 1992; Bailey *et al.*, 2000; Rugg *et al.*, 2000; Ball, 2006; Lowe, 2007; Leyson and French, 2009). Consequently, the better access to finance and the demand for accommodation by continually increasing number of the HE students who were not accommodated in university-provided accommodation encourages private landlords, as well as developers, to provide HMOs for these HE students (Smith, 2005; Smith and Denholm, 2006; Lowe, 2007).

## 2.2 Effects and implications of studentification on the University suburb

Aligned with theorisations of gentrification and other current processes of change, four main scopes of the effects of studentification have been identified. These are: (i) the social impact, which is considered to be the primary one; (ii) the economic impact; (iii) the cultural impact; and (iv) the physical impact (see Smith, 2005; Smith and Denholm, 2006; Smith and Holt, 2007). The implications of these dimensions of the effects of studentification may be considered to be positive or negative, depending on the context and the social group it impacts. It can be argued that the *social dimension* of the effect of studentification on a university town involves the development of a new social group of ephemeral and young middle-class residents which displaces the original established residents of the area (Kenyon, 1997; National HMO Lobby, 2005; Smith, 2005). Research has shown that in a university precinct, the sheer numbers of young adults of higher educational learning engenders an assumed distinct culture, lifestyle and pattern of consumption associated with particular retail service outlet provisions (see Chatterton, 1999; Smith, 2005; Smith and Denholm, 2006; Smith and Holt, 2007). This defines the *cultural dimension* of the effect of studentification (see Chatterton, 1999; Rugg *et al.*, 2000; Chatterton and Hollands, 2003; Gopal, 2008; Hubbard, 2008). Research has shown that the *economic impact* of the effect of studentification on a university suburb is usually marked by the inflation of property prices, which is underpinned by the recommodification of 'single-family' houses or the remodelling of private rented housing to supply HMO for the HE students (Rugg *et al.*, 2000; Smith, 2005; Smith and Denholm, 2006). The impact on the *physical environment* is characterised as follows. There is an initial upgrading of the physical environment, driven by valorised property rentals and prices, which is induced by the conversion of single-family housing stock to HMO to meet the accommodation needs of the large HE student population (see Cox, 2000; Martin *et al.*, 2005; National HMO Lobby, 2005; Smith, 2005; Smith and Denholm, 2006; Smith, 2008; Doward, 2009; Osborne, 2009). Notably, the impact of studentification on the residential sector is not only limited to the supply-demand imbalance in accommodation within HMO (Rugg *et al.*, 2000). There are telling implications for issues such as the lack of regulation of HE student housing, property prices, availability of

housing stock, and the growth of the student sub-market (Rugg *et al.*, 2000). The constantly growing HE student population ensures an increased demand for student accommodation and, inevitably, the establishment of a ‘niche’ student housing market. The tendency of students to live in concentrated pockets in large numbers within parts of the university suburb is a major feature of this market (Rugg *et al.*, 2000; Smith, 2005; Hubbard, 2008; Munro *et al.*, 2009; Smith, 2009). Although the literature above refers largely to the UK, and not much research has been done on the subject of studentification and its effects in South Africa, Benn, (2009) pointed out that it occurs in Stellenbosch. In Cape Town, the only similar example where a residential neighbourhood is host to an HEI of similar size is the UCT in Rondebosch – Rosebank – Mowbray areas. Surveys of UCT students, commercial property owners and tenants, residents and shoppers in the Rondebosch area, which is a significant part of the study area, give useful insights regarding the aspects of studentification discussed in the literature (Moilola, 2007; Cattell *et al.*, 2008). The survey of UCT students revealed that a majority of students live ‘off-campus’ in rental accommodation (Moilola, 2007; Cattell *et al.*, 2008). Of these students, 33% use the UCT Jammie shuttle (university provided transportation) to travel to and from the campus, and 32% walk (Cattell *et al.*, 2008). Sixty-one percent (61%) of the respondents perceived the area what area? to be unsafe. The most common types of crime committed in the area were found to be muggings and snatchings, theft from cars, and armed robberies (Cattell *et al.*, 2008). Sixty-five percent (65%) of the respondents described the quality of the public environment as “average” (Cattell *et al.*, 2008).

### 3. The case study

The research method involved a single case study comprising semi-structured interviews of selected stakeholders from within the area of study, as well as Local Authority officials. Generalizations from the research findings are made to the proposition, in line with Yin’s (2003) assertions regarding single case studies (see Remenyi *et al.*, 1998; Yin, 2003; Flyvbjerg, 2006; Yin, 2009). Information was obtained from three tiers of sources, analysed and inferences made, within the framework of the issues identified in the literature. The first tier comprised semi-structured interviews of selected stakeholders made from within UCT and its host communities. The stakeholders from within the UCT included Administrative/Council members as well as officials of the Planning Unit office and the Student Housing office. Stakeholders in the host community consisted of local property letting agents, landlords, local business owners, Rondebosch-Rosebank-Mowbray community and neighbourhood leaders. In order to validate the data, a second tier of source of information was obtained from interviews with Local Authorities and Ward Councillor in the area, who, unlike the selected stakeholders, have a fiduciary and social responsibility over the area of study. The third tier of source of information is from records from the police, and local municipal authorities with jurisdiction over the area of study, as well as relevant archival sources such as UCT admission and student housing records. Having defined the issues to be investigated and the case, semi-structured interviews was the preferred means of data collection, as it is better suited to qualitative research, and fosters the pursuit in-depth information, and not just statistical facts. The semi-structured interview was then designed in accordance with the issues and questions raised from

the literature on studentification and its social, cultural, environmental and economic impact on residential neighbourhoods and businesses in a university precinct. Selected stakeholders to be interviewed were identified and their informed consent for an interview was sought telephonically as well as via e-mail. The interviewees were carefully selected to ensure that the information obtained would be from different and multiple sources. However, while the Police were willing to grant interviews, they were not will to part with hard copies of historical and statistical data on crime. A potential risk in having adopted a single case study is that the findings could be anecdotal or peculiar to the UCT-Rondebosch – Rosebank – Mowbray areas. The single case choice was, however, unavoidable, as there are no similar cases in Cape Town where a residential suburb is home to a university of UCT's scale.

### 3.1 Analysis

#### 3.1.1 Evidence of the number of students exceeding UCT-provided accommodation

The findings from the data collected indicated that for over a decade there had been a sustained and rapid growth in the UCT student population to 23, 600 in 2009. This is attributed to government policies aimed at achieving societal transformation outlined in the Reconstruction and Development Programme, as articulated in Education White Paper 3 (Republic of South Africa, 1997). This agreement with the department of education sees UCT targeting a total student enrolment of 24, 000 in 2010 (UCT, 2008). This growth has put pressure on UCT infrastructure, including student accommodation. It is evident that there is a substantial 'imbalance' between the UCT student population and the capacity of the university-provided accommodation. Furthermore, the information from records of, and interviews with the officials of the UCT Planning Unit Office and the Student Housing Office indicate that although the university-provided student accommodation has increased by 30% to 5, 700 between 1994 and 2009, only 24% of the student population is housed in UCT-provided residences. It follows then that 76% of the UCT student population live outside of UCT-provided accommodation. This supports Cattell *et al.*'s (2008) finding that 72% of the UCT students live 'off-campus'. The UCT officials further pointed out that some students who live off-campus lived at home with their parents, while others lived outside the study area. It was further revealed that, excluding the students who live with their families and those who live outside the study area, 47% of the students who live outside the UCT residences, live within the study area in PRS homes. This statistic is similar to Moilola's (2007) finding that 51% of the students lived in the Rondebosch – Rosebank area. The slight difference in the figures can be attributed the fact that Moilola's (2007) study did not make the distinction between the students who lived in the PRS and those living in the UCT-provided residences in the Rondebosch – Rosebank area. Given the above, it may be concluded that the majority of UCT students live outside of UCT-provided residences, but within the study area and that it is evident that the number of students exceed the UCT-provided accommodation.

The above discuss from the study findings implies that UCT does not have the capacity to provide accommodation for its entire student population. Furthermore, the interviews with the UCT officials indicate that UCT's plan to build an 880 bed student residence is expected to add only 3.7% to the total UCT-provided accommodation. This limited intervention strongly indicates that there will continually be a substantial over-spill of students without university-provided housing who live within the area of study. In line with theorisations of the phenomenon of studentification, it is asserted that the pressures by the large HE student population on its host community begin with the over-spill of the students without institution-provided accommodation (Kenyon, 1997). The study findings discussed above therefore suggest that the presence of UCT in the study area gives rise to a large HE student population, which indicates potential for the phenomenon of studentification to occur in the Rondebosch – Rosebank – Mowbray areas.

### **3.1.2 Evidence of students' dependence on the private rented sector**

The case study data obtained from the local Letting Agents, Landlords and Officials of the UCT all indicate that the students who live outside of the UCT-provided housing, but within the study area, live in HMOs. It was revealed that in past years the students mainly lived in HMOs in digs, but in recent times HMOs in flats and sectional titled complexes are better preferred. In some cases the parents of such students buy the property to provide accommodation for their child while he or she remains a student at the UCT. Furthermore, Letting Agents in the study area confirm that in the last ten years, over 90% of their clientele in the area have been students or their parents. Information from the Letting Agents and Landlords interviewed in the area further point to the fact that investors have taken note of this opportunity, and now buy property in the study area with the intention of remodelling, if they need to, and leasing the properties to student tenants. This discourse suggests that the large number of students who desire to live in the study area guarantee a steady demand for student accommodation from the PRS and depend on the housing stock supplied by the PRS to meet their demand for accommodation. Furthermore, it was indicated above that the study findings showed that 47% of the students lived in the study area in the PRS. This result also confirms Moilola's (2007) finding that 51% of UCT students live in the Rondebosch – Rosebank area, and that 33% of the total number of students surveyed pay rent. It can therefore be inferred that the majority of the students who live in the study area pay rent, and, as such, depend on the private rented sector. The discussion on the case study findings above show that there is evidence of in-migration of HE students from UCT, which explains the high concentration of such students in the study area. Furthermore, the findings reveals that there is strong evidence of the remodelling of existing private rented housing, as well as the development of purpose-built houses to create flats and HMOs for the HE students in the study area. These findings which show the high concentration of HE students living in HMOs in the study area strongly indicate a condition that defines studentification as discussed in the literature (see Smith, 2005; Hubbard, 2008; Sabri and Ludin, 2009). In line with theorisations regarding the formation of student areas in a university precinct, the study findings suggest that the choice of Rondebosch as the preferred area of residence of the students outside the university-provided accommodation is influenced by: the proximity of such accommodation to the UCT academic campus; access to

transportation; and desire for houses on secure streets. The survey of UCT students in Rondebosch (Cattell *et al.*, 2008) supports this as it showed that the majority of the students travel to and from the area on foot (32%) or by the UCT dedicated Jammie bus shuttle (33%) (Cattell *et al.*, 2008). In addition to these findings above, there is evidence showing that students are attracted to those areas of the neighbourhood where other students live. Inevitably, definable 'student areas' are formed along these parts of the suburb, as large numbers of students converge there. These areas are mainly along the Main road in Rondebosch, Rosebank and Mowbray. Furthermore, the UCT interventions aimed at providing student accommodation are also located within the community, thereby exacerbating the creation of 'student areas' within the study area. Consequently, an imbalance in the demographic composition of those parts of the study area can be expected, whereby the area becomes dominated by a transient student population. This was observed to be the case with the area behind the Riverside Centre in Rondebosch, for instance. These findings reflect the formation of 'student areas' identified in the literature review, which is a hallmark of the conditions which define studentification (see Kenyon, 1997; Rugg *et al.*, 2000; Smith, 2005).

### 3.1.3 The impact on residential properties in the area

The findings from officials of the UCT, local property letting agents and landlords in the study area point to the fact that investors often receive better returns on their properties let to student tenants in the study area. This is because student tenants share accommodation and are thus able to pay higher rentals than would otherwise be affordable to a single family. This finding aligns with the Moilola (2007) survey, which revealed that individual students can afford monthly rentals of up to R3000. Thus, a group of three students sharing a HMO can afford a rental of R9000, which is more than it would attract from a single-family tenant. Thus, residential property rentals in the 'student areas' of the case study area have been valorised as a result of studentification. The local property letting agents and landlords point out that there is consequently great pressure on the PRS to meet the demand for student housing and this has ensured that rentals and property prices have not fallen. This guaranteed demand for student housing and the steady overflow of students without UCT-provided accommodation ensure the existence of a unique 'student market' in the study area. Furthermore, the study findings also show that the constant low vacancy rates recorded in the area is strongly correlated to the UCT academic year and the presence of the students in the area.

### 3.1.4 Effects of a large concentration of students in the study area

The case study data show that the clustering of a large population of students in the 'student areas' influences those parts of the suburb. *The social influence* referred to in the literature is supported by the case study findings, which point towards the increased occurrence of antisocial behaviour such as late night and general noise pollution and public drunkenness. The response from the Police also indicates increased levels of crime in the student areas, especially burglaries, muggings, break-ins and thefts from parked cars. The response from Rondebosch, Rosebank and Mowbray community and neighbourhood leaders attributed the increased levels of crime to the naïve carefree attitude of the student population which attracts such crimes. This

finding is further buttressed by the Police response, which revealed that majority of these crimes mentioned in the area occur along the Main road, which is a known 'student area' as shown in earlier discussions. This finding discussed above reflects Cattell *et al.*'s (2008) survey finding that 61% of their respondents regarded the area as 'unsafe'. It also strongly mirrors the patterns of the social influences identified by Chatterton (1999) and Smith and Denholm (2006), which resulted from the presence of a large HE student population in the area. In addition to this the interview with the Police showed a clear correlation between the presence of the students in the area during the UCT academic year and the increase in levels of crime. All respondents on the issue above, however, made the distinction that the students did not commit the crimes, but attracted it as explained above. *The cultural influence* is evident in the case study findings, in which the response from the Rondebosch, Rosebank and Mowbray community and neighbourhood leaders as well as the Council Member and the UCT administrative Official all agreed that the study area is more inclusive, with a cosmopolitan and 'international' feel. This finding mentioned above is ascribed to the large number of international and regional, non-local students and staff in the area. In addition, there is also the distinct student culture as well as evidence of a buoyant social scene that is directly linked to the presence of UCT. There is also evidence that the existence of a student culture in the area is not well accepted by some sections of the local community thereby encouraging social tensions between the established non-student population and the student population. The presence of a large and increasing number of students in the area inevitably creates *economic* opportunities. This assertion is supported by evidence from the case study findings that indicate that there are businesses in the area that take advantage of the opportunities and thrive on catering to the needs of the students and in some cases the broader university community. Some of these businesses identified in the area which thrive on the large student population, include fast-foods, internet cafes, nightclubs, pubs and bars as well as business centres, most of which are located along the Main road, which has been identified by earlier discussions above as a 'student area'. Conversely, the interviews with business owners in the area has shown that the economic operations of these businesses are cyclical, experiencing buoyant and lean periods, in line with the UCT academic calendar and the presence of the student population. In addition to the findings above, findings also show that the large student population in the area invariably influence appeal of the retail market, which primarily caters to the needs of the students. This significantly narrows the appeal of the market for non-student buyers who sometimes struggle to identify with the goods and services being offered.

*The environmental influence* is supported by the response from neighbourhood and community leaders in the study area, which show that, generally, students do not have a high degree of maintenance culture, which consequently contributes negatively to the quality of the public environment. This lack of maintenance ultimately influences the gradual decline of the environs of the student areas. This finding mirrors Cattell *et al.*'s (2008) survey finding that 61% of respondents in the survey described the cleanliness of the area as 'average', 21% considered it unclean, and 65% described the quality of the public environment as 'average'. All the respondents to interviews also pointed out that these lack of maintenance issues mentioned above create a tense relationship between the students and the landlords. Study findings show that UCT tries to circumvent the tension through its planned greater involvement



through a head lease agreement with landlords. The findings also show that ultimately, the student culture and the perceived antisocial behaviour associated with their presence in the area makes it somewhat unattractive location for the non-student population to live in. This means that the property type and stock in the area mostly have to target the student clientele.

### 3.1.5 Public policy regulating student housing and HMO in the study area

The interviews with the Local Authorities and Ward Councillor in the area revealed that there is no real public policy regulating student geographies and student HMOs in the area. However, the growth of these student areas coincides with the planned densification of the city, a policy which seeks to combat urban sprawl and maximise land use in the city. It appears that the issue of student geographies and student HMO and their effects on the study area have been left by the Local Authority to the complex interplay of market forces. This unregulated aspect of student geographies in the study area seems to repeat the same lack of public policy regulation identified in the literature, which was seen to have encouraged the studentification in university precincts, and ultimately bring about the disintegration of established communities.

## 4. Conclusion

The purpose of the study was to explore the phenomenon of studentification, its effects, and the implications of these effects on the university precincts of Rondebosch – Rosebank – Mowbray. The case study findings generally support the acceptance of the proposition, *i.e.* “that the University of Cape Town causes studentification in its host communities, negatively impacting on the social, economic, cultural and environmental attributes of the residential neighbourhood and businesses area”. However, the part of the proposition which states that the social, economic, cultural and environmental impact of the effects of studentification on the residential neighbourhood and businesses in the area is negative, was found to only be partially true. From the analysis of the data, it is evident that some of the impacts of studentification on the residential neighbourhood and businesses are positive. Examples of such impacts of studentification which have a positive impact include the vibrant social scene created by the large student population and the establishment of retail outlets, businesses and services which cater to the needs of the large student population in the area, are positive. This observation largely depends on the section of the community being considered. Finally, the study adopted the lens of selected stakeholders, and only the key dimensions of the social, economic, cultural and environmental impacts were considered. Further research involving multiple cases of South African HEIs, thereby widening the population and the reach of the inferences and generalisations, is necessary. It would also be pertinent to conduct detailed studies of known properties with perennial student occupancies, as well as such issues as the trade-offs between the apparent profitability of the ‘student market’ and the challenges of urban management in these areas. In addition, further studies are needed on the patterns of the ‘student areas’, *i.e.* what influences such formations and their effects on the city.

## References

- Atkinson, R. and Bridge, G. (2005) *Gentrification in a global context: the new urban colonialism*, London, Routledge.
- Bailey, N., Findlay, J. and Gibb, K. (2000) *Deregulation and the Structure of Urban Rental Housing Markets*. Economics and Finance of Property and Housing Discussion Paper No. 2 (available online [http://www.gla.ac.uk/media/media\\_7418\\_en.pdf](http://www.gla.ac.uk/media/media_7418_en.pdf) [accessed on 28/05/2010]) .
- Ball, M. (2006) *Buy to Let: The Revolution 10 years on. Assessment and Prospects*, Amersham, Association of Residential Letting Agents.
- Benn, J. (2009) "The studentification of Stellenbosch", *Proceedings of the Annual Student Geography Conference*, 30 August – 3 September, St George Hotel, Centurion, Pretoria, South Africa.
- Cattell, K., Bowen, P. and Michell, K. (2008) "Stakeholders' perceptions of city improvement districts : the case of Rondebosch / Rosebank." *Journal of Contemporary Management* **5**: 106-112.
- Chatterton, P. (1999) "University students and city centres—the formation of exclusive geographies: The case of Bristol, UK." *Geoforum* **30**(2): 117-133.
- Chatterton, P. and Hollands, R. (2003) *Urban Nightscapes: Youth Cultures, Pleasure Spaces and Corporate Power*, London, Routledge.
- Cox, D.N. (2000) "Developing a framework for understanding university-community partnerships." *Cityscape: a Journal of Policy Development and Research* **5**(1): 9-26.
- Crook, A.D. (1992) Private rented housing and the impact of deregulation. In *Housing Policy in the 1990s*. J. Birchall (Ed.), London: Routledge, 91-112.
- Doward, J. (2009) *Rising student numbers blight residents' lives* (available online <http://www.theguardian.co.uk> [accessed on 05/10/2009])
- Flyvbjerg, B. (2006) "Five misunderstandings about case-study research." *Qualitative Inquiry* **12**(2): 219-245.
- Gopal, P. (2008) *College towns: Still a smart investment*. (available online [http://www.businessweek.com/lifestyle/content/mar2008/bw20080313\\_093883.htm](http://www.businessweek.com/lifestyle/content/mar2008/bw20080313_093883.htm) [accessed on 05/10/2009])
- Hubbard, P. (2008) "Regulating the social impacts of studentification: a Loughborough case study." *Environment and Planning A* **40**(2): 323-341.
- Hubbard, P. (2009) "Geographies of studentification and purpose-built student accommodation: leading separate lives?" *Environment and Planning A* **41**(8): 1903-1923.
- Kenyon, E.L. (1997) "Seasonal sub-communities: the impact of student households on residential communities" *British Journal of Sociology* **48**(2): 286-301.
- Leyshon, A. and French, S. (2009) "'We all live in a Robbie Fowler house': The geographies of the buy to let market in the UK." *British Journal of Politics and International Relations* **11**(3): 438-460.

Lowe, S. (2007) The new private rented sector - regulation in a deregulated market. In *The Private Rented Housing Market: Regulation or Deregulation?* D. Hughes and S. Lowe (Eds.), Aldershot, Ashgate, 1-14.

Martin, L. L., Smith, H. and Phillips, W. (2005) "Bridging 'town and gown' through innovative university-community partnerships." *The Innovation Journal: The Public Sector Innovation Journal*, **10**(2): 1-16.

Moilola, M. (2007) *Gentrification and City Improvement Districts: Possible consequence for the student rental market in Rondebosch/Rosebank*. Unpublished Honours dissertation, University of Cape Town.

Munro, M., Turok, I. and Livingston, M. (2009) "Students in cities: a preliminary analysis of their patterns and effects." *Environment and Planning A* **41**(8), 1805-1825.

National HMO Lobby (2005) *Studentification: discussion document*. 2005. (available online <http://www.hmobby.org.uk/lobbystudentif.htm>. [accessed on 04/10/2009])

Osborne, H. (2009) *Recession boost for student towns*. (available online <http://www.guardian.co.uk/money/2009/aug/02/student-housing-buy-to-let> [accessed on 15/01/2010])

Remenyi, D., Williams, B., Money, A., and Swartz, E. (1998) *Doing Research in Business and Management*, London, Sage Publications.

Republic of South Africa (1997) "Education white paper 3: A programme for the transformation of higher education". *Government Gazette*, No.18207, Notice No. 1196, 15 August.

Rugg, J., Rhodes, D. and Jones, A. (2000) *The nature and impact of student demand on housing markets*, York, York Publishing Services.

Sabri, S. and Ludin, A.N.M. (2009) *Studentification: is it a key factor within the residential decision making process in Kuala Lumpur?* (available online <http://www.fab.utm.my/download/ConferenceSemiar/SEATUC200904P.pdf> [accessed on 29/01/2010])

Shelter (2002) *Private Renting: A New Settlement* (available online <http://www.landlordlaw.co.uk/content/PRSmidiareport.pdf> [accessed on 28/05/2010])

Smith, D.P. (2002) "Patterns and processes of 'Studentification' in Leeds." *The Regional Review* **12**(1): 15-16.

Smith, D.P. (2005) 'Studentification': the gentrification factory? In *Gentrification in a Global context: the new urban colonialism*. R. Atkins and G. Bridge (Eds.), New York, Routledge, 72-89.

Smith, D.P. (2009) "'Student geographies', urban restructuring, and the expansion of higher education." *Environment and Planning A* **41**(8): 1795-1804.

Smith, D.P. and Denholm, J. (2006) *Studentification: a guide to challenges, opportunities and good practice*, London: Universities UK.

Smith, D.P. and Holt, L. (2007) "Studentification and 'apprentice' gentrifiers within Britain's provincial towns and cities: extending the meaning of gentrification." *Environment and Planning A* **39**(1):142-161.

Smith, D. (2008) "The politics of studentification and '(un)balanced' urban populations: lessons for gentrification and sustainable communities?" *Urban Studies* **45**(12): 2541-2564.

Steinacker, A. (2005) "The economic effect of urban colleges on their surrounding communities". *Urban Studies* **42**(7):1161-1175.

University of Brighton (2007) "International studentification." *Channel Magazine* (available online [www.brighton.ac.uk/news/channel/index.php?PageId=805](http://www.brighton.ac.uk/news/channel/index.php?PageId=805) [accessed on 13/10/2009])

University of Cape Town (2008) *Annual report*. (available online <http://www.uct.ac.za> [accessed on 29/01/2010])

Yin, R.K. (2003) *Case study research: design and methods*. London: Sage Publications.

Yin, R.K. (2009) *Case study research: design and methods*. 4<sup>th</sup> ed. California: Sage Publications.

## Session 8 - ISTP - Input Savings Technologies and Processes

Prof. Dr. Keith Stone Cattell<sup>1</sup> & Prof. Dr. Orestes M. Gonçalves<sup>2</sup>

<sup>1</sup>University of Cape Town - Rondebosch-Cape Town/South Africa

<sup>2</sup>EPUSP Escola Politécnica, University of São paulo - MBA/USP FM - São Paulo/Brazil

<b>Efficiency assessment of thermal environment for Grade A air-conditioned offices in Hong Kong</b> WONG, Ling Tim; HUI, Pui Shan; MUI, Kwok Wai; CHEUNG, Chin To The Hong Kong Polytechnic University	<b>559</b>
<b>State of Standardization in Embodied Energy Computation: The need for a Protocol</b> DIXIT, Manish Kumar; FERNÁNDEZ-SOLÍS, Jose; LAVY, Sarel; CULP, Charles Texas A&M University, USA	<b>571</b>
<b>Examination of existing facilities management approaches to climate change</b> DESAI, Apeshka; JONES, Keith University of Greenwich, UK	<b>585</b>
<b>Building energy management support system for managing the facilities of individual departments within universities</b> TU, Kung-Jen; LIN, Cheng-Hong; LAI, Jing-Fen National Taiwan University of Science and Technology	<b>597</b>
<b>BIM server for HVAC energy consumption simulations: new data structure and interfaces for a popular application</b> FERREIRA, Sérgio Leal; PETRECHE, João Roberto Diego; LEITE, Brenda Chaves Coelho Escola Politécnica da Universidade de São Paulo, Brazil	<b>615</b>
<b>The water demand management throughout twelve years of the Water Conservation Program of the University of São Paulo</b> SILVA, Gisele Sanches da; TAMAKI, Humberto Oyamada; GONÇALVES, Orestes Marraccini Polytechnic School, University of São Paulo, Brazil	<b>629</b>



## Efficiency assessment of thermal environment for Grade A air-conditioned offices in Hong Kong

L.T. Wong<sup>\*</sup>, P.S. Hui, K.W. Mui and C.T. Cheung

Department of Building Services Engineering, The Hong Kong Polytechnic University, Hong Kong, China.

*Corresponding email: \*beltw@polyu.edu.hk*

### Abstract

Air-conditioned offices in the subtropics are recommended to operate within specified ranges of indoor temperature, relative humidity and air velocity as a consequence of thermal energy conservation. As thermal discomfort leads to productivity loss, air-conditioned offices conducted with some indoor environmental policies for Hong Kong are investigated in this study with relation to thermal energy consumption and productivity loss due to thermal discomfort. Thermal environment in over 1000 air-conditioned Grade-A offices with some indoor environmental policies of Hong Kong being carried out is investigated. Occupant thermal response is specifically considered as an adaptive factor in evaluating the energy consumption and productivity loss. The results provide quantitative means for an environment policy regarding impacts on occupant thermal comfort and worker productivity as an important factor in determining the office environmental efficiency. The model parameters are not exhaustive, with assumptions made for the thermal comfort of occupants in offices in the subtropical areas and have only been determined from recent studies in Hong Kong, which perhaps will limit the model's usefulness elsewhere. This study is a useful reference source for evaluating an indoor thermal environmental policy regarding the energy consumption, thermal comfort and productivity loss in air-conditioned offices in the subtropical areas.

**Keywords:** Air-conditioned office, indoor environment, policy, thermal energy consumption, productivity

## 1. Introduction

Hong Kong, characterized by its 'hot and humid' climates, is a developed city with a population of 7 million and a limited area of 1067 km<sup>2</sup>. In 2005, the commercial sector accounted for 61% (i.e. 40000 GWh yr<sup>-1</sup>) of the total annual energy consumption in Hong Kong (EMSD, 2007). Energy conservation is now a global concern and some scientists suggest that at least half of the current energy consumption should be cut over the next 50 years to avert a future global warming disaster (Pacala and Socolow, 2004).

It was reported that a Mechanical Ventilation and Air-conditioning (MVAC) system, an essential feature for a comfortable office environment, would consume half of the total electrical energy of an air-conditioned commercial building (Mui, 2006). Apart from improvement on equipment efficiency, increment of indoor temperature and reduction of ventilation rate could also offer potential energy saving in air-conditioned offices (Yamtraipat et al., 2006). Maintaining satisfactory thermal conditions for the occupants by an adjustable indoor temperature set point of the air-conditioning system is one of the primary concerns in many air-conditioned office buildings (Wong et al., 2008). It was reported that there is a tendency for people to over-dress because of over-cooling in a number of offices (Mui and Wong, 2007). A survey of Hong Kong air-conditioned offices indicated a 'slightly cool' thermal environment was preferred by the occupants (Wan and Chao, 2002).

According to the Environmental Protection Department, indoor air quality (IAQ) objectives for office environment are proposed as a voluntary IAQ certification scheme (HKEPD 2003). The guidelines listed the exposure limits of CO<sub>2</sub> (800-1000 ppm) plus other 8 indoor air pollutants at a thermal environment of air temperature 20-25.5°C, relative humidity 40-70% and air speed below 0.2 ms<sup>-1</sup>. A number of offices adopted dilution to address the IAQ objectives with minimal alternations to existing building air-conditioning systems and fresh air quantity for ventilation was adjusted.

Concerns have been arisen and calls for reviewing some of the indoor environmental policies have been identified. Besides the issues related to psychosocial health and mould growth problems, productivity loss due to thermal discomfort in an air-conditioned office should be evaluated (Clausen and Wyon, 2008; Tsutsumi et al., 2007). Unfortunately, there is always a trade-off between energy saving and occupant comfort. An eco-efficient air-conditioning system conserves energy but not necessarily suits the thermal comfort needs of all occupants, and that will bring forth potential productivity loss (Kosonen and Tan, 2004). Therefore, in the assessment of eco-efficiency, electricity use, occupant discomfort, and worker productivity are all important factors (Assefa et al., 2007).

Thermal energy consumption for air-conditioned office buildings in Hong Kong was reported in literature (Mui, 2006; Wong et al., 2008). Using estimates of the probable occupant thermal votes for acceptance, this study investigated the impact of an indoor thermal environmental policy on the potential of energy consumption against the deterioration of corresponding productivity in some offices in Hong Kong.



## 2. Indoor environment of Grade A offices of Hong Kong

According to a property review, in the end of 2007, 60% of a total stock of 10106700 m<sup>2</sup> of office buildings in Hong Kong can be classified as Grade A (RVD, 2008). Grade A Offices are attributed according to their facilities and finishes. Modern design with high quality finishes, flexible layout, large floor plates, spacious, well decorated lobbies and circulation areas, effective central air-conditioning system, good lift services zoned for passengers and goods deliveries, professional management and parking facilities are provided. In Grade A offices, the design and maintenance of air-conditioning systems are the best among the office building stock and regular cleaning of air handling units and air ducts and replacement of filters are scheduled for a desired Grade A environment.

Indoor environmental assessments were conducted in 1021 Grade A air-conditioned offices of Hong Kong, with variable air volume (VAV) type ventilation system adopted. All these offices were certified with satisfactory IAQ under the Hong Kong IAQ certification scheme. The samples were randomly picked from all regions for air-conditioned office development, which covered a wide range of open-plan offices, conference rooms and individual small offices. Human activities and dress codes among them were reported to be similar. The measurement included IAQ assessments on 12 parameters regarding the IAQ objectives for the IAQ certification scheme from HKEPD (HKEPD, 2003).

Table 1 shows a summary of environmental conditions of assessed offices and compared with the design targets and some surveyed conditions in other Grade A offices as base case (HKEPD, 2003; Wong et al., 2006; Hui et al., 2008, 2009). The base case environmental conditions were assumed for Grade A offices before certified by the IAQ certification scheme.

The survey results of the assessed VAV air-conditioned Grade A offices in this study showed that a more precise environmental condition can be maintained as a narrower range of parameters were reported as compared with the base case values. It was noted that indoor air temperature and CO<sub>2</sub> concentrations increased and corresponding energy saving would be resulted. Ventilation rates were adjusted to dilute indoor air pollutants to the exposure limits and CO<sub>2</sub> exposure levels in a number of offices were below 1000 ppm. Nevertheless, the office environmental conditions would deviate from their target values in an occupied air-conditioned office.

*Table 1: Indoor environment of 1021 VAV air-conditioned Grade A offices*

Parameters	Design target	Base case	Assessed Grade A offices
	Range	Range (average)	Range (average)
CO <sub>2</sub> $\Phi_c$ (ppm)	800-1000	450-2000 (641)	500-1668 (851)
Indoor air temperature $T_s$ (°C)	20-25.5	13.4-27.8 (22)	18.2-26.6 (23.1)
Indoor relative humidity $R_h$ (%)	40-70	20-80 (60)	31-76 (57)
Local air speed $v_s$ (ms <sup>-1</sup> )	≤0.2	<0.05-0.41 (0.27)	0.05-0.35 (0.07)

### 3. Thermal energy consumption

Taking account of the conductive heat gain through the building fabric  $E_{en}$  ( $\text{kWh m}^{-2} \text{ yr}^{-1}$ ), and the heat generated by ventilation  $E_{ve}$  ( $\text{kWh m}^{-2} \text{ yr}^{-1}$ ) as well as all other internal loads  $E_{in}$  ( $\text{kWh m}^{-2} \text{ yr}^{-1}$ ) including the occupants  $E_{oc}$  ( $\text{kWh m}^{-2} \text{ yr}^{-1}$ ), lighting system  $E_{li}$  ( $\text{kWh m}^{-2} \text{ yr}^{-1}$ ) and electrical equipment  $E_{eq}$  ( $\text{kWh m}^{-2} \text{ yr}^{-1}$ ), the normalized annual thermal energy consumption for an air-conditioned office  $E_c$  ( $\text{kWh m}^{-2} \text{ yr}^{-1}$ ) is approximated by (Wong et al., 2008),

$$E_c = E_{en} + E_{ve} + E_{in}; E_{in} = E_{oc} + E_{li} + E_{eq} \quad (1)$$

The thermal energy consumption through the building envelope  $E_{en}$  can be approximated by a multivariate regression model given below, where  $T_s$  ( $^{\circ}\text{C}$ ) is the indoor air temperature,  $L_{max}$  (m) is the maximum length of the floor,  $L_f$  (m) is the length of the floor,  $W_f$  (m) is the width of the floor,  $A_f$  ( $\text{m}^2$ ) is the floor area,  $V_f$  ( $\text{m}^3$ ) is the floor volume,  $U_{ww}$  ( $\text{W m}^{-2} \text{ K}^{-1}$ ) is the average U-value of floor envelope,  $r_w$  is the window-to-wall ratio,  $S_c$  is the shading coefficient,  $\varepsilon$  is an error term approximated by a geometrical distribution with a geometric mean of 1 and a geometric standard deviation of 1.4623 (Wong et al., 2008).

$$\tilde{E}_{en} = 27749 T_s^{-0.8833} A_f^{-0.7861} V_f^{0.2205} r_w^{0.3936} L_{max}^{0.3670} U_{ww}^{0.3591} S_c^{0.4948} + \varepsilon;$$

$$L_{max} = \max(L_f, W_f) \quad (2)$$

The average U-value of floor envelope  $U_{ww}$  is the sum of window  $U_{wd}$  ( $\text{W m}^{-2} \text{ K}^{-1}$ ) and wall  $U_{wl}$  ( $\text{W m}^{-2} \text{ K}^{-1}$ ) U-values weighted by the window area  $A_{wd}$  ( $\text{m}^2$ ) and wall area  $A_{wl}$  ( $\text{m}^2$ ),

$$U_{ww} = \frac{A_{wd} U_{wd} + A_{wl} U_{wl}}{A_{wd} + A_{wl}}; r_w = \frac{A_{wd}}{A_{wd} + A_{wl}} \quad (3)$$

By defining  $N_d$  ( $\text{d yr}^{-1}$ ) as the number of working days per year,  $\Phi_c$  (ppmv) the indoor  $\text{CO}_2$  concentration and  $O_a$  ( $\text{hd m}^{-2}$ ) the occupancy factor, the normalized annual energy consumption for ventilation  $E_{ve}$  ( $\text{kWh m}^{-2} \text{ yr}^{-1}$ ) can be approximated by a regression Equation (Wong et al., 2008),

$$E_{ve} \approx 3.5 \times 10^8 \Phi_c^{-2.01} T_s^{-0.33} O_a^2 N_d \quad (4)$$

Based on the total operating hours in a year  $N_h$  ( $\text{h yr}^{-1}$ ), thermal energy consumption for the internal loads  $E_{in}$  ( $\text{kWh m}^{-2} \text{ yr}^{-1}$ ) is the sum as shown below, where  $K_0$  is a coefficient for unit conversion,  $P_{oc}$  ( $\text{kW hd}^{-1} \text{ m}^{-2} \text{ yr}^{-1}$ ) is the normalized per occupant thermal load while  $P_{li}$  ( $\text{kW m}^{-2} \text{ yr}^{-1}$ ) and  $P_{eq}$  ( $\text{kW m}^{-2} \text{ yr}^{-1}$ ) are the normalized thermal loads for lighting and other electrical equipment respectively,

$$E_{in} = E_{oc} + E_{li} + E_{eq} = K_0 \left( \sum_{i=1}^{N_h} O_a P_{oc,i} + \sum_{i=1}^{N_h} P_{li,i} + \sum_{i=1}^{N_h} P_{eq,i} \right) \quad (5)$$

For a standard Hong Kong office floor of an area in between 230 and 6600  $\text{m}^2$ , a window-to-wall ratio  $r_w$  in between 0.25 and 0.64, and a floor envelope U-value  $U_{ww}$  in between 2.4 and 2.7  $\text{W m}^{-2} \text{ K}^{-1}$ , this energy consumption model would under-predict the fabric load by 2.5% on average (Yu and Chow, 2007). For those office floors with  $r_w$  ranging from 0 to 1 and  $U_{ww}$  from 0.51 to 4.21  $\text{W m}^{-2} \text{ K}^{-1}$ , 63% of the simulation cases were found within the  $\pm 20\%$  consumption prediction, while 37% of the cases were in the 20-50% 'overestimation' range (Lam and Chan, 1997).

## 4. Productivity loss

The percentage loss of productivity  $D$  of an office worker can be expressed by combining the percentage productivity losses in thinking tasks  $T_k$  and typing tasks  $T_p$  with a thinking-to-overall task ratio  $\alpha$ ,

$$D = \alpha T_k + (1 - \alpha) T_p \quad (6)$$

$T_k$  and  $T_p$  measured in laboratory environments were correlated with the occupant-preferred mean thermal sensation vote  $\gamma_1$  ranged between  $-0.21$  and  $1.28$  (Kosonen and Tan, 2004),

$$T_k = 1.5928\gamma_1^5 - 1.5526\gamma_1^4 - 10.401\gamma_1^3 + 19.226\gamma_1^2 + 13.389\gamma_1 + 1.8763 \quad (7)$$

$$T_p = -60.543\gamma_1^6 + 198.41\gamma_1^5 - 183.75\gamma_1^4 - 8.1178\gamma_1^3 + 50.24\gamma_1^2 + 32.123\gamma_1 + 4.8988 \quad (8)$$

Fanger's predicted mean vote (PMV) index  $\gamma$ , a measure of occupant acceptance of the thermal environment, is a function of indoor air temperature  $T_s$  ( $^{\circ}\text{C}$ ), relative humidity  $R_h$  (%), local air speed  $v_s$  ( $\text{ms}^{-1}$ ), radiant temperature  $T_r$  ( $^{\circ}\text{C}$ ), occupant metabolic rate  $M_e$  (Met) and clothing value  $C_L$  (clo), i.e.  $\gamma \sim \gamma(T_s, R_h, v_s, T_r, M_e, C_L)$  (Fanger, 1972). Mathematical expressions of  $\gamma$  were addressed in open literature (Fanger, 1972). Some field studies of direct measurement for thermal acceptability reported a narrower operative temperature range for 80% thermal acceptability than the values specified in current design guidelines (ANSI/ASHRAE, 2004). This study also recorded a narrow thermal comfort acceptance range of PMV when compared with the chamber tests. With a correlation coefficient  $R=0.988$  ( $p<0.001$ , t-test), the preferred predicted mean vote (PPMV)  $\gamma_1$  obtained from the field measurements in Hong Kong air-conditioned offices can be correlated with  $\gamma$  by (Mui and Wong, 2007),

$$\gamma_1 = 3.86 \gamma + 3.05; -3 \leq \gamma_1 \leq +3 \quad (9)$$

The estimation of clothing value has long been recognized as a critical weakness in the field of research methodology and also in the application of standards and comfort indices to the 'real world' (Yamtraipat et al., 2006; Wong et al., 2008; Mui and Wong, 2007). In Hong Kong, there is a tendency for people to over-dress because of over-cooling in many air-conditioned workplaces. In this study of alternative warmer thermal environment conditions for the best estimate of energy saving, occupants should adjust their clothing volumes so that the maximum thermal acceptance can be obtained. Taking  $1 \text{ clo} = 0.155 \text{ m}^2 \text{ } ^{\circ}\text{C}\text{W}^{-1}$ , the clothing value noted in this study for an occupant sitting on an office chair with a pair of walking shorts and a short-sleeved shirt was  $0.46 \text{ clo}$ , and that for a standing occupant wearing thermal long underwear and a pair of insulated overalls was  $1.37 \text{ clo}$  (ANSI/ASHRAE, 2004).

To simulate the maximum occupant acceptance of a given thermal environment  $\phi_{\max}$ , the probable range of clothing volume found in typical Hong Kong air-conditioned offices (i.e.  $C_L = 0.3 - 1.7 \text{ clo}$ ) is assumed,

$$\phi = \phi_{\max}; 0.3 \leq C_L \leq 1.7 \quad (10)$$

## 5. Simulation for environmental efficiency

Impacts of the indoor environmental policy on the thermal energy consumption of the surveyed VAV air-conditioned Grade A offices, as well as the probable occupant thermal acceptance and the associated productivity loss, were analyzed in this study. In particular, three cases of environmental conditions listed in Table 1 were simulated, i.e. (A) the offices maintained at the design target conditions; (B) the ‘base case’ VAV air-conditioned Grade A offices and (C) the IAQ certification schemed VAV air-conditioned Grade A offices.

Table 2 summarizes the attributes required as the input parameters of office floors for the evaluation. The simple Monte Carlo sampling technique (Binder, 2002) was used to sample the input parameters in Equations (1) to (10) for cases (A), (B) and (C) in Table 1. Simulations were repeated 10,000 times for each case and the corresponding changes of the expected energy consumption and variance were 0.02% and 0.03% respectively for further simulations to be conducted.

*Table 2: Floor characteristics of air-conditioned office buildings in Hong Kong*

<b>Parameter</b>	<b>Range (average)</b>
Floor area $A_f$ ( $m^2$ )	200-3000 (900)
Floor space volume $V_f$ ( $m^3$ )	600-15000 (3500)
Floor length and width $L_f, W_f$ (m)	14-54 (30)
Window-to-wall ratio $r_w$	0.2-0.8 (0.5)
U-value of wall $U_{wl}$ ( $W m^{-2} K^{-1}$ )	0.57-3.41 (2.0)
U-value of window $U_{wd}$ ( $W m^{-2} K^{-1}$ )	2.97-6.16 (4.5)
Shading coefficient $S_c$	0.1-0.9 (0.47)
Occupancy factor $O_a$ ( $hd m^{-2}$ )	0.05-0.12 (0.074)
Normalized per Occupant thermal load $P_{oc}$ ( $kW hd^{-1} m^{-2} yr^{-1}$ )	94-170 (128)
Normalized thermal load of lighting $P_{li}$ ( $kW m^{-2} yr^{-1}$ )	10-30 (18)
Normalized thermal load of other electrical equipment $P_{eq}$ ( $kW m^{-2} yr^{-1}$ )	5-25 (12)
Number of operating hours in a year $N_h$ ( $h yr^{-1}$ )	2600-2800

Fig. 1 shows the annual thermal energy consumption per unit floor area for VAV air-conditioned Grade A offices in Hong Kong. It was reported that the average was  $586 kW h m^{-2} yr^{-1}$ ,  $965 kW h m^{-2} yr^{-1}$  and  $661 kW h m^{-2} yr^{-1}$  for cases (A), (B) and (C) respectively. The results showed that the target design conditions offered a maximum potential thermal energy saving of 39%. For the offices implemented the scheme, an average thermal energy reduction of 31% was reported. It was noted that some offices did not fully compile with the target design conditions but excessive reduction in the thermal energy could be resulted. This is shown in the bottom 30% in case (C) as compared with case (A).

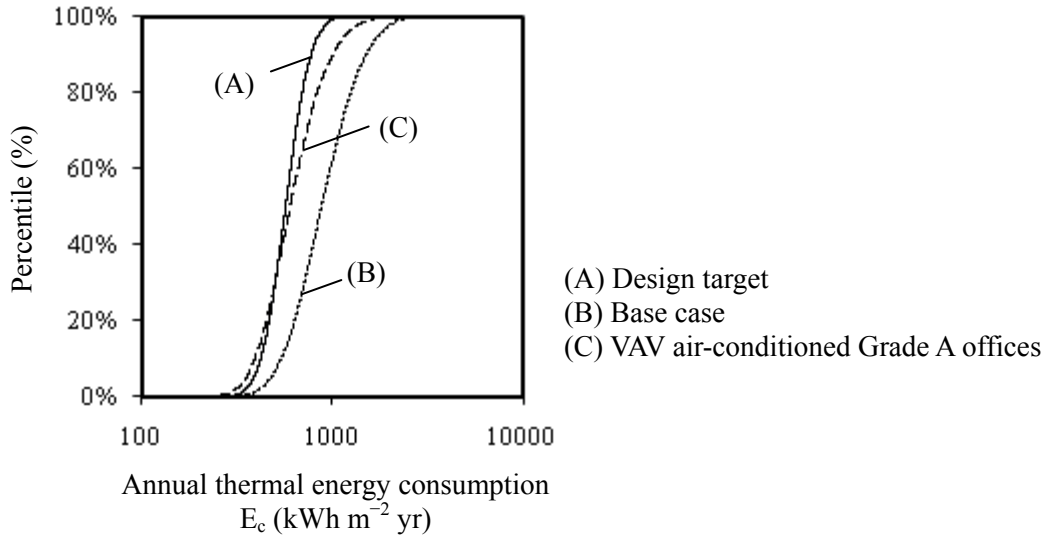


Figure 1: Thermal energy consumption.

Simulated occupant acceptance is graphed in Fig. 2. The PPMV index distributions showed that case (A) (the offices at the design target conditions) was not ( $p > 0.1$ , Chi-square test) whereas case (C) was ( $p < 0.05$ , Chi-square test) significantly different from the ‘base case’. Probably, most occupants in the ‘base case’ and case (A) were able to adjust their clothing volumes for maximum thermal comfort. Taking  $-0.5 \leq \gamma_1 \leq 0.5$  as the acceptable acceptance threshold (ANSI/ASHRAE, 2004), 94%, 78% and 95% of the occupants in cases (A), (B) and (C) respectively reported thermal satisfaction. Although 94% occupants are satisfied with the offices targeted thermal environment, in practice it had difficulties in achieving demanded environmental conditions for some occupants. In this study, the thermal acceptance rate from case (C) to case (A) dropped from 95% to 78% and some complaints of thermal discomfort could be expected.

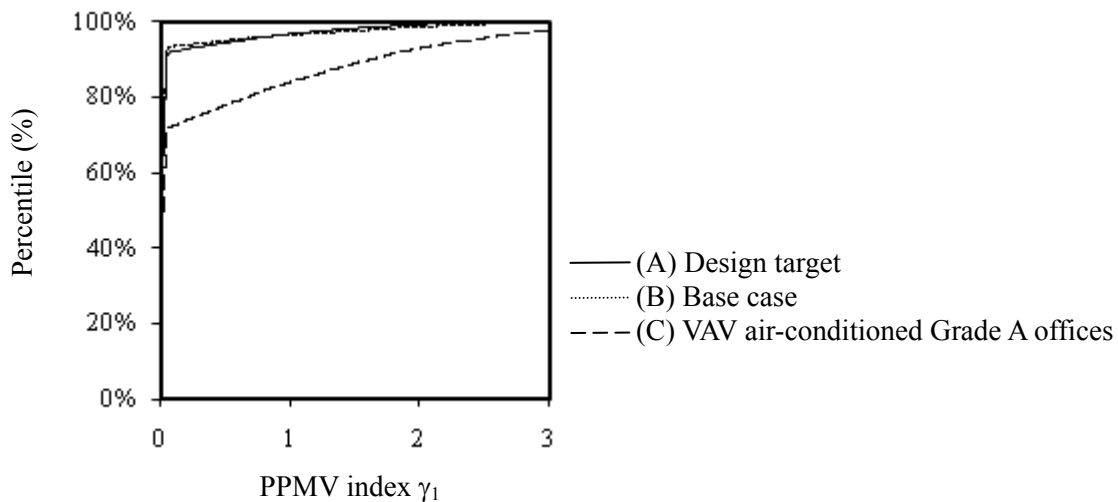
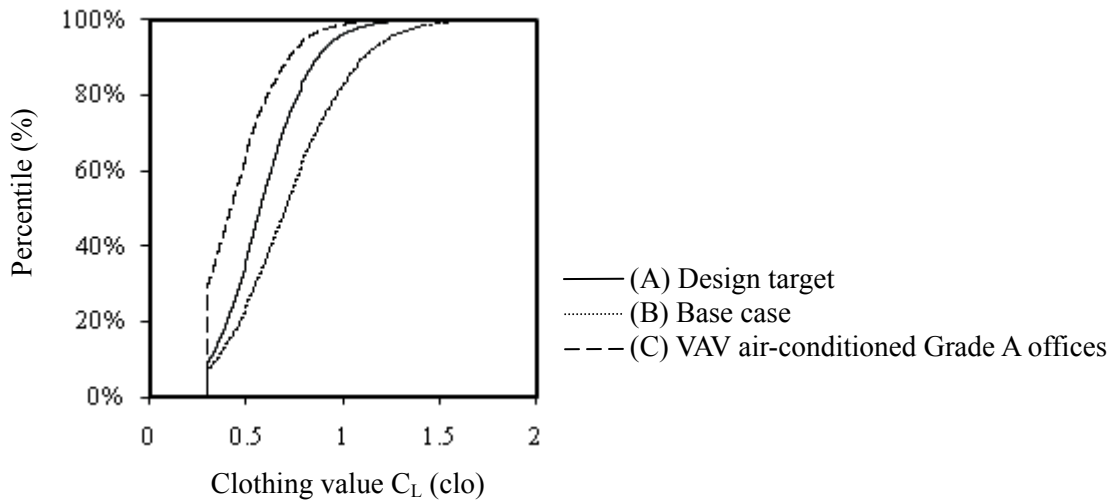
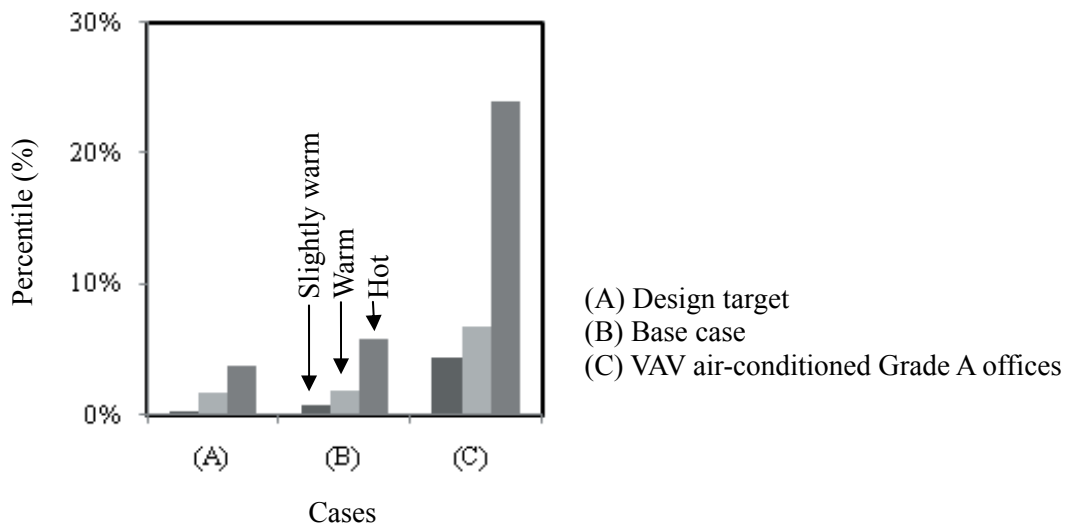


Figure 2: Simulated occupant acceptance.

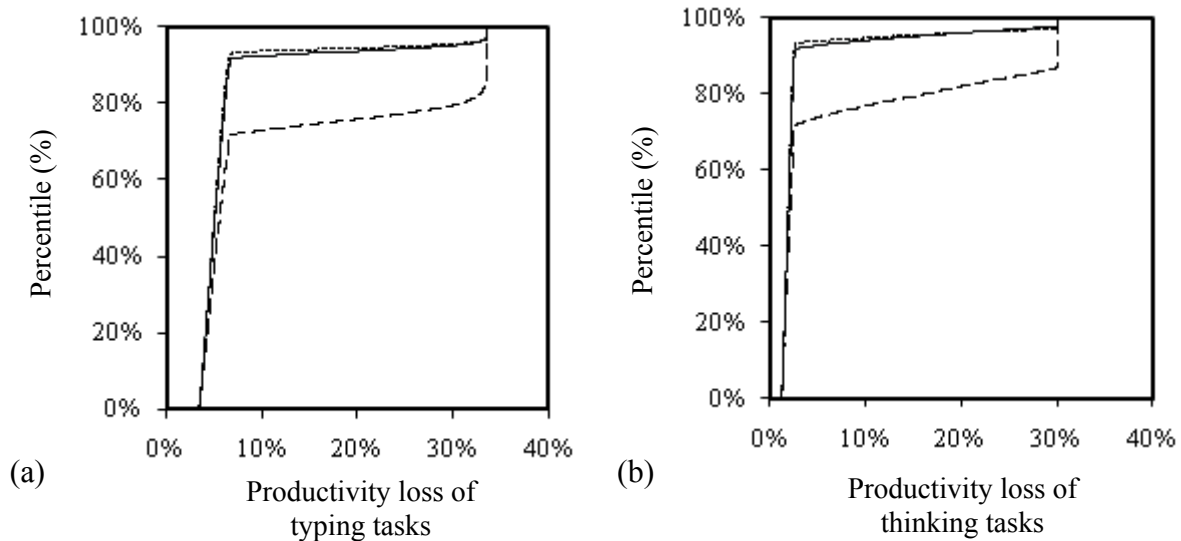


**Figure 3: Occupant clothing values for different thermal environments.**

Distributions of the clothing values for the three cases, among which significant differences were reported ( $p < 0.01$ , t-test), are exhibited in Fig. 3. The average clothing values were (A) 0.59 clo, (B) 0.73 clo and (C) 0.47 clo for the design target condition, base case and the Grade A offices with VAV air-conditioning system respectively. In case (C), a clothing value of 0.3 clo or below was found required for 30% occupants to adapt to the thermal environment; in contrasts, 9% and 7% occupants required 0.3 clo for cases (A) and (B) respectively were reported. Hypothetically, for a minimum clothing value  $C_L = 0.3$  imposed in (B), 4.4% of the occupants ( $\gamma_1 \geq 2.5$ ) would feel hot, 6.7% ( $2.5 < \gamma_1 \leq 1.5$ ) warm and 24% ( $1.5 < \gamma_1 \leq 0.5$ ) slightly warm as shown in Fig. 4. An improvement on thermally hot sensation was reported. It was noted that the target design offers over thermally comfortable environment to 94% occupants, while only 24% occupants felt thermally comfortable for offices in base case thermal conditions.. A predicted thermal acceptance of the environment in the surveyed VAV air-conditioned Grade A offices was about 65% as shown in the figure.



**Figure 4: Thermal response of occupants.**



**Figure 5: Potential productivity loss of office workers: (a) typing tasks; (b) thinking tasks**

Fig. 5 shows the predicted productivity loss among office workers in terms of (a) typing task and (b) thinking task respectively. Taking a think-to-overall task ratio  $\alpha=0.5$ , the average percentage productivity losses for the cases (A), (B) and (C) were 5.1%, 4.9% and 9.8% respectively.

## 6. Conclusion

Air-conditioned offices in the subtropics are recommended to operate within specified ranges of indoor temperature, relative humidity and air velocity for thermal energy conservation. However, productivity loss due to thermal discomfort in an overly warm office environment is a concern that cannot be ignored. In this study, some indoor environmental policies for Hong Kong air-conditioned offices were investigated at some VAV air-conditioned Grade A offices for maintaining satisfactory thermal conditions and productivity loss due to thermal discomfort. Occupant thermal response was specifically considered as an adaptive factor in evaluating the energy consumption and productivity loss based on the following three cases: (A) the target design conditions for air-conditioned office of Hong Kong where air temperature  $T_s=20-25.5^\circ\text{C}$ , relative humidity  $R_h=40-70\%$ , air velocity  $v_s=0.2\text{ ms}^{-1}$  and  $\text{CO}_2$  concentration  $\Phi_c=800-1000\text{ ppm}$ ; (B) the base case – a typical Hong Kong air-conditioned office where  $T_s=22^\circ\text{C}$  (SD= $2^\circ\text{C}$ ),  $R_h=60\%$  (SD= $9\%$ ),  $v_s=0.27\text{ ms}^{-1}$  (SD= $0.05\text{ ms}^{-1}$ ) and  $\Phi_c=641\text{ ppm}$  (SD= $160\text{ ppm}$ ) and case (C) – a VAV air-conditioned office with implementation of an environmental strategy for (A) where the measured values of  $T_s=23.1^\circ\text{C}$ ,  $R_h=57\%$ ,  $v_s=0.07\text{ ms}^{-1}$  and  $\Phi_c=851\text{ ppm}$ . Probable office thermal environments were determined via Monte Carlo simulations using the entire Hong Kong air-conditioned office building stock, and the corresponding energy consumption, and productivity loss were evaluated.

It was demonstrated that, in comparison with the ‘base case’, a VAV air-conditioned Grade A office in Hong Kong with an implemented environmental policy had a reduction of thermal energy consumption and a reduction of productivity. This study presents a useful reference source for

building designers and policymakers to evaluate indoor thermal environment, especially those for air-conditioned offices in the subtropical areas, regarding energy consumption, thermal comfort and productivity loss.

## Nomenclature

A	area (m <sup>2</sup> )
C <sub>L</sub>	clothing value (clo)
D	percentage loss of productivity
E	annual thermal energy consumption (kWh m <sup>-2</sup> yr <sup>-1</sup> )
K	constant
L	length (m)
M <sub>e</sub>	metabolic rate (met)
N <sub>d</sub>	number of working days in a year (d yr <sup>-1</sup> )
N <sub>h</sub>	number of operating hours in a year (h yr <sup>-1</sup> )
O <sub>a</sub>	occupancy factor (hd m <sup>-2</sup> )
P	normalized thermal load (kW m <sup>-2</sup> yr <sup>-1</sup> )
p	p-value of a statistic test of significance
R	correlation coefficient
R <sub>h</sub>	relative humidity (%)
r <sub>w</sub>	window-to-wall ratio
S <sub>c</sub>	shading coefficient
SD	standard deviation
T	temperature (°C)
T <sub>k</sub>	thinking task
T <sub>p</sub>	typing task
U	U-value (W m <sup>-2</sup> K <sup>-1</sup> )
v	velocity (ms <sup>-1</sup> )
V <sub>f</sub>	volume (m <sup>3</sup> )
W	width (m)
Φ <sub>c</sub>	indoor CO <sub>2</sub> concentration (ppmv)
α	thinking-to-overall task ratio
ε	error term
φ	occupant acceptance of the thermal environment
γ	predicted mean vote (PMV)
γ <sub>1</sub>	preferred predicted mean vote (PPMV)

### *Superscript*

~ distribution function

### *Subscript*

0,1,2,...of conditions 0,1,2,...

c of an air-conditioned office

en of conductive heat gain through building envelope



eq	of electrical equipment
f	of floor
i	of the i-th item
in	of internal loads
li	of lighting system
max	of maximum
oc	of occupants
r	of radiant
s	of indoor air
ve	of ventilation
wd	of window
wl	of wall
ww	of floor envelope

## Acknowledgement

The work described in this paper was partially supported by a grant from the Research Grants Council of HKSAR, China (PolyU5248/06E). The facilities were partially supported by a grant from the Research Grants Council of HKSAR, China (PolyU5305/06E, PolyU5164/08E) and a grant from The Hong Kong Polytechnic University (GU551).

## References

ANSI/ASHRAE 55-2004 *Thermal Environmental Conditions for Human Occupancy*, Atlanta: American Society of Heating, Refrigerating and Air-Conditioning Engineers, USA.

Assefa G, Glaumann M, Malmqvist T, Kindembe B, Hult M and Myhr U et al. (2007) "Environmental assessment of building properties-where natural and social sciences meet: the case of ecoeffect." *Building and Environment* **42(3)**: 1458-1464.

Binder K (2002) *Monte Carlo simulation in statistical physics: an introduction*, 4th Ed. Springer, New York, USA.

Clausen G and Wyon DP (2008) "The combined effects of many different indoor environmental factors on acceptability and office work performance." *HVAC&R Research* **14(1)**: 103-113.

EMSD (2007) *Energy End-use Data 2007*, The Energy Efficiency Office, Electrical and Mechanical Department, Hong Kong, China.

Fanger PO (1972) *Thermal comfort*, McGraw-Hill, NY, USA.

HKEPD (2003) *Indoor air quality certification scheme for offices and public places*. Environmental Protection Department, Hong Kong, China.

Hui PS, Mui KW, Wong LT, and Leung CH (2009) "Benchmarking indoor air quality for 'Grade A' offices in Hong Kong", *Joint Symposium 2009 on building sustainability under one sky*, Tian Yu Hotel, 28-29 June, Tianjin, China, pp. 1-7.

Hui PS, Wong LT and Mui KW (2008) "Indoor air quality benchmarks of 'Grade A' offices in Hong Kong", *1st International Conference on Building Energy and Environment (COBEE)*, 13-16 Jul, Dalian, China, pp. 685-690.

Kosonen R and Tan F (2004) "Assessment of productivity loss in air-conditioned buildings using PMV index." *Energy and Buildings* **36(10)**: 987-993.

Lam JC, Hui SCM and Chan ALS (1997) "Regression analysis of high-rise air-conditioned office buildings." *Energy and Buildings* **26(2)**: 189-197.

Mui KW (2006) "Energy policy for integrating the building environmental performance model of an air conditioned building in a subtropical climate." *Energy Conversion Management* **47(15/16)**: 2059-2069.

Mui KW and Wong LT (2007) "Neutral temperature in subtropical climates – a field survey in air-conditioned offices." *Building and Environment* **42(2)**: 699-706.

Pacala S and Socolow R (2004) "Stabilization Wedges: Solving the climate problem for the next 50 years with current technology." *Science* **305(5686)**: 968-972.

RVD (2008) *Hong Kong property review 2008*, Rating and Valuation Department, Hong Kong, China.

Tsutsumi H, Tanabe S, Harigaya J, Iguchi Y and Nakamura G (2007) "Effect of humidity on human comfort and productivity after step changes from warm and humid environment." *Building and Environment* **42(12)**: 4034-4042.

Wan MP and Chao CY (2002) "Experimental study of thermal comfort in an office environment with an underfloor ventilation system." *Indoor and Built Environment* **11(5)**: 250-265.

Wong LT, Mui KW and Hui PS (2006) "A statistical model for characterizing common air pollutants in air-conditioned offices." *Atmospheric Environment* **40(23)**: 4246-4257.

Wong LT, Mui KW and Shi KL (2008) "Energy impact of indoor environment policy for air-conditioned offices of Hong Kong." *Energy Policy* **36(2)**: 714-721.

Yamtraipat N, Khedari J, Hirunlabh J and Kunchornrat J (2006) "Assessment of Thailand indoor set-point impact on energy consumption and environment." *Energy Policy* **34(7)**: 765-770.

Yu PCH and Chow WK (2007) "A discussion on potentials of saving energy use for commercial buildings in Hong Kong." *Energy* **32(2)**: 83-94.

# State of Standardization in Embodied Energy Computation: The need for a Protocol

**Dixit, Manish K., Fernández-Solís, Jose L., PhD, Lavy, Sarel, PhD, and Culp, Charles H., PhD**

College of Architecture, Texas A&M University, USA

## Abstract

**Aim:** Current Embodied Energy (EE) data and databases suffer from the problems of inconsistency, uncertainty and variability that eventually make data incomparable and unreliable. This paper aims to assess the current state of standardization in EE analysis and identifies the need to develop a protocol for the process of EE measurement.

**Methodology or approach:** An extensive literature search was performed and data from literary sources was gathered. The literature includes papers and reports that critically evaluate the current standards being used for EE analysis.

**Conclusions:** Parameters differ in current databases and influence the process of decision-making in the construction industry. Current embodied energy computations are based on guidelines and requirements set forth for performing Life Cycle Assessments. However, research has pointed out discrepancies in issues related to system boundaries and allocation, which need to be eliminated or clarified. Furthermore, subjectivity and lack of clarity exist in current standards, which could distort the results of Life Cycle Assessments or embodied energy analyses. There is a strong and stated need to develop and implement an EE measurement protocol.

**Limitations of the research:** The scope of this paper is limited to building materials and their embodied energy. Life Cycle Assessment is only discussed peripherally and is out of the scope of this paper.

**Practical applications:** Owing to the increasing significance of EE, global comparability and reliability of results are vital data qualities, especially in environmental practices like eco-labeling, low embodied energy material preference and green building rating systems. This protocol incorporates requirements and guidelines for embodied energy analysis to deal with differing parameters. The evolution and establishment of an embodied energy protocol would facilitate much needed environmental labeling and would support informed decision making for materials

**Keywords:** Embodied energy, building materials, Life Cycle Assessment, LCA standards, embodied energy standards

## 1. Introduction

The total energy consumed by a building is the sum of its operating and embodied energy (Dixit et al., 2010; Crowther, 1999; Ding, 2004). Operating energy is expended in operating the building, whereas embodied energy is consumed in building material production, construction processes, transportation activities, renovation and refurbishment processes and demolition and disposal activities (Dixit et al., 2010). Until recently, embodied energy was considered insignificant as compared to operational energy; however, current research has demonstrated that embodied energy is significant and in some studies it is found to be 20 to 50 times the annual operational energy in a building (Ding, 2004; Nassen et al., 2007; Crowther, 1999; Sartori and Hestnes, 2007). Furthermore, operational energy is being curbed down by evolving advanced building envelope materials and high performing equipment. Embodied energy can only be reduced if low energy intensive building materials are selected in the pre-construction phases (Nassen et al., 2006; Sartori and Hestnes, 2007; Ding, 2004).

Current embodied energy data suffer from the problem of variation and inaccuracy (Dixit et al., 2010). Parameters, including system boundaries, primary energy, delivered energy and feedstock energy, define the input variables that are included in developing the embodied energy. Other parameters, such as age and source of data, representativeness (temporal, spatial and technological), and methods of measurement, also affect the data quality (Dixit et al., 2010). These parameters differ amongst current databases and influence the process of decision-making in the construction industry. Environmental practices, such as environmental selection of building materials, eco-labelling and green building assessment systems rely on Life Cycle Assessment (LCA) and embodied energy data. These data, however, differ and suffer from the problem of inaccuracy; thus, they cannot be used for such practices (Wan, 2008; Vonka, 2005; Pears, 1996; Worth, 1996; Davies, 2001; Ross, 2000; Esin, 2007; Atkinson et al., 1996; Trusty and Horst, 2002; Cole, 2000; Larsson, 1999).

Most current efforts in the embodied energy calculation have used LCA methods and guidelines or standards. Databases of embodied energy include data that are derived using guidelines set forth by the International Standardization Organization (ISO) for Life Cycle Assessment (LCA). Hammond and Jones (2006), Crawford (2009), Huberman and Pearlmutter (2008) and John et al. (2009) have performed embodied energy assessments and analyses based on ISO standards. Standards like ISO 14040 and 14044 and the code of practice set forth by the Society for Environmental Toxicology and Chemistry (SETAC) present requirements and guidelines for the process of Life Cycle Assessment of materials or products (Udo de Haes and Heijungs, 2007; Fava, 2005; Rebitzer et al., 2004; Ross et al., 2002; Zamagni et al., 2008; SETAC, 2008; Levan, 1995). Embodied energy analysis is a subpart of LCA that appears in the life cycle energy analysis stage (Atkinson, 1996; Lawson, 1996). LCA guidelines could provide direction to the embodied energy analysis, but literature suggests that these guidelines fail to address certain vital issues. The process of embodied energy analysis lacks standardization and requires more clarification and calculation guidelines that can be applied globally in order to address the

problems of inaccuracy and variability (Pears, 1996; Pullen, 1996; Menzies et al., 2007; Udo de Haes and Heijungs, 2007). This paper identifies a need to establish an embodied energy measurement protocol and assesses the state of standardization in embodied energy research by surveying existing standards that are used for LCA and embodied energy measurement. Furthermore, it determines the issues that these standards still fail to address.

## 2. Research Methods

The research methods used include extensive literature review using various search engines to collect relevant information from peer reviewed and published bibliographic sources. This research method is called Literature Based Discovery (LBD), widely used in the realm of biomedical science, which was proposed by Dr. Don R. Swanson from the University of Chicago. Kenneth A. Cory (Wayne State University, Detroit) has demonstrated that the concept of LBD is valid outside the biomedical science field (Weeber et al., 2001; Weeber, 2007). The literature suggests that there are no standards or guidelines that could be used for embodied energy analysis. This study applies the LBD approach to survey current standards and guidelines used for embodied energy measurement. Furthermore, this paper cites the critical reviews of the referred standards and guidelines to point out issues that need to be addressed. Finally, a necessity to develop and implement an embodied energy protocol is identified by deriving a matrix of three arguments indicating urgency for the protocol.

## 3. Literature Review

### 3.1 Embodied Energy and Its Significance

The embodied energy of a building material or product is the sum of energy inputs required to manufacture, process, and deliver that material or product to the building site. Furthermore, it also includes energy required to dispose of that material or product at the end of its service life. Embodied energy in a building includes embodied energy in building materials or products; energy inputs in construction processes; energy required during building use in maintenance and refurbishment and; energy inputs in the demolition and disposal of the building. However, Dixit et al. (2010) assert that the definitions of embodied energy rendered by different research studies demonstrate a difference of opinion. According to Miller (2001), the term “embodied energy” is subject to various interpretations rendered by different authors and its published measurements are found to be quite unclear.

Until recently, the emphasis of energy conservation research was on the operating energy of a building. However, current research disproved this assumption and found that embodied energy accounts for a significant proportion of total life cycle energy (Crawford and Treloar, 2003; Crowther, 1999). Operational energy conservation could be accomplished with energy efficient appliances and advanced insulating materials, which are available more readily (Nassen et al., 2006; Sartori and Hestnes, 2007; Ding, 2004). However, preferring only low energy intensive materials can reduce embodied energy, as well. Commonwealth Scientific and Industrial Research Organization (CSIRO) research has demonstrated that the embodied energy content of

an average household in Australia is nearly equivalent to 15 years of operational energy (Commonwealth of Australia, 2005). Crawford and Treloar (2003) insinuate that, in Australia, the embodied energy contained in a building is 20 to 50 times the operational energy needed for the building annually.

### **3.2 Variation and Inconsistency in Embodied Energy Measurement Results**

Buchanan and Honey (1994); Crowther (1999); Crawford and Treloar (2003); Ding (2004); Horvath (2004); Nassen et al. (2007); and Langston and Langston (2008) suggest that the embodied energy results from research studies show significant variation in embodied energy figures, which are derived from information from disparate sources and different countries. According to Dixit et al. (2010), embodied energy figures vary due to differing parameters, such as data qualities (geographic, temporal and technological representativeness), methods of embodied energy calculation, differing system boundary and inclusion of primary and/or delivered energy. Literature suggests that the determination of embodied energy is difficult and that no standard methodology is available to estimate the energy levels of building materials (Crowther, 1999). It is relatively facile to configure the operating energy of a building; however, embodied energy determination is more time consuming and complex (Langston and Langston, 2008).

### **3.3 Lack of a Reliable and Robust Embodied Energy Database: Implications on Environmental Practices**

Among prevailing environmental practices are eco-labelling, environmental selection of building materials and products and the green building assessment. The eco-labelling of a product is comparatively useful in informing consumers or customers about the product's environmental characteristics (Marin and Tobler, 2002; Trusty, 2004; Levan, 1995; Hes, 2000). The embodied energy of a product is a useful criterion for judging environmental performance (Wan, 2008; Vonka, 2005) and if embodied energy data are inaccurate and possess variations, the purpose of eco-labelling is not fulfilled.

Environmental selection of materials or products could result in large savings in energy use and eventual decrease in CO<sub>2</sub> emissions due to energy production (Atkinson et al., 1996; Gonzalez and Navarro, 2006; Thormark, 2006). Atkinson et al. (1996) found that energy savings due to environmental preference could be as great as 20 percent, while Thormark (2006) determined a reduction of 17 percent and an increase of 6 percent in embodied energy values due to the right and wrong selection of materials. Unfortunately, no reliable information exists about the embodied energy of a material or product, which could be used for the purpose of environmental preference (Fernandez, 2006). Conversely, available information about embodied energy is uncertain; thus, people involved in decision-making and their decisions are influenced by uncertainty (Pears, 1996). Such differing embodied energy data pose difficulty in making the right decisions about selecting environment friendly materials or products (Pears, 1996; Worth, 1996; Davies, 2001; Ross, 2000).

Embodied energy in buildings and their materials and components can be used as an important criterion in green building assessment systems (Holloway and Bunker, 2006; Mistry, 2007; Todd et al., 2007; Larsson, 1999). Green building rating systems or tools, like LEED, GBTOOL, CASABEE, and BREEAM use energy consumption in buildings as one important criterion. Calibration of embodied energy is not only complex but also difficult, and as a result, it is not considered important in comparison with operating energy in building assessment systems (Fowler and Raunch, 2005; Cole, 2000). Unavailability of valid data and lack of appropriate tools limit the potential of embodied energy as a vital criterion in environmental assessment of buildings (Trusty and Horst, 2002; Cole, 2000; Larsson, 1999).

### **3.4 Survey of Current Standards and Guidelines Used for Embodied Energy Analysis and Life Cycle Assessment (LCA)**

Embodied energy calculation is integral to the LCA of a material or a product (Atkinson, 1996; Lawson, 1996). LCA can be used for measuring energy consumption and energy usage in a material's useful life (Lawson, 1996). Atkinson et al. (1996) adopted LCA methodology for calculating embodied energy in building materials; in doing so, they revealed that the British Research Establishment (BRE), United Kingdom, is working to develop a set of guidelines and methodology for embodied energy calculation based on LCA methodology and Society for Environmental Toxicology and Chemistry (SETAC) guidelines. No standard for embodied energy calculations and analysis exists. Most current embodied efforts use LCA methods and standards to determine the energy intensiveness of a building material or a component. ISO and SETAC are among the pioneer organizations responsible for the standardization and scientific development of LCA, respectively (Udo de Haes and Heijungs, 2007; Fava, 2005; Rebitzer et al., 2004; Ross et al., 2002; Zamagni et al., 2008; SETAC, 2008; Levan, 1995). The following section presents a brief survey of the codes and standards put forth by these organizations to perform an LCA:

*ISO – International Standardization Organization:* The International Standardization Organization (ISO) is a global federation of national standards bodies or ISO member bodies that released the following standards for conducting LCA of a material or a product (ISO, 2006a and 2006b):

1. ISO 14040-2006: Environmental Management – Life Cycle Assessment – Principles and Framework (ISO, 2006a): The international standards mention general requirements and a description of the issues and requirements specific to the four phases of LCA (Goal and scope definition, Life cycle inventory analysis, Life cycle impact assessment and Life cycle interpretation). Furthermore, these standards describe the requirements of reporting the results and conclusions of LCA by listing the aspects that need to be reported.
2. ISO 14044-2006: Environmental Management – Life Cycle Assessment – Requirements and Guidelines (ISO, 2006b): The ISO 14044 standards list the basic requirements and guidelines in detail and address issues related to allocation and system boundaries. The standards describe data and data sources and state data quality requirements (in the form of data quality indicators)

to ensure higher quality data. Moreover, explanation is given for the treatment of missing data or data gaps in the LCA database.

*Society for Environmental Toxicology and Chemistry (SETAC)*: SETAC is the pioneer organization dedicated to the scientific development of the LCA. According to Cole (1996), “SETAC offers the most comprehensive and widely cited LCA methodology.” SETAC evolved a document to provide direction to the LCA: “SETAC: Guidelines for Life Cycle Assessment – A Code of Practice.” This document provides direction to LCA methodology by describing the general principles and framework to execute, review, present and use the results of LCA (SETAC, 1993). Levan (1995) states that LCA methodology, which later provided the foundation for the ISO 14040 series of standards for LCA, was originally developed by SETAC in the early 1990’s. However, Fava (2005) claims that like ISO, SETAC is not responsible for standardizing LCA, but for improving the science and practice of LCA.

## 4. Findings

### 4.1 Critical Review of ISO Standards and SETAC Code of Practice

Critical reviews of current LCA standards pinpoint issues that still need to be addressed in these standards. Weidema et al. (2008) argue that despite the available ISO and SETAC standards for LCA, individual efforts to create methodology and guidelines still exist. Researchers, like Weidema et al. (2008), Zamagni et al. (2008), Reap et al. (2008), Suh et al. (2004), Rebitzer et al. (2004) and Reynolds et al. (2000), point out the issues of system boundary and allocation in current ISO standards for LCA. Weidema et al. (2008) refer to system boundary and co-product allocation in ISO standards when they state, “ISO 14044 LCA standard is unnecessarily open for misinterpretation.” Furthermore, the cut-off rules for system boundaries are presented in a complicated manner. Zamagni et al. (2008) argue that the ISO procedures for allocation in LCA are prone to conflicting interpretations and researchers at times do not agree with these procedures.

ISO framework lacks clear procedural guidance for the interpretational phase of LCA. The ISO standards discuss a framework for LCA steps but do not provide a clear method for executing such steps. Reap et al. (2008) and Zamagni et al. (2008) assert that the manner in which ISO standards deal with system boundary and allocation issues in LCA introduces subjectivity and truncation error into the assessment. Suh et al. (2009), Reynolds et al. (2000) and Reynolds et al. (2000) question the ability of ISO standards by claiming that it is impossible to select a system boundary that truly complies with ISO standards.

Reap et al. (2008), Zamagni et al. (2008) and Ross et al. (2002) explain that ISO standards lack proper uncertainty and sensitivity analysis; ISO discusses and acknowledges these problems but does not elaborate further or furnish appropriate methods for performing them. Furthermore, Suh et al. (2009) suggest that an input/output-based approach must be incorporated into current ISO standards for LCA instead of a process-based approach. Hammond and Jones (2008) claim



that it would be ideal to comply with ISO standards, but studies that follow ISO standards still face larger differences in results.

## 4.2 Issues for Current Standards

This paper presents critical reviews of standards, such as ISO 14040, ISO 14044 and SETAC codes of practice. Issues of system boundaries, allocation, methodology and sensitivity and uncertainty analysis are identified by the review of current literature, as a critical appraisal of LCA standards. Following is a summary of these issues:

*System Boundaries:* There is a lack of clarity and subjectivity and the issue of truncation error in the current selection criteria and procedures mentioned by LCA standards (Weidema et al., 2008; Zamagni et al., 2008; Reap et al., 2008; Suh et al., 2009; Rebitzer et al., 2004; Raynolds et al., 2000).

*Allocation:* It is still unclear which approach must be adopted for the purpose of allocation, as there is disagreement regarding current approaches. The feasibility of the current method of allocation is questionable according to critiques (Weidema et al., 2008; Zamagni et al., 2008; Reap et al., 2008; Suh et al., 2009; Rebitzer et al., 2004; Raynolds et al., 2000).

*Methodology:* the literature suggests that the methodology prescribed by the LCA standards is still unclear (Curran and Young, 1996; Smith and Peirce, 1996; Trusty, 2004; Zamagni et al., 2008).

*Sensitivity and uncertainty analysis:* according to the literature, the current standards mention conducting sensitivity and uncertainty analyses, but fail to provide an appropriate method for performing this analysis (Reap et al., 2008; Zamagni et al., 2008; Ross et al., 2002).

## 4.3 Need to Develop an Embodied Energy Measurement Protocol

An extensive literature search indicates that there is no simple and standardized method available for embodied energy measurement, and there is a need to standardize the process of embodied energy calculation by developing a measurement protocol. The three arguments presented in Table 1 indicate a need to develop a protocol for embodied energy calculation.

Research efforts in the field of EE computation and analysis call for a need to create a robust global database of energy intensities. There needs to be a robust, reliable and accurate database of embodied energy in building materials that is possible only if standardization and comparability are introduced into current research efforts (Pears, 1996; Raynolds et al., 2000; Peereboom et al., 1998; Worth, 1993; Trusty, 2004).

Table 1 various arguments indicating the need for an EE protocol

<i>Research Studies</i>	<i>Recommendations</i>			
	<i>Critical review of ISO and SETAC</i>	<i>Need to develop a protocol</i>	<i>Need to establish a robust database</i>	<i>There is no standard or correct method for EE calculation</i>
<i>AWC, 2007</i>		√		
<i>Suh et al., 2004</i>	√			
<i>Hammond and Jones, 2007</i>	√		√	
<i>Reap et al., 2008</i>	√			
<i>Weidema et al., 2008</i>	√			
<i>Zamagni et al., 2008</i>	√			
<i>Esin, 2007</i>			√	
<i>Menzies et al., 2007</i>		√		√
<i>ICANZ, 2006</i>		√		
<i>John-Fernandez, 2006</i>			√	
<i>Rebitzer et al., 2004</i>	√			
<i>Trusty, 2004</i>			√	
<i>Davies, 2001</i>			√	
<i>Raynolds et al., 2000</i>	√		√	
<i>Ross, 2002</i>			√	
<i>Crowthier, 1999</i>				√
<i>Peereboom et al., 1998</i>			√	
<i>Lawson, 1996</i>				√
<i>Pears, 1996</i>		√	√	√
<i>Pullen, 1996</i>		√	√	√
<i>Worth, 1993</i>			√	
<i>Lippiatt and Norris, 1995</i>		√		

Research studies indicate the need for a set of guidelines or framework for EE calculation and analysis to deal with the evident problems. Pullen (1996) suggests that inaccurate, variable, and incomparable data is among the major hindrances to a preference for more energy-efficient materials. Pullen (1996) warns that the development of a sound EE method will not be possible without addressing the problems associated with data quality. Menzies et al. (2007) argue that, despite a number of efforts to conduct LCA and establish inventories, no global protocol has been developed to avoid variation and inconsistency in LCA results or EE values. Furthermore, there is a strong need for a standardized approach to embodied energy analysis to address the problems, such as variation and inaccuracy (Pears, 1996; Menzies et al., 2007). An ICANZ (2006) media release comments that it is quite difficult to obtain confidential commercial

information from industry regarding EE. Moreover, there exists no international protocol for EE calibration in building materials. The Federal Stimulus Package for energy efficiency and energy conservation in the United States requires that construction and major renovation projects perform LCA and EE energy calculations for building materials used (Bill, SB 5385). Moreover, Bill SB 5385 requires the Department of General Administration to develop guidelines for the establishment of a method for EE calculation in building materials (AWC, 2009).

## 5. Conclusions

The energy embodied in buildings and building materials is significant and is vital for reducing total energy consumption in a building. However, a difference of opinion exists among research studies that focus on this topic. Embodied energy data suffer from the problem of variation and inaccuracy and eventually are incomparable. Environmental practices, such as low energy material selection, eco-labelling and green building assessment cannot fulfil their environmental goals if there is a lack of accurate and robust data. Most embodied energy research involving calibration of embodied energy uses LCA methods and standards.

The International Standardization Organization (ISO) and Society for Environmental Toxicology and Chemistry (SETAC) are primarily responsible for advancements in standardization and scientific development of LCA. However, literature suggests that LCA studies that follow current standards are coming up with differing results. Moreover, a critical appraisal of these standards recommends major improvements and modifications in their current status. The literature in the field of embodied energy analysis reveals that there exist no standards that could address the problems in embodied energy databases and that there is a strong need to develop a protocol or standard to standardize embodied energy analysis.

This paper identifies an urgent need to establish a protocol to guide the process of embodied energy measurement and analysis. Moreover, it points out vital issues that current standards fail to address. The issues raised by the critical appraisal of the current standards must be addressed in the protocol in order to eliminate those problems.

## References

- Atkinson, C. (1996). "Life cycle embodied energy and carbon dioxide emissions in buildings." *Industry and Environment*, 19(2), 29-31.
- Association of Washington Cities. (2009). Association of Washington Cities Legislative Bulletin, *Energy and Telecommunication*, 32(4), 6 February 2009.
- Buchanan, A.H., and Honey, B.G. (1994). "Energy and carbon dioxide implications of building construction." *Energy and Buildings*, 20(3), 205-217.

- Cole, R.J. (1996). "Determining permissible degree of inaccuracy in life cycle assessment protocols." *In proceedings of the air & waste management association's 89th annual meeting and exhibition*, Nashville, Tennessee, USA, 23-28 June, 1996.
- Cole, R.J. (2000). "Building environmental assessment methods: assessing construction practices." *Construction Management and Economics*, 18(8), 949-957.
- Commonwealth of Australia (2005). *Sustainable Home Technical Manual - 3: Materials*. Commonwealth of Australia.
- Crawford, R. H. (2009). "Life cycle energy and greenhouse emission analysis of wind turbines and the effect of size on energy yield," *Renewable and Sustainable Energy Review*, 13 (9), 2653-2660.
- Crawford, R.H., and Treloar, G.J. (2003). "Validation of the use of Australian input output data for building embodied energy simulation." *In eighth international IBPSA conference*, Eindhoven, Netherlands, August 2003.
- Crowther, P. (1999). "Design for disassembly to recover embodied energy." *In the 16<sup>th</sup> annual conference on passive and low energy architecture*, Melbourne-Brisbane-Cairns, September 1999.
- Curran, M.A., and Young, S. (1996). "Report from EPA conference on streamlining LCA." *International Journal of LCA*, 1(1), 57-60.
- Davies, H. (2001). "Environmental benchmarking of Hong Kong buildings." *Structural Survey*, 19(1), 38-46.
- Ding, G. (2004). *The development of a multi-criteria approach for the measurement of sustainable performance for built projects and facilities*. PhD Thesis, University of technology, Sydney.
- Dixit, M.K., Fernández-Solís, J., Lavy, S., and Culp, C.H. (2010). "Identification of parameters for embodied energy measurement: A literature review." *Energy and Buildings*, 42 (8), 1238-1247.
- Esin, T. (2007). "A study regarding the environmental impact analysis of the building materials production process (in Turkey)." *Building and Environment*, 42(11), 3860-3871.
- Fava, J. (2005). "Can ISO Life Cycle Assessment Standards Provide Credibility for LCA?" *Building Design and Construction*, November 2005, 17-20.
- Fernández, J. (2006). Materials and construction for low-energy buildings in China. *In Sustainable urban housing: Principles and case studies for low-energy design in China*, L. Glicksman and J. Lin. Dordrecht, (Eds.) the Netherlands: Springer.
- Fowler, K.M. and Rauch, E.M. (2006). "Sustainable Building Rating Systems Summary." Pacific Northwest National Laboratory, US Department of Energy, Battelle, USA.
- Gonzalez, M.J., and Navarro, J.G. (2006). "Assessment of the decrease of CO<sub>2</sub> emissions in the construction field through the selection of materials: practical case studies of three houses of low environmental impact." *Building and Environment*, 41(7), 902-909.
- Hammonds, G. and Jones, C. (2006). "Inventory of Carbon and Energy (ICE), Version 1.5a Beta." Carbon vision buildings program, UK.
- Hammond, G., and Jones, C. (2008). "Embodied energy and carbon in construction materials." *Energy*, 161 (2), 87-98.
- Hes, D. (2000). "Introduction to eco-labelling standards, issues, experiences and the use of LCA." *In proceedings of second national conference on LCA, Melbourne, Australia, 23-24 February 2000*.

- Holloway, D., and Bunker, R. (2006). "Planning, Housing and Energy Use: A Review." *Urban Policy and Research*, 24(1), 115-126.
- Horvath, A. (2004). "Construction materials and the environment." *Annual Review of Energy and the Environment*, 29, 181-204.
- Huberman, N., and Pearlmutter, D. (2008). "A life-cycle energy analysis of building materials in Negev desert." *Energy and Buildings*, 40 (5), 837-848.
- Insulation Council of Australia and New Zealand. (2006). Insulation Council of Australia and New Zealand. *Media Release*, 20 February 2006.
- ISO. (2006a). *ISO 14040 Environmental Management –Life Cycle Assessment - Principles and Framework*. International Organization for Standardization, Geneva, Switzerland.
- ISO. (2006b). *ISO 14044 Environmental Management –Life Cycle Assessment –Requirements and Guidelines*. International Organization for Standardization, Geneva, Switzerland.
- John, S., Nebel, B., Perez, N., and Buchanan, A. (2009). Environmental Impacts of Multi-Storey Buildings Using Different Construction Materials. Research Report 2008-02, University of Canterbury, NZ.
- Langston, Y.L., and Langston, C.A. (2008). "Reliability of building embodied energy modelling: an analysis of 30 Melbourne case studies." *Construction Management and Economics*, 26(2), 147-160.
- Larsson, N.K. (1999). "Development of a building performance rating and labelling system in Canada." *Building Research & Information*, 27(4/5), 332-341.
- Lawson, B. (1996). "LCA and Embodied energy: some contentious issues." In proceedings of embodied energy seminar: current state of play, Deakin University, Geelong, Australia, 28-29 November 1996.
- Levan, S.L. (1995). "Life Cycle Assessment: Measuring Environmental Impact." In *49th Annual Meeting of the Forest Products Society*, Portland, Oregon, June 1995.
- Lippiatt, B., and Norris, G. A. (1995). Selecting environmentally and economically balanced building materials, in: 2nd International Green Building Conference and Exposition-1995, NIST, Gaithersburg, United States, 37-46.
- Marin, A.W., and Tobler, M. (2002). "The Purpose of LCA in Environmental Labels and Concepts of Products." *International Journal of LCA*, 8(2), 115-116.
- Menzies, G.F., Turan, S., and Banfill, P.F.G. (2007). "Life-cycle assessment and embodied energy: a review." *Construction Materials*, 160(4), 135 – 143.
- Miller, A.J. (2001). "Embodied energy – a life cycle of transportation energy embodied in Construction materials." In *COBRA 2001, conference papers*, RICS Foundation.
- Mistry, V. (2007). "Briefing: BREEAM—making what is important measurable." *Engineering Sustainability*, 160(1), 11-14.
- Nassen, J., Holmberg, J., Wadeskog, A., and Nyman, M. (2007). "Direct and indirect energy use and carbon emissions in the production phase of buildings: An input output analysis." *Energy*, 32(9), 1593-1602.
- Pears, A. (1996). "Practical and policy issues in analysis of embodied energy and its application." In *proceedings of the embodied energy the current state of play: seminar*, Geelong, Australia, 28 – 29 November, 1996.

- Peereboom, E.C., Kleijn, R., and Lemkowitz, S. and Lundie, S. (1998). "The Influence of Inventory Data Sets on Life Cycle Assessment Results: A Case Study on PVC." *Journal of Industrial Ecology*.2 (3), 109-130.
- Pullen, S. (1996). "Data Quality of embodied energy methods." *In proceedings of the embodied energy the current state of play: seminar*, Geelong, Australia, 28 – 29 November, 1996.
- Raynolds, M., Fraser, R., and Checkel, D. (2000). "The Relative Mass-Energy-Economic (RMEE) Method for System Boundary Selection." *International Journal of Life Cycle Assessment*, 5(1), 37-46.
- Reap, J., Roman, F., Duncan, S., and Bras, B. (2008). "A survey of unresolved problems in life cycle assessment Part 2: impact assessment and interpretation." *International Journal of Life Cycle Assessment*, 13(5), 374-388.
- Rebitzer, G., Ekvall, T., Frischknecht, R., Hunkeler, D., Norris, G., Rydberg, T., Schmidt, W.P., Suh, S., Weidema, B.P., and Pennington, D.W. (2004). "Life Cycle Assessment part 1: Frame work, goal and scope definition, inventory analysis and application." *Environment International*, 30(5), 701-720.
- Ross, S. (2000). Life Cycle Assessment (LCA): "Data aggregation and how this affects comparison." *In proceedings of second national conference on LCA, Melbourne, Australia, 23-24 February 2000*.
- Ross, S., Evans, D., and Webber, M. (2002). "How LCA studies deal with uncertainty." *International Journal of LCA*, 7(1), 47-52.
- Sartori, I., and Hestnes, A.G. (2007). "Energy use in the life cycle of conventional and low – energy buildings: A review article." *Energy and Building*, 39(3), 249 – 257.
- Smith, J.K., and Peirce, J.J. (1996). "Life Cycle Assessment Standards: industrial sector and environmental performance." *International Journal of LCA*, 1(2), 115-118.
- SETAC. (1993). *Guidelines for Life Cycle Assessment-A "Code of Practice"*. Society for Environmental Toxicology and Chemistry, Brussels, Belgium.
- SETAC, Europe LCA Steering Committee (2008). "Standardization Efforts to Measure Greenhouse Gases and 'Carbon Foot printing' for Products." *International Journal of Life Cycle Assessment*, 13(2), 87-88.
- Suh, S., Lenzen, M., Treloar, G. J., Hondo, H., Horvath, A., and Huppes, G., (2004). "System Boundary Selection in Life Cycle Inventories Using Hybrid Approaches." *Environmental Science and Technology*, 38(3), 657-664.
- Thormork, C. (2006). "The effect of material choice on the total energy need and recycling potential of a building." *Building and Environment*, 41(8), 1019-1026.
- Todd, J.A., Crawley, D., Geissler, S., and Lindsey, G. (2001). "Comparative assessment of environmental performance tools and the role of the Green Building Challenge". *Building Research & Information*, 29(5), 324-335.
- Trusty, W.B. (2004). "Life cycle assessment databases and sustainable buildings." *In proceedings of the Latin-American Conference on Sustainable Building*, Sao Paulo, Brazil, July 2004.
- Trusty, W.B., and Horst, S. (2002). "Integrating LCA Tools in Green Building Rating Systems." *The Austin Papers: Best of the 2002 International Green Building Conference*, Environmental Building News, Ed., 2002, pp. 53-57.

- Udo de Haes, H.A., and Heijungs, R. (2007). "Life Cycle Assessment for energy analysis and management." *Applied Energy*, 84(7/8), 817-827.
- Vonka, M. (2005). "Environmental impact assessment of the residential buildings in the Czech republic and the multi-criterion approach." *In proceedings of the 2005 World Sustainable Building Conference*, Tokyo, 27-29 September 2005, 2016-2019.
- Wan, W.C. (2008). "Greening the Materials for Building and Construction – Part 1." *The Contractor*, Official Publication of the Singapore Contractors Association Limited (SCAL), September/October, 2008.
- Weeber, M. (2007). "Drug discovery as an example of literature based discovery," in: Dzeroski, S. and Todorovski, L. (Eds.) *Computational Discovery*, Springer, Berlin, pp. 290-306.
- Weeber, M., Klein, H., and Jong-van den Berg, L.T.W. (2001). "Using Concepts in Literature-Based Discovery: Simulating Swanson's Raynaud–Fish Oil and Migraine–Magnesium Discoveries," *Journal of the American Society for Information Science and Technology*, 52(7), 548-557.
- Weidema, B.P., Thrane, M., Christensen, P., Schmidt, J., and Løkke, S. (2008). "Carbon Footprint, a Catalyst for Life Cycle Assessment?" *Journal of Industrial Ecology*, 12(1), 3-6.
- Worth, D. (1993). "Embodied energy analysis of buildings part 1: determining the energy contents of building materials." *Exedra*, 4(1), 6-13.
- Zamagni, A., Buttol, P., Porta, P.L., Buonamici, R., Masoni, P., Guinee, J., Heijungs, R., Ekvall, T., Bersani, R., Bienkowska, A., and Pretato, U. (2008). "Critical review of the current research needs and limitations related to ISO-LCA practice." Co-ordination Action for innovation in Life-Cycle Analysis for Sustainability project, ENEA, The Italian National Agency on new Technologies, Energy and the Environment.





# Examination of existing facilities management approaches to climate change and future directions.

**Miss. Api Desai**

University of Greenwich, UK  
Da04@gre.ac.uk

**Prof. Keith Jones**

University of Greenwich, UK  
K.G.Jones@gre.ac.uk

## Abstract

It is widely accepted that human activities have contributed to changing the world's climate and that the pace of this change is ever increasing. Two approaches are being promoted by the international community to address the issue of climate change (1) Mitigation, seeking to reduce the amount of CO<sub>2</sub>; (2) Adaptation, which seeks to alter the way humankind live and work in response to the changing climate.

Whilst facilities managers and their organisations have prioritised mitigation action, there is less evidence to suggest that they are addressing the implications that a changing climate may have on the demands being placed on their organisation's hard and soft facilities (adaptation).

This paper reports findings from a case study and questionnaire survey to ascertain the present approach taken by facilities managers to address mitigation and adaptation, their respective drivers, their view on climate change and their environmental inclination.

It concludes that the facilities manager's approach to climate change is derived by a combination of factors; namely a) Organisation approach to climate change b) Legislation and c) the facilities managers perception of the risks posed by future climate change and of the use of risk assessment methods and climate change projection data. The study concludes that the prevailing measure for addressing climate change impacts is reactive in nature, taking the form of Disaster Recovery and Business Continuity Planning.

The practical implication of the work is in the realization that mitigation, being quantifiable and legislative driven, is viewed as a strategic issue and of importance to an organisations Corporate Social Responsibility agenda which can be planned over the longer term (10-20 yrs). Adaptation on the other hand is measured through successful survival, increased resilience and adaptive capacity (absence of quantitative performance target), each of which are viewed as short term operational issues and as such adaptation struggles to find strategic importance. If organisations are to adapt to inevitable climate change then this situation needs to change.

**Keywords:** Facilities management, climate change, adaptation, impacts on buildings,

## 1. Introduction

The IPCC fourth assessment report 2007 reiterated that ‘Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century’ (IPCC 2007). It maintains that ‘There is *high confidence* that neither adaptation<sup>1</sup> nor mitigation<sup>2</sup> alone can avoid all climate change impacts; however, they can complement each other and together can significantly reduce the risks of climate change (IPCC, 2007).

In recent years international action on climate change has been ad-hoc without consensus on emission targets or adaptation actions. The UK government has addressed the issue of climate change through its Climate Change Program (2001; 2006) and, more recently, through its Low Carbon Transition Plan (DECC, 2009). The present response to mitigation has manifested itself through increased legislation such as The Climate Change Levy (HMSO, 2001); The Building (Amendment) Regulations 2001 (Part L) (HMSO, 2001); and the CRC Energy Efficiency Scheme Order (HMSO, 2010). These legislations have driven organisations to consider CO<sub>2</sub> reduction targets in their corporate social responsibility strategies.

### 1.1 Research study and structure of paper

The increasing importance of sustainability and in particular CO<sub>2</sub> reduction and energy efficiency in facilities and operational management are well addressed by Brown & Pitt (2001) and Junnila (2004).

Increased legislation has ensured that mitigation aimed at reducing CO<sub>2</sub> emissions through reduced consumption of fossil fuels and improved energy efficiency has become part of the strategic business agenda, partly due to compliance issues and partly due to corporate image amongst stakeholders and customers. Addressing mitigation strategies has forced the Facilities Managers (FM) to consider their approach to asset management and examine the degree to which alternate FM strategies can contribute to a reduction in CO<sub>2</sub> emissions from business premises and operations. In contrast, the issues related to adapting to the impacts of inevitable climate change (adaptation to building fabric and operations), including approaches to assessment of risk and the ability of existing business and facilities strategies to manage these risks, have received less attention. In recent years the UK has experienced increasing climate hazards as a result of extreme weather events (e.g. heat wave 2003, floods in 2002, 2004 & 2007) that has emphasised the need for disaster recovery planning for such impacts. Further, it

---

<sup>1</sup> Adaptation: Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects.(IPCC AR4).

<sup>2</sup> Mitigation: An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks. (IPCC AR4).

has been suggested that addressing these issues will require modification in the present practice to facilities management away from primarily responsive actions to more predictive approaches that seek to understand the impact of events on the holistic performance of the built asset in-use (Jones & Copper, 2009). This research project addresses these issues and this paper presents the findings of a case study of a major UK commercial organisation and a follow-up questionnaire survey of 474 members of British Institute of Facilities Managers (BIFM), to ascertain whether existing approaches to facilities management can effectively support the development of long term planned mitigation and adaptation strategies for commercial property subjected to climate change. The paper examines facilities managers perception of future climate change impacts and the extent to which risk based models (UKCIP decision-making framework) provide a decision making framework for facilities managers to plan adaptation and mitigation interventions to commercial property that address climate change projections. The paper concludes that if the risk based approach is to be successful then there is a need to establish simpler assessment approaches supported by easy to use climate change projection data for quantifying future impacts than is currently available in the UK<sup>3</sup>. If this can be achieved then it should be possible to formulate asset management strategies based on quantified impact assessment of risk that results in increased resilience of organisational property to climate change.

## **2. Climate change impacts on commercial built assets.**

Climate change impacts on businesses and their premises are twofold: those due to increasing mitigation legislation affecting organisational energy use and management; and those that increase physical risk to business operations and buildings: coastal flooding and erosion, increased cooling load, increased water penetration from driving rain, increased maintenance cost as a result of reoccurring repair due to high winds (Graves and Phillipson, 2000).

### **2.1 Mitigation initiative and commercial stock**

In the UK, none domestic buildings (excluding industrial building) account for 13% of emissions, of which 27% (of the 13%) is attributable to the retail sector; 14% to the hotel and catering sector and 10% to the general commercial sector (Pout and MacKenzie 2005; Carbon Trust, 2009). The majority of emissions are attributed to electricity use (63%) and thus attracts the attention of the Climate Change Levy (CCL) - a tax levied on industrial and commercial use of coal, gas and electricity and reimbursed as a rebate through National Insurance Contributions (NIC). The impact of the levy on the service sector has been positive one. According to the CBI (CBI & EEF, 2002) survey, the service sector benefited from a £417.7 m

---

<sup>3</sup> At time of the fieldwork only UKCIP 02 projections were available in the UK.. The recent probabilistic UKCIP 09 projection could have yielded different results for the study.

reduction in NIC whilst it paid £365.1m in CCL, thus retaining a net profit of £61.6m. The service sector initiated simple climate change measures: appointing personnel with responsibility for energy management and metering; installing low energy lighting; and procuring energy from renewable sources to lower CO<sub>2</sub> emissions to meet their targets. This finding is also emphasised by Ekins and Etheridge (2006) who found that inclusion of renewable energy procurement and setting lower CO<sub>2</sub> reduction targets has encouraged managers (through potential financial gains) to implement simple energy efficiency measures.

In spite of this initial drive for implementing energy efficiency measures there remain barriers to further reducing CO<sub>2</sub> emissions from commercial buildings. These include: low demand for energy efficient buildings; insistence on low operating costs over energy efficiency standards; none ownership (tenant-landlord barrier) of built assets; long refurbishment cycles; lack of awareness/information of mitigation ; and lack of transparency in building performance (Scarce 2001; Adyeye et al, 2007; Carbon Trust 2009).

## 2.2 Need for commercial sector to adapt

Whilst there are still issues to be addressed with mitigation regulation, and in particular the need to set more demanding mitigation targets that address the problems of further warming and unavoidable impacts of climate change, it would appear that the existence of regulation has had the effect of raising mitigation up corporate agendas, ensuring that it is now considered as a strategic issue for facilities management. On the other hand the same can't be said for adaptation. Even if global CO<sub>2</sub> levels are held at current values, the effects of the increased levels currently in the atmosphere will mean that the UK will face inevitable climate change over the next 30 years resulting in increased flooding and overheating (amongst others) and requiring adaptation of existing buildings and infrastructure to such impacts (IPCC, 2007). The drivers for adaptation however are not only physical, but also economic. This is emphasised by Frith and Colley (2006) who examined the business case for adaptation, drawing attention to the high initial costs and longer-term obsolescence if adaptation was not undertaken.

In the UK the raised awareness of adaptation can be seen as a result of increasing flood events in 2002, 2004, 2006, 2007 and 2009. The 2007 floods caused damage to 35,000 commercial properties at a cost of £3billion and resulted in increased buildings insurance costs of 3% (ABI, 2007). The ABI also suggested that in the light of the heavy losses a review of buildings insurance would be conducted, with the possible removal of cover (BBC, 2007) if property owners failed to take adaptation measures to reduce flood risk to their individual properties (DEFRA, 2008). A similar recommendation was also made by the Pitt Review (2007) whilst identifying that many of the interventions to reduce flooding did not lie within the remit of business, insisted that the commercial and private sector should consider making their buildings resilient and resistant, This need for businesses to improve the resilience of their built assets and invest in the adaptive capacity to survive future flooding events is indicative of the wider importance placed on adaptation plans that seek to address inevitable climate change.

Developing this resilience and adaptive capacity will require a planned proactive (as opposed to reactive) approach to operation; maintenance and management of their business function and the built assets they occupy. In order to encourage a proactive approach it is essential to assess future risk associated with climate change, and possess the adaptive capacity to plan interventions. Such an approach should include an assessment of the future climate change risks on the obsolescence of an organisation's built assets and on the role that routine maintenance and refurbishment can play preparing the assets to withstand the risks (Jones & Desai, 2006). Jones & Desai (ibid) further hypothesised that, by combining the UKCIP02 projections with the expert knowledge that facilities managers possess about their built assets, facilities managers would be able to assess future climate change risks (with the aid of the UKCIP decision-making framework) and develop adaptation plans as part of their routine maintenance and refurbishment programmes. This hypothesis was examined through a case study of a major UK commercial organisation and a detailed questionnaire survey of 474 facilities managers.

### 3. Case study process and observation

A commercial organisation, and in particular its FM department, was chosen as the basis to test the appropriateness of the risk based model described by Jones & Desai (2006). Through a series of formal management meetings; informal discussions with operational managers responsible for the development and implementation of the facilities management strategy and presentations to the senior facilities management board, the research team examined both attitudes towards climate change (mitigation and adaptation) and the organisational response which was believed to be inclined towards increase resilience. During these discussions the research team introduced UKCIP 02 projections and implemented the UKCIP decision-making framework (Willows & Connell, 2003), through an action research programme with facilities management team. Throughout the development and implementation process, regular meetings were held with internal stakeholders to evaluate progress and to develop appropriate tools to operationalise the UKCIP decision-making framework. The following section summarises the key findings from this process.

The results of the UKCIP decision-making framework application are presented in the table 1. Although a range of climate impacts were considered, the two impacts that were perceived to be most important to the organisation were flooding and overheating, with flooding being given the highest priority - primarily because the organisation had already experienced business disruption due to flooding events. With the problem defined, the next stage was to identify which of the organisations built assets were currently at risk, or likely to be at risk as a result of future climate change. This task proved more complicated than was originally envisaged. The climate scenarios (UKCIP 02) available were able to give future projections over wide geographical areas, but lacked specific probabilities of occurrence at micro level due to which site specific quantitative risk assessment proved difficult to undertake. Although higher resolution climate projection data was available, the UKCIP team has stated that this does not imply that detailed climate change information is available at the 5km scale, as there are many local climatic influences and feedbacks at this level that could modify the general pattern of

change. Similar concerns are also noted by Luc Salagnac (2004) and O’Brien et al (2004). In light of these concerns The Environment Agency flooding maps and information from local councils was used to make site specific (at the individual building location level) flood risk assessments. The decision to use the Environment Agency data was a pragmatic one based on the views of the organisations facilities management team who argued that buildings located in areas already prone to the risk of flooding and are likely to face increased risk in the future. These predictions they had confidence in and felt able to defend to senior management. Whilst this may appear a somewhat short sighted approach, it is in line with the suggestions Willows & Connell 2003, who identified lack of understanding of climate change projections and related uncertainties being a key issue in assessing the risks associated with future climate change amongst business decision-makers.

<div style="text-align: center;"><i>Outcome</i></div> <div style="text-align: left;"><i>Framework stage</i></div>	<i>Concise Outcome</i>
<i>Stage 1- Define Problem</i>	<i>The Problem consideration was based on experience of a flood event and consecutive financial loss. The criteria were to look for ways to adapt to present and future climate related flood events( and overheating). Climate change will be an important aspect in deciding on the adaptation measures. The scale of problem was deemed to be at the project level (i.e. operational). The decision were expected to provide short term and long term ≥10 yrs benefits.</i>
<i>Stage 2- Establish decision making criteria</i>	<i>The attitude of the organisation towards risk was considered along with the level of risk acceptable (risk threshold). The major receptors were business function and built assets. Flood maps were used to decide on upper, medium and lower thresholds of risk to the properties (considering these levels are likely to increase or remain same in event of future climate change).</i>
<i>Stage 3- Assess risk (tier 1 &amp; 2)</i>  <i>Stage 3-Assess risk (tier 3),</i> <i>Stage 4- Identify options,</i> <i>Stage 5- Appraise option,</i> <i>Stage 6- Make decision, ,</i> <i>Stage 7- Implement,</i> <i>Stage 8- Monitor were not undertaken at required detail.</i>	<i>Precipitation, extreme rain fall, costal sea level rise and summer temperature were regarded as variables of interest. The Medium High climate scenario with time scale of 2020 was considered. The limitations of existing measures were considered (resistance and resilience to flooding). Although uncertainty was looked at it proved very difficult to persuade the organisation to consider further data collection and quantitative assessment and thus consider long term planned adaptation interventions. A qualitative and semi quantitative assessment and matrix was developed to assess the likely risk and resilience of sample properties. Due to time constraints this matrix was not fully tested.</i>
<i>Coping strategies</i>	<i>As a consequence of the action research programme, the organisation strengthened its business continuity and disaster recovery plans. High-risk properties were placed under 'ongoing observation' and flood resistant refurbishment contingencies were identified for at high risk sites. Further research on business value of at risk sites and strategy for disposal or continuing acquisition was considered.</i>

Table 1: A summary of outcome relating to stages of framework

By way of compromise, the research team extrapolated future flood assessments by combining the existing flood risk maps with the wider macro level climate change projection. These enabled the team to augment the list of buildings that were at "known risk" with those that were at "possible risk". However, much of the implementation process remained qualitative or semi quantitative in nature. The implementation of quantitative risk assessment methods (e.g. Monte Carlo method, Bayesian method) were not pursued for probabilistic risk assessment due to lack of micro level probabilistic climate change projections and unavailability of historic data on property damage (cost) and business interruptions as a result of previous flooding events. It was also difficult to establish validity for investing in elaborate quantification of the impacts of future flooding on built asset management plans (including adaptation strategies) as a result of the unpredictable cycle of acquisition and disposal of built assets in response to business demands (why invest in protecting a building against future flooding if we may not occupy it in five years time?) and the 30 year time line for climate change risk compared to business and facilities management strategy upgrade time period of 3-5 years. As a result, the organisation decided to adopt a responsive strategy for climate change adaptation, (keep a watching brief and only intervene when a problem presents) until such a time as the level of certainty surrounding the impacts was reduced or the risks more clearly quantified. In adopting this strategy a number of "trigger points" were established against which further detailed survey and quantitative assessments could be made.

In case of flooding the most favoured long term strategic option was that of strengthening business continuity planning through risk transfer (insurance) and the provision of temporary flood defences where required (to reduce premiums). Properties rated at high risk and where a recent flood event had occurred had flood resistance and resilience measures planned as part of the next normal refurbishment cycle, depending upon the budget availability (e.g. moving equipment above flood level, replacing carpets with hard floor, installing flood gates etc.). The relocation of the business operation from the property (even on a temporary basis) would be considered if persistent climate related extreme events were experienced.

In terms of immediate operational adaptation, routine maintenance was extended to include more regular gutter cleaning and drainage system testing; maintaining roof tiles and monitoring the façade for any water ingress. The main business operational measure was an extension to home based working (which was already being promoted as a part of a mitigation drive)

The case study identified a number of problems in implementing the UKCIP decision-making framework. These include: uncertainty relating to climate change projection and absence of micro level probability data; organisational and the facilities managers perception of risk, associated with belief in occurrence of climate change; difficulty in translating climate change projections into business operational risk. To test whether these problems were specific to the case study organisation or represented a wider generic view of facilities managers a questionnaire survey was undertaken of professional facilities managers based in the UK (BIFM members).

### 4. Questionnaire survey and findings

The questionnaire survey made three key inquiries: 1) Are facilities manager’s response to climate change primarily driven by a legislative response? 2) Does past experience of an extreme weather event change a facilities managers perception of climate risk (in terms of business function / asset management) and is this the key to implementing adaptation measures? 3) What is the relationship between adaptation/mitigation, planned and reactive maintenance, operational and strategic planning.

In order to reach the wider facilities management population all BIFM members were chosen as the target population. A web based questionnaire with mix of multiple choice, attitudinal scale questions and open-ended questions was prepared and piloted between 13<sup>th</sup> February 2008 and the 3<sup>rd</sup> March 2008, achieving a 9.09% response rate. Minor modifications were made to the questionnaire to remove some ambiguity and confusion with terminology, and the main survey was carried out between 10<sup>th</sup> March and 30<sup>th</sup> April 2008. A total of 4,357 e-mail questionnaires were distributed and 474 completed responses were received, a response rate of 10.8%.

Following an initial analysis, a correlation analysis was performed between variables relating to adaptation and mitigation action. The variables influencing adaptation inquired on a) experience of a climate related / extreme weather events b) perception of future impact of climate change as a risk or opportunity c) identification of future impacts of climate change on properties and business functions. The analysis confirmed that past experience of an extreme event and perception of climate change as a risk resulted in consideration of future impacts and their treatment in disaster recovery planning where adaptation was perceived as an operational issue. The correlation established between a) drivers responsible for mitigation action. b) strategic approach for mitigation c) involvement with institutes facilitating mitigation action and d) financial benefit from implementing such measures confirmed that mitigation was primarily a strategic response to legislation.

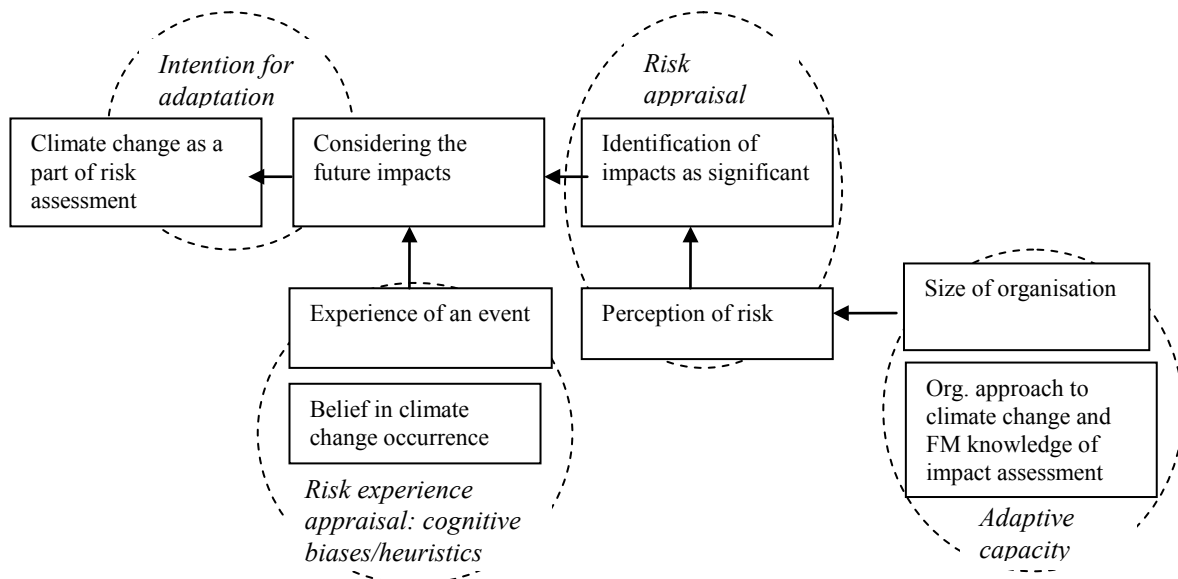


Figure 1 : Adaptation Process-Mapped through Logistic regression



Figure 1 represents the logistic regression carried out to establish the drivers for adaptation which were found to be similar to those observed in the case study. Similar models were proposed by Berkhout (2004) and Grotmann (2005). With regards to coping measures and adaptive capacity only 59% addressed future climate change, primarily through reactive disaster recovery planning.

The survey also threw light on differences between public and private sector organisations to mitigation and adaptation. Although mitigation was found to be a strategic issue for both public and private sector organisations, the private sector identified corporate social responsibility as the prime driver. In contrast the public sector identified compliance with legislation (e.g. The Decent Home Standards, EPC and Building Regulations) as the prime driver. With regards to adaptation, the public sector is more likely to perceive climate change as a strategic risk than the private sector that sees it as an operational risk. Further, within the private sector smaller organisations appear unconvinced about anthropogenic emissions being responsible for climate change (compared to multinational and middle level organisations) and see little financial benefit from mitigation measures (unlike multinational and larger organisations). The slow implementation of energy efficiency and CO<sub>2</sub> reduction are also identified by Bradford and Fraser (2007), Halila (2007) and Hillary (2004).

## 5. Conclusions

In light of present initiatives for climate change mitigation and adaptation, this study has examined facilities managers approaches for emission reduction from their business function and specifically adaptation of their built asset and business operation to impacts of future climate change. In doing so the paper draws following conclusions.

The first finding of this study is that mitigation and adaptation strategies have played a very different role in most FM's routine practice. Emission reduction (mitigation) is viewed strategically due to a) organisations regarding it as an environmental, moral and market standing issue and b) Government legislation and well defined quantitative targets which encourages long term future planning. Consequently mitigation is considered as capital investment. Adaptation on the other hand, lacks initial drive for action, is not planned for from a long term perspective, remaining reactive in nature. It is treated as an operational issue and thus competes with day-to-day maintenance and refurbishment operational budgets for practical realisation.

The second conclusion is that the strategic importance for adaptation is difficult to make due to the absence of quantifiable risks (in specific quantified probabilities) linked to the business case. The use of probabilistic risk assessment was restricted to qualitative and semi quantitative methods as quantitative risk (probability) assessment tools (e.g. Bayesian methods, Monte Carlo techniques) were difficult to pursue due to:

- the lack of micro level (site level) climate projection, historic property management and maintenance data;

- constrained resources (time & finance) and expertise limiting the use of elaborative quantification methods; and
- limited understanding of facilities managers of climate science/projections to interpret the quantitative data and metrics in the context of their organisation.

Thirdly, there is a need for a tool assisting the assessment and quantification of future risk to building facilities, which can enable facilities managers to prepare the business case for adaptation. This tool kit must be able to: quantify the likelihood of a micro level climate change related event affecting the built assets; quantify the impact that such an event will have on both the physical attributes of a building and the business operations; predicts the degree to which coping strategies, either permanent or temporary in nature, can reduce the impact; and assess the adaptive capacity available to the organisation. Given the current state of knowledge (risk and uncertainty) associated with climate change projections it is likely that such a model will require a mix of both qualitative and quantitative metrics.

Finally, more drivers need to be introduced to stimulate adaptation actions in the private sector in order to protect businesses and their built asset from obsolescence induced through consistent impacts of climate change. For example:

- regulation needs to be introduced which ensures implementation of primary adaptation measure in addition to mitigation in refurbishment and retrofit of existing buildings.
- reporting long term coping strategies against key climate changes (e.g. overheating and flooding) as part of CSR (which will need to be based on overall risk assessment) to inform stakeholders of organisation preparedness.
- Government encouragement for uptake of adaptation measures against the level of insurance cover for long term changes and generating a market for properties with adaptation measures similar to one being presently driven for mitigation.

In addition the government needs to provide easy to use and clear climate projections and promote uptake of risk based planning in long term management of built asset in private sector.

## References

ABI (2007) “*Latest Flood Cost*” (Available on line at <http://www.abi.org.uk/Information/InsuranceAdvice/Consumers/General/15258.pdf> [accessed on 03/05/10]).

Adeyeye K, Osmani M, Brown C (2007) “Energy conservation and Building Design: The Environmental Legislation Push and Pull Factors” *Structural Survey*, **25(5)**: 375-390.

Berkhout F, Hertin J, Arnell N (2004) “*Business and Climate Change: Measuring and Enhancing Adaptive Capacity.*” The Adapt Project, Technical Report 11, Tyndall Centre for Climate change Research. Norwich.

BBC (2007) "Flood funding too inconsistent", (Available on [Http://news.bbc.co.uk/go/pr/fr/-/1/hi/uk/7143711.stm](http://news.bbc.co.uk/go/pr/fr/-/1/hi/uk/7143711.stm) [Accessed: 23/05/10])

Bradford J, Fraser E (2007) "Local Authorities, Climate Change and Small and Medium Enterprises : Identifying Effective Policy Instruments to Reduce Energy Use and Carbon Emissions." *Corporate social Responsibility and Environmental Management* **15(3)**: 156-172.

Brown A, Pitt M (2001) "Measuring the Facilities Management Influence in Delivering Sustainable Airpor Development and Expansion." *Facilities* **19 (5/6)**: 222-232.

CBI and EEF (2002) "*The Climate Change Levy: First Year of Assessment.*" The Confederation of British Industries, London, UK.

Carbon Trust (2009), "*Building the Future Today: Transforming the economic and carbon performance of the buildings we work in*". London , UK

DECC (2009) "*The UK Low carbon Transition Plan: National Strategy for Climate and Energy*" HM Government, UK.

DEFRA (2008) "ABI/Government statement" (Available at <http://www.defra.gov.uk/environment/flooding/policy/insurance/> [accessed on 23/05/10]).

Ekins P, Etheridge B (2006) "The Environmental and Economic Impacts of the UK Climate change Agreements." *Energy Policy* **34**: 2071-2086.

Firth, J, and Colley, M (2006) *The Adaptation Tipping Point: Are UK Businesses Climate Proof? Acclimatise and UKCIP*, Oxford.

Graves H, Phillipson M (2000) "*Potential Implications of Climate Change in Built Environment.*" Foundation of Built Environment, BRE, Watford.

Grothmann T, Patt A (2005) "Adaptive Capacity and Human Cognition: The Process of Individual Adaptation to Climate Change." *Global Environmental Change* **15**: 199-213.

Halila F (2007) "Networks as Means of Supporting the Adoption of Organisational Innovations in SMEs: The Case of Environmental Management System (EMS) Based on ISO 14001." *Corporate social Responsibility and Environment Management* **14 (3)**: 167-181.

HMSO (2001) *The Climate change Levy (General) Regulations 2001*, Statutory Instrument 2001 No. 838 (Available online at <http://www.opsi.gov.uk/si/si2001/20010838.htm> [accessed on 03/05/10]).

HMSO (2001), *The Building (Amendment) Regulations 2001*, Statutory Instrument 2001 No. 3335 (Available online at <http://www.opsi.gov.uk/si/si2001/20013335.htm> [accessed on 03/05/10]).

HMSO (2010), *Climate Change: The CRC Energy Efficiency Scheme Order 2010*, Statutory Instruments 2010 No. 768 (Available online at [http://www.opsi.gov.uk/si/si2010/uksi\\_20100768\\_en\\_1](http://www.opsi.gov.uk/si/si2010/uksi_20100768_en_1) [accessed on 03/05/10])

Hillary R (2004) “Environment Management Systems and the Smaller Enterprise.” *Journal of Cleaner Productions* **12**:561-569.

IPCC (2007) *Summary for policymakers of the synthesis report of the IPCC Fourth Assessment Report*, IPCC Fourth Assessment Report, IPCC.

Jones K and J Cooper (2009) “Measuring Performance in – use in UK Social Housing.” *The construction and building research conference of the Royal Institution of Chartered Surveyors, University of Cape Town*, 10-11th September 2009, Cape town, South Africa.

Jones K, Desai A (2006) “An Asset Management Strategy to Accommodate a Changing Climate.” *Proceedings of CIB W70 Trondheim International Symposium, Changing user Demands on Buildings: Needs for Lifecycle Planning and Management*, 12-14 June 2006, Trondheim, Norway.

Junnila S (2004) “The Environmental Significance of Facilities in Service Sector Companies.” *Facilities* **22** (7/8):190-198.

Luc Salagnac, J. (2004), “*French perspective on emerging climate change issues*”, *Building Research & Information*, Vol. 32 No. 1, pp. 67-70.

Pout C and MacKenzie F (2005), “*Reducing carbon emission from commercial and public sector buildings in the UK*” Building Research Establishment, London UK

O’Brien K, Sygna L, Haugen J.E (2004) “Vulnerability or Resilient? A Multi-Scale Assessment of Climate Impacts and Vulnerability in Norway.” *Climatic Change* **64**: 193-225.

Scrase I J (2001) “Curbing the Growth in UK commercial Energy Consumption.” *Building Research & Information* **29**(1): 51-61.

Sir Michael Pitt (2008) “*Learning Lessons from 2007 Floods.*” The Pitt Review. (Available online at [http://archive.cabinetoffice.gov.uk/pittreview/thepittreview/final\\_report.html](http://archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html) [accessed on 03/05/10]).

Willows, R.I. and Connell, R.K. (Eds.). (2003). *Climate adaptation: Risk, uncertainty and decision-making*. UKCIP Technical Report. UKCIP, Oxford.

# Building energy management support system for managing the facilities of individual departments within universities

**Kung-Jen Tu**

National Taiwan University of Science and Technology  
kjtu@mail.ntust.edu.tw

**Cheng-Hong Lin**

National Taiwan University of Science and Technology  
sky8956033@hotmail.com

**Jing-Fen Lai**

National Taiwan University of Science and Technology  
jing9713020@gmail.com

## Abstract

The objective of this research is to establish a Building Energy Management Support System (BEMSS) to assist individual departments within universities in diagnosing the energy efficiency of their facilities and identifying the problem areas to be further improved. Research concepts, such as 'type of space', 'standard settings', 'standard energy consumption' and 'energy efficiency index', are adopted. It is assumed that the same 'type of space' within each department may have similar task processes, occupancy use patterns, environmental quality and needs, as well as equipment densities. They therefore are likely to have similar 'energy usage intensity' values (EUI, kWh/m<sup>2</sup>-yr). It is further postulated that, for each type of space, 'standard settings' of its environmental quality, occupancy use patterns and equipment densities (lighting, miscellaneous equipment) can be defined, and its corresponding 'standard energy consumption EUI' identified as its energy efficiency benchmark. The 'standard energy consumption EUI' represents the least possible amount of energy consumed by one type of space under reasonable uses and settings. Each department can diagnose the energy efficiency of its facilities by comparing its actual energy consumption with standard energy consumption, and can identify problem areas by comparing the actual and standard energy consumptions of all types of spaces. The system architecture of the BEMSS consisting of three parts: (1) the input module that receives data of existing climate and building infrastructure, existing operation conditions and standard operation settings; (2) the energy consumption prediction module that generates energy consumption estimates; and (3) the output module that produces energy efficiency indices, sensitivity analysis results and problem areas identified. The Department of Architecture, National Taiwan University of Science and Technology is used as a case to demonstrate how the BEMSS functions.

**Keywords:** university facility, type of space, standard operation settings, standard energy consumption, energy efficiency index

## 1. Introduction

The Taiwan government has stipulated that energy consumptions of universities be reduced by 1% annually. Individual departments within each university, being responsible for achieving this energy management goal, are facing great challenges. Several obstacles lie before them. First of all, these departments usually do not know the amount of energy they have consumed. In Taiwan, individual campus buildings within universities are often mixed used and occupied by several departments with unique work processes and energy demands. Therefore, it is difficult for the departments within the same building to estimate correctly their energy consumptions based on building electricity bills, not to mention for them to further diagnose the energy performance of their facilities. Installing electricity meters on every floor in all buildings might be a way to measure and monitor accurately the energy consumptions of individual departments. However, the tremendous costs associated would have made this installation plan less feasible. Secondly, these departments lack for reasonable energy consumption benchmarks or indices. Taiwan government has used the national average university energy usage intensity (EUI, 120.8 kWh/m<sup>2</sup>-yr) as the benchmark for university's energy management. However, this benchmark has failed to become an effective reference. An earlier domestic study has shown that the energy consumptions of the thirteen campus buildings in a certain university varied greatly (EUIs averaging 180.3 kWh/m<sup>2</sup>-yr, and ranging from 63.6 to 220.1 kWh/m<sup>2</sup>-yr), due to large variances in building characteristics, occupancy use patterns and energy needs among different departments (Tu et al., 2010). In such case, the national average EUI 120.8 kWh/m<sup>2</sup>-yr would be meaningless for those departments/buildings with lower EUIs (since they have already surpassed the national average) and may be unattainable for those with higher EUIs (since their work processes might inherently incur higher energy consumptions than the national average).

When first facing the issue of energy management, most institutions or departments would ask: How much energy was consumed by our department? How was the energy consumed? Was the energy consumed efficiently? What are the problem areas? What they need at this stage is a straightforward tool or method to help them answer the above questions, before they decide specific actions to take to reduce their energy consumptions. The tool should also allow the departments to monitor the energy performance of their facilities periodically.

This research intends to establish a Building Energy Management Support System (BEMSS) to assist departments in universities in dealing with their energy management issues. The BEMSS is expected to have the capabilities of: (1) offering a method for a department to estimate its energy consumption, (2) establishing reasonable energy consumption benchmarks catering to department's functional and energy needs, (3) assessing the energy performance of department's facility, and (4) identifying major problem areas that will have the highest energy saving potential if further improvement actions are taken. The remaining sections will present:

1. Existing literature review regarding the energy management issues of existing buildings;
2. The core research concepts and the system architecture of the BEMSS;

3. Demonstration of the procedures and results of applying the BEMSS to the Department of Architecture, National Taiwan University of Science and Technology.

## 2. Literature review

This research reviewed the existing literature that focused on the energy management aspects of ‘existing buildings’ in order to realize current research trends. The studies reviewed can be categorized into two groups based on their research objectives. The first group of studies diagnosed the energy efficiency of a ‘building or system’, proposed improvement measures (such as installing external shading devices, enhancing the insulation of external walls, and replacing HVAC systems), and employed energy simulation software to assess the magnitude of energy savings achieved by various measures (Zhu, 2006; Hatamipour, 2007; Sun and Lee, 2006). This type of study usually involves in-depth investigation and larger scale of building refurbishment, and incurs higher costs. This approach or concept is not as useful for the departments in universities, who simply need a tool to perform preliminary evaluation on the energy performance of their facilities and to identify problem areas in the first place. The second group of studies developed energy efficiency scales or evaluation methods to measure and compare the energy efficiency of multiple buildings. In Hong Kong, Lee et al. (2007) developed the Building Environmental Assessment Method (HK-BEAM), which defined the worst energy performance building as the ‘baseline building’ (reference point) to measure the energy performance of other buildings; and Chung et al. (2006) established an energy consumption regression model for supermarket facilities and used it to further define a ten-level scale to measure supermarkets’ energy efficiency. In Netherlands, complying with European Energy Performance of Building Directive (EPBD), Poel et al. (2007) developed the EPA-ED to measure the energy efficiency of existing housing and established national energy consumption benchmarks. In Sweden, Bohdanowicz and Martinac (2007) used the built regression models to establish the energy consumption benchmarks for the facilities of two different classes of hotel chains respectively. In Singapore, Haji-Sapar and Lee (2005) investigated the energy consumptions of 16 office buildings based on which three levels of energy efficiency were established and criteria defined. This energy efficiency scale could be used to assess the energy efficiency of a whole building or a certain building system. The above energy efficiency scales or evaluation methods typically produce an ‘efficiency score or level’ to indicate the energy efficiency of a building. However, such single ‘efficiency score’ does not inform a department much of the energy efficiency or problem areas of its facility.

## 3. Core Concepts of the BEMSS

Several core concepts were adopted by this research to develop the BEMSS. First of all, it is proposed that the spaces in a department be classified into several ‘**types of spaces**’. Then, for each type of space, the ‘**standard operation settings**’ such as occupancy use patterns, environmental quality, building systems and equipment characteristics are defined, which are then used to derive the ‘**standard energy consumption**’ of the department. The ‘standard

energy consumption’ represents the reasonable energy consumption benchmark of the department. Then, its ‘actual energy consumption’ is compared against its ‘standard energy consumption’ to yield its ‘**energy efficiency index**’. Finally, several energy performance analyses will be further conducted to identify the potential problem areas.

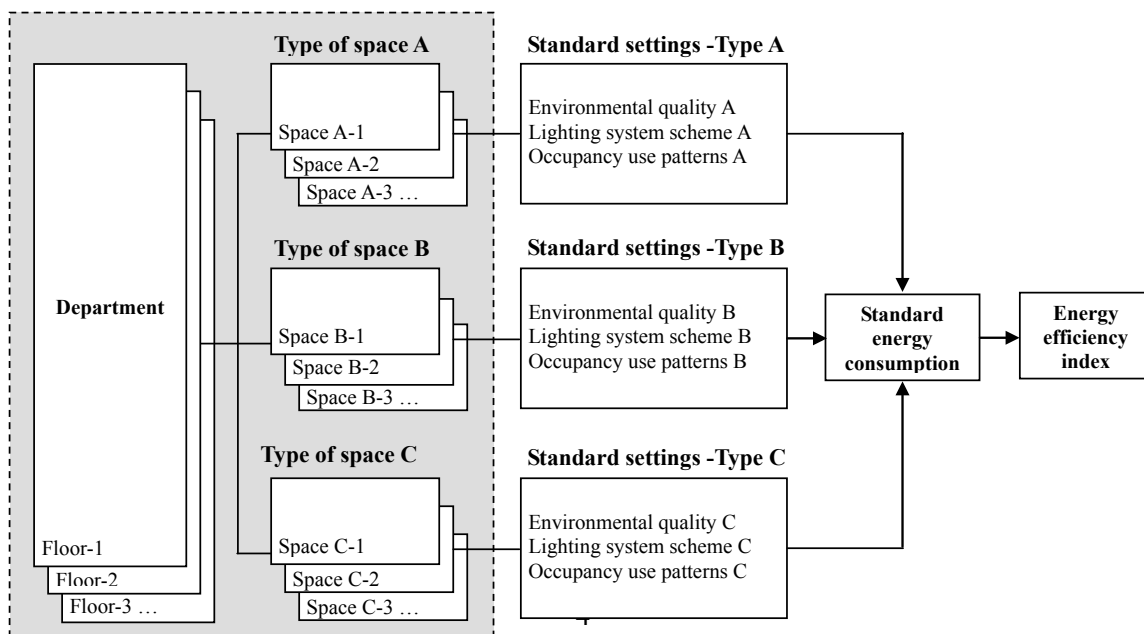
### 3.1 Type of space

A department in a university, typically occupying a portion of a facility (across several floors), usually consists of several ‘types of spaces’. In this research, the spaces within a department are categorized according to their occupants and ‘functional uses’ (Figure 1). In the same type of space, the tasks and processes performed by its occupants, the occupancy use patterns (operation schedule and occupant density), task-supporting equipment, as well as the environmental quality needed could be quite similar. It is thus logical to assume that the energy consumptions (per square meter) of the same type of space could be quite close, if other variables such as external weather conditions, building envelope and building control systems are kept the same. Conceptually, an effective yet reasonable ‘energy standard’ can be identified and established for each type of space as its benchmark. The ‘energy standards’ of all types of spaces of a department can then be used to generate an ‘energy benchmark’ for the department.

### 3.2 Standard settings and standard energy consumption

This research proposed that the following ‘standard settings’ be defined for all ‘types of spaces’ in a department (Figure 1):

1. Standard environmental quality: the preferred illuminance of each type of space; set point temperature of the HVAC system.
2. Standard lighting system scheme: lighting fixture type and density of each type of space.
3. Standard occupancy use patterns: the occupant density, schedule profile, major equipment density, and supplementary equipment density of each type of space.





***Figure 1: Core concepts of the BEMSS: type of space, standard settings, standard energy consumption and energy efficiency index.***

Conceptually, these ‘standard settings’ represent the most reasonable yet effective way of operation (energy-wise) for a certain type of space. The operation of a certain type of space under its ‘standard settings’ can be imagined as such: certain amount of occupants (as the pre-defined density) are performing their tasks following their normal procedures according to the pre-defined schedules, while given minimal but acceptable environmental quality and lighting system scheme as well as predetermined amount of major and supplementary equipment. Consequently, a certain type of space operating under its ‘standard settings’ is expected to consume the least amount of energy possibly. When all types of spaces within a department are operating under their ‘standard settings’, the total of the energy consumed by individual spaces is defined as the ‘standard energy consumption’ of the department (Figure 1). It represents the minimal energy consumption of the department, and is considered as a reasonable yet effective energy benchmark for the department (measured in kWh/m<sup>2</sup>-yr or –month, same as EUI).

The ‘standard energy consumption’ of a ‘space’ is affected not only by its ‘standard settings’ but also other factors such as the existing external weather conditions, building characteristics (orientation, floor dimensions, building envelope, etc), and HVAC system schemes. It is suggested that data of all factors of all types of spaces be input to an energy simulation software (such as eQuest) or other energy prediction models.

### **3.3 Energy efficiency index**

The ‘energy efficiency index (EEI)’ of a department, defined as the ratio of its ‘actual energy consumption’ to its ‘standard energy consumption’ (%), is used to indicate the energy performance of a department and its facility (Figure 1). Since the actual energy consumption is usually larger than the standard energy consumption, the EEI of a department normally exceeds 100%. When a department has a larger EEI, its facility is considered less energy efficient. When the actual energy consumption of a department can not be physically measured, it is advised that it be estimated by various energy simulation software or other energy prediction models.

The term ‘variable energy consumption’ of a department is further defined as the ‘variable’ portion of its ‘actual energy consumption’. It is calculated by subtracting its ‘standard energy consumption’ from its ‘actual energy consumption’. It is the portion of the EEI that exceeds 100% and represents the portion of energy that can be saved potentially. For example, an EEI of 120% means that the variable energy consumption is 20% of its standard energy consumption; and the department has a 20% energy saving potential if it operates under its ‘standard settings’.

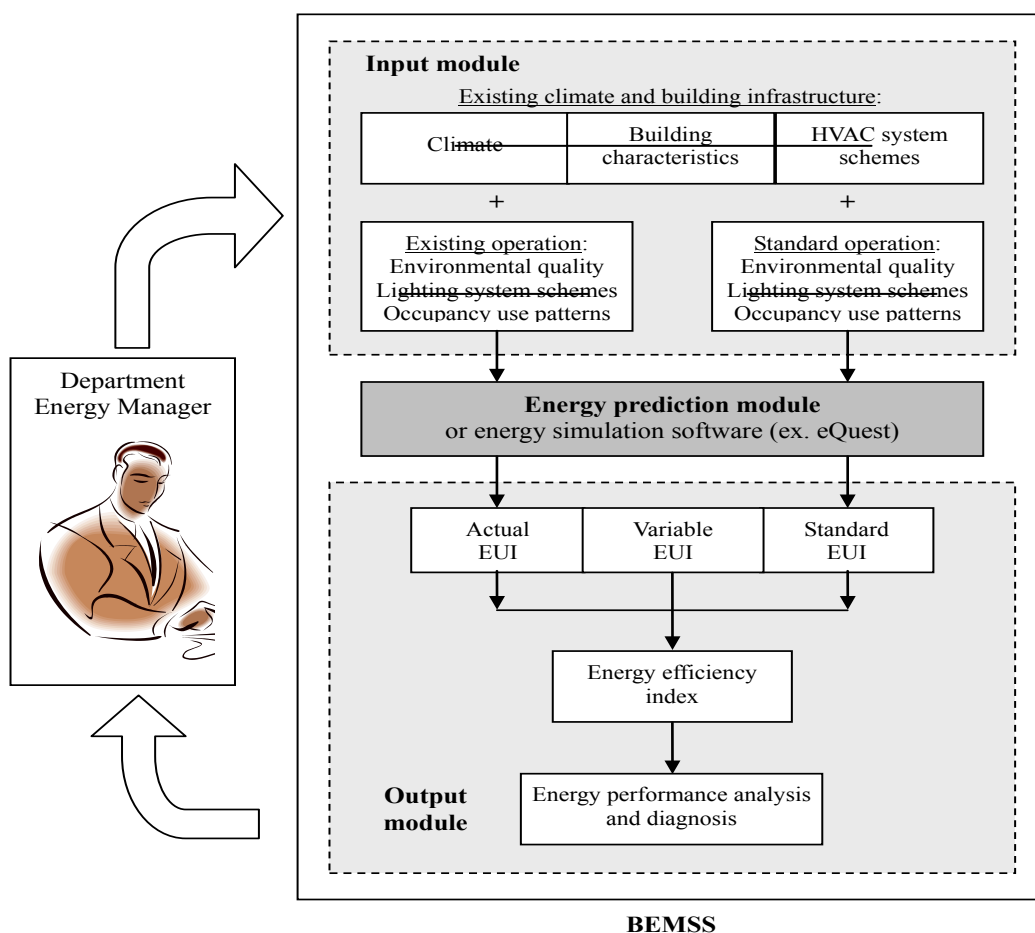
## 4. System architecture of the BEMSS

This research implemented the above research concepts and developed the Building Energy Management Support System (BEMSS) to assist institutions or departments in diagnosing the energy performance of their facilities. The system architecture of the BEMSS consists of three major modules: the input module, energy prediction module, and output module (Figure 2).

### 4.1 The input module

The 'input module' of the BEMSS is designed to gather the following three types of data from a department (Figure 2):

1. Existing climate and building infrastructure: including the climate conditions around the building, building envelope characteristics of the building, and HVAC system schemes installed in the occupied spaces. These are considered the 'fixed' building conditions given to the department and are less likely to alter due to large investment involved.
2. Existing operation conditions: including the existing conditions of the environmental quality, lighting system schemes, as well as the occupancy use patterns in all types of spaces. These are considered the 'actual and usual' conditions under which the department is operating. These data along with the 'existing climate and building infrastructure' data will be used to estimate the 'actual EUI' of the department.
3. Standard operation settings: including the 'standard settings' of the environmental quality, lighting system schemes, and occupancy use patterns in all types of spaces. The 'standard settings' established should reflect the 'reasonable and efficient' conditions under which the department has agreed operate. These data along with the 'existing climate and



building infrastructure' data will be used to estimate the 'standard EUI' of the department.

*Figure 2: The system architecture of the BEMSS*

## 4.2 The energy prediction module

The collected data will be fed to the 'energy prediction module' of the BEMSS to estimate various types of energy consumptions of the department (Figure 2). The predictive accuracy and easiness are two criteria of an ideal energy prediction module. There are two options currently. One is to employ the existing energy simulation software, such as DOE-2 or eQuest, to estimate the energy consumptions of the department. Their energy estimates are generally considered accurate, although some learning effort is required. The other is to conduct further research to establish energy prediction models that are easy to use and accurate in energy predictions.

## 4.3 The output module

The output module of the BEMSS generates the following outputs for a department (Figure 2):

1. Energy consumption estimate: The output module of the BEMSS will generate estimates of 'actual EUI' and 'standard EUI' for the whole department and for each floor it occupies. Then the 'variable EUI' of the department are calculated by subtracting its standard EUI from its actual EUI. Similarly, the 'various EUI' of each floor can be calculated.
2. Energy efficiency index (EEI): the EEI of the department is the ratio of the actual EUI to standard EUI of the department. The EEI of each floor occupies is calculated similarly.
3. Energy performance analysis: 'energy analysis by type of equipment' is performed to identify the major equipment types consuming the most energy and their energy saving potentials for a department. 'Sensitivity analysis' is performed to assess the energy saving effects of the four sets of 'standard operation settings' for all types of spaces.

## 5. Demonstration

The Department of Architecture, National Taiwan University of Science and Technology (NTUST) is used as a case to demonstrate, step by step, how the BEMSS is used to assist the department in diagnosing the energy efficiency of its facility.

The Department of Architecture of NTUST was established in 1992. Currently, there are around 200 undergraduate students, 120 graduate students, 15 full time faculty members, 10 research assistants, and three full time administrative staffs. The department occupies the 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> floor of the *Research Building* on campus (Figure 3).

NTUST is located in the Taipei City, whose geographic latitude and longitude is 25° N and 121.5° E respectively. Taipei has a humid subtropical climate. The average annual temperature is 23.6 °C, with a summer average of 29.4 °C and a winter average of 11 °C. Summers are hot (there are 133 days in a year with maximum temperature exceeding 30 °C) and humid (mean relative humidity 74.0~81.1%), and accompanied by occasional rainstorms and typhoons. Winters are short and mild. Its average annual sunshine hour is 1,408 hours (67% of the time is cloudy), and average annual precipitation is 2,325 mm (46% of the days rain).

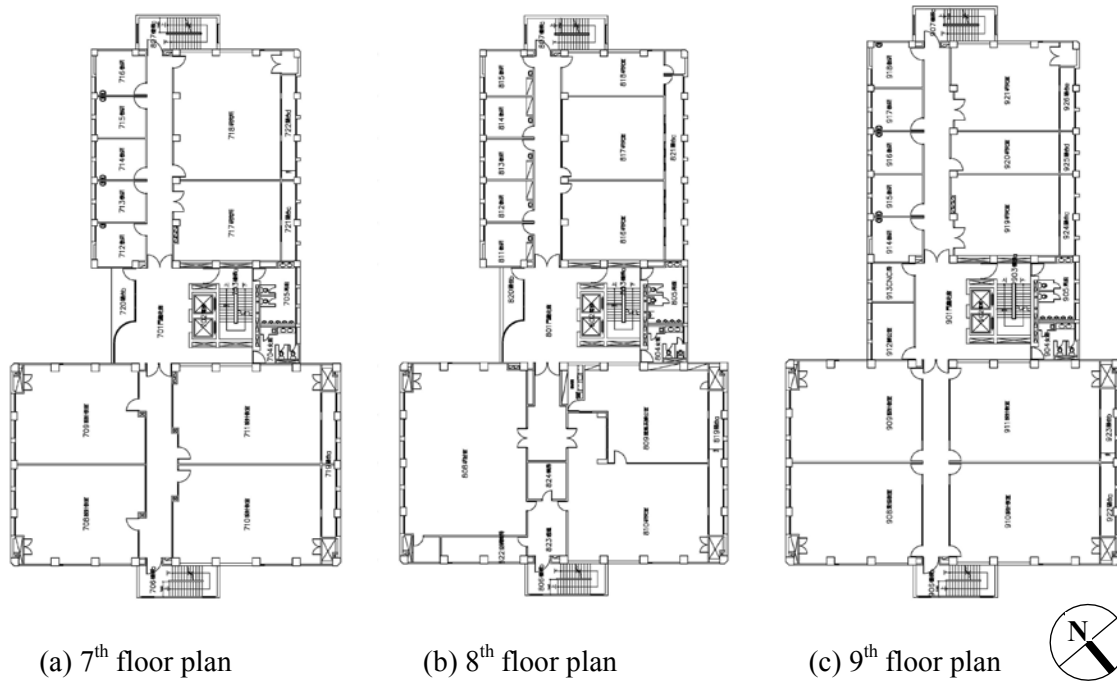


Figure 3: 7<sup>th</sup>, 8<sup>th</sup>, and 9<sup>th</sup> floor plans of the Department of Architecture, NTUST.

### 5.1 Step 1: Classifying spaces

The spaces in the department were classified according to their ‘functional uses’. There is a total of 66 spaces in the Department of Architecture, taking up a total of 3,386 m<sup>2</sup> of floor area (Table 1). These spaces were classified into seven major types: administrative office, faculty office, research lab (for graduate students), design studio (for undergraduate students), classroom, workshop and service (lobby, corridor, elevator, toilet and staircase). The number and area of each type of space on the 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> floors of the Department of Architecture are shown in Table 1. The major differences in the number of each type of space among the three floors are highlighted by the gray area in Table 1.

Table 1: The number and area of each type of space in the Department of Architecture

Type of space	7 <sup>th</sup> fl.		8 <sup>th</sup> fl.		9 <sup>th</sup> fl.		Total	
	Number	Area (m <sup>2</sup> )	Number	Area (m <sup>2</sup> )	Number	Area (m <sup>2</sup> )	Number	Area (m <sup>2</sup> )
Administrative	0	0	3	264	0	0	3	264 (7.8%)
Faculty office	5	99	5	98	6	122	16	319 (9.5%)
Research lab	2	207	3	202	3	205	8	614 (18.2%)

<i>Design studio</i>	4	502	0	0	2	276	6	778 (23.0%)
<i>Classroom</i>	0	0	1	203	2	236	3	439 (13.0%)
<i>Workshop</i>	0	0	0	0	2	30	2	30 (0.4%)
<i>Service</i>	8	310	12	339	8	293	28	942 (28.0%)
<i>Total</i>	19	1,118	24	1,106	23	1,162	66	3,386

### 5.2 Step 2: Investigating existing building conditions

The existing conditions of the 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> floors of the *Research Building* were investigated. The following two types of existing building conditions were examined:

- Existing climate and building infrastructure:
  - Climate: hourly weather data of average temperature, average relative humidity, solar, and precipitation in Taipei City are collected from the Central Weather Bureau.
  - Building characteristics: building orientation, floor plate dimensions, floor height (m), envelope construction and materials, surface area, opening percentage of fenestration (%), U-value (K m<sup>2</sup>/W), shading coefficient of fenestration of the *Research Building* (Table 2).
  - Building system schemes: data of the common type, refrigeration capacity (ton) and energy efficiency ratio (EER) of the HVAC system, as well as the type and the average density of the artificial lighting fixtures (watt/m<sup>2</sup>) in each type of space (Table 3).
- Existing operation conditions: the existing conditions of ‘occupancy use patterns’, such as occupant density (m<sup>2</sup>/per), occupancy schedules and HVAC operation schedules (weekday, weekend, summer weekday, summer weekend), primary and miscellaneous office equipment densities (watt/m<sup>2</sup>), as well as ‘environmental quality’, such as HVAC set point temperature, in the Department of Architecture are investigated and collected (Table 4).

**Table 2: The existing ‘building characteristics’ of the Research Building, NTUST**

	Orientation	Floor Plate	Floor Height	Envelope construction	Surface area	Fenestration percentage	Fenestration U-value & SC
7 <sup>th</sup> floor	SE-NW	Around 48m*31m RC slab	4.0 m	15cm RC wall + tile	SE: 196m <sup>2</sup>	SE: 27.9%	Single glazed clear; aluminum U = 7.4 W/m <sup>2</sup> K SC = 0.79
8 <sup>th</sup> floor					SW: 115m <sup>2</sup>	SW: 0.4%	
9 <sup>th</sup> floor					NW: 196m <sup>2</sup>	NW: 26.4%	
					NE: 115m <sup>2</sup>	NE: 11.9%	

**Table 3: The existing ‘building system schemes’ of the Department of Architecture**

Type of space	HVAC system									Lighting system						
	Type			Cooling capacity (ton)			Energy efficiency ratio (EER)			Light fixture type			Lighting density (w/m <sup>2</sup> )			
	7th	8th	9th	7th	8th	9th	7th	8th	9th	7th	8th	9th	7th	8th	9th	
<i>Administrative</i>	-	air	-	-	2.5	-	-	2.7	-	60cm*120cm louver fixture, 4@40 watt fluorescent lamps	-	-	-	-	18.7	-
<i>Faculty office</i>	air	air	air	1.2	1.2	1.2	3.0	3.0	3.0		14.4	13.9	14.3			
<i>Research lab</i>	air	a/w	air	2.1	2.1	2.1	2.7	2.7	2.7		16.7	16.7	17.1			
<i>Design studio</i>	air	-	air	2.7	-	2.7	2.7	-	2.7		14.4	-	16.5			
<i>Classroom</i>	-	water	air	-	4.6	1.2	-	2.9	3.1		-	21.6	18.9			
<i>Workshop</i>	-	-	-	-	-	-	-	-	-		-	-	18.1			
<i>Service</i>	-	-	-	-	-	-	-	-	-		15.4	15.7	10.5			

**Table 4: The existing ‘occupancy use patterns and environmental quality’ of the Department of Architecture**

Type of space	Occupant density (m <sup>2</sup> /person)			Occupancy schedule (hour)			HVAC operation schedule (hour)			Primary office equip density (watt/m <sup>2</sup> )			Misc. office equip. density (watt/m <sup>2</sup> )			HVAC set point temperature (°C)		
	7th	8th	9th	7th	8th	9th	8th	7th	9th	7th	8th	9th	7th	8th	9th	7th	8th	9th
Administrative	-	15.0	-				-	9	-	-	41.4	-	-	3.6	-	-	27	-
Faculty office	20.0	29.1	19.1	a.	a.	a.	10	11	8	39.2	27.9	46.7	22.	7.5	16.6	26	26.4	25.4
Research lab	5.6	10.0	5.2	9-24 b.	9-23 b.	9-23 b.	13	14	16	54.7	33.5	48.2	5.6	10.9	6.9	23. 3	24.4	23.8
Design studio	4.3	-	4.6	9-20 c.	9-18 c.	9-17 c.	16	-	15	6.8	-	10.3	0.2	-	0.0	23. 5	-	23
Classroom	-	7.0	3.4	9-21 d.	9-21 d.	9-20 d.	-	9	8	-	0.0	0.0	-	0.0	5.6	-	26.5	25.2
Workshop	-	-	10.1	9-16	9-17	9-15	-	-	2	-	-	3.2	-	-	130. 3	-	-	26.5
Service	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-

a: weekday; b: weekend; c: summer weekday; d: summer weekend

### 5.3 Step 3: Establishing the ‘standard settings’ for each space type

The third step is to establish the ‘standard operation settings’ of a department, such as the environmental quality, lighting system schemes and occupancy use patterns for each type of space. For demonstration purpose, this research established only the ‘standard settings’ of ‘occupancy use patterns’ and ‘environmental quality’ (same as in step 2) for all types of spaces in the Department of Architecture: occupant density (m<sup>2</sup>/per), occupancy schedules and HVAC operation schedules (weekday, weekend, summer weekday, summer weekend), primary and miscellaneous office equipment densities (watt/m<sup>2</sup>), and HVAC set point temperature (Table 5).

**Table 5: The ‘standard settings’ of ‘occupancy use patterns’ and ‘environmental quality’ in the Department of Architecture**

Type of space	Occupant density (m <sup>2</sup> /person)			Occupancy schedule (hour)			HVAC operation schedule (hour)			Primary office equip density (watt/m <sup>2</sup> )			Misc. office equip. density (watt/m <sup>2</sup> )			HVAC set point temperature (°C)		
	7th	8th	9th	7th	8th	9th	7th	8th	9th	7th	8th	9th	7th	8th	9th	7th	8th	9th
Administrative	-	7.9	-				-	8	-	-	54.1	-	-	4.0	-	-	28	-
Faculty office	19.8	19.8	19.8	a.	a.	a.	8	8	8	33. 3	33.3	33.3	5.5	5.5	5.5	28	28	28
Research lab	5.5	5.5	5.5	b.	b.	b.	12	12	12	43. 1	43.1	43.1	1.1	1.1	1.1	28	28	28
Design studio	3.3	-	3.3	c.	c.	c.	12	-	12	6.6	-	6.6	0.0	-	0.0	28	-	28
Classroom	-	2.9	2.7	9-20 d.	9-20 d.	9-19 d.	-	8	6	-	4.7	0.0	-	0.0	0.0	-	28	28
Workshop	-	-	9.9	9-14	9-16	9-14	-	-	2	-	-	4.0	-	-	128. 3	-	-	28
Service	-	-	-				-	-	-	-	-	-	-	-	-	-	-	-

a: weekday; b: weekend; c: summer weekday; d: summer weekend

### 5.4 Step 4: Estimating the energy consumptions

The energy simulation software eQuest V.3 was employed as the ‘energy prediction module’ to simulate and estimate the ‘actual’ and ‘standard’ energy consumptions of the Department.

1. The estimated ‘actual EUI’: As shown in Table 6, the total annual energy consumption of the Department of Architecture is 606,890 kWh/yr, and that of the three floors are also similar, from 195,070 kWh/yr (9<sup>th</sup> floor) to 207,920 kWh/yr (8<sup>th</sup> floor). The ‘actual EUI’ of the Department is 180.0 kWh/m<sup>2</sup>-yr, almost 50% higher than the national average EUI for universities (120.8 kWh/m<sup>2</sup>-yr). The ‘actual EUIs’ of the three floors do not vary a lot, ranging from 170.1 kWh/m<sup>2</sup>-yr (9<sup>th</sup> floor) to 188.0 kWh/m<sup>2</sup>-yr (8<sup>th</sup> floor). In theory, the differences in the ‘actual EUIs’ of three floors are mainly caused by the differences in the ‘types of spaces’ (Table 1), ‘building system schemes’ (Table 3) and ‘actual occupancy use patterns’ (Table 4) among the three floors.
2. The estimated ‘standard EUI’: As shown in Table 6, the ‘standard EUI’ of the Department of Architecture is 132.7 kWh/m<sup>2</sup>-yr, and the ‘standard EUIs’ of the three floors vary a lot. The ‘standard EUI’ of the 8<sup>th</sup> floor is 161.9 kWh/m<sup>2</sup>-yr, much higher than those of the 7<sup>th</sup> and 9<sup>th</sup> floors (117.8 and 119.2 kWh/m<sup>2</sup>-yr). This means, given the tasks to be performed, existing climate and building infrastructure, and the pre-defined ‘standard operation settings’, the 8<sup>th</sup> requires inherently more energy to operate than the other two floors. In theory, the differences in the ‘standard EUIs’ of three floors are mainly caused by the differences in the ‘types of spaces’ (Table 1), ‘building system schemes’ (Table 3), ‘actual occupancy use patterns’ (Table 4), and standard settings (Table 5) among the three floors.
3. The estimated ‘variable EUI’: As shown in Table 6, the ‘variable EUI’ of the department was estimated to be 47.3 kWh/m<sup>2</sup>-yr, and there are large variations in ‘variable EUIs’ among the three floors. The ‘variable EUI’ of the 8<sup>th</sup> floor (26.1 kWh/m<sup>2</sup>-yr) appears to be much less than those of the 7<sup>th</sup> and 9<sup>th</sup> floors (64.5 and 50.9 kWh/m<sup>2</sup>-yr). This means the potential for energy saving on the 8<sup>th</sup> floor is not as large as those on the other two floors. Theoretically, the ‘variable EUI’ of a certain floor indicates the amount of energy that can be potentially saved, if its ‘existing operation conditions’ (Table 4) can be changed to its ‘standard operation settings’ (Table 5).

## 5.5 Step 5: Analyzing and diagnosing the energy performance

### 5.5.1 Energy efficiency index

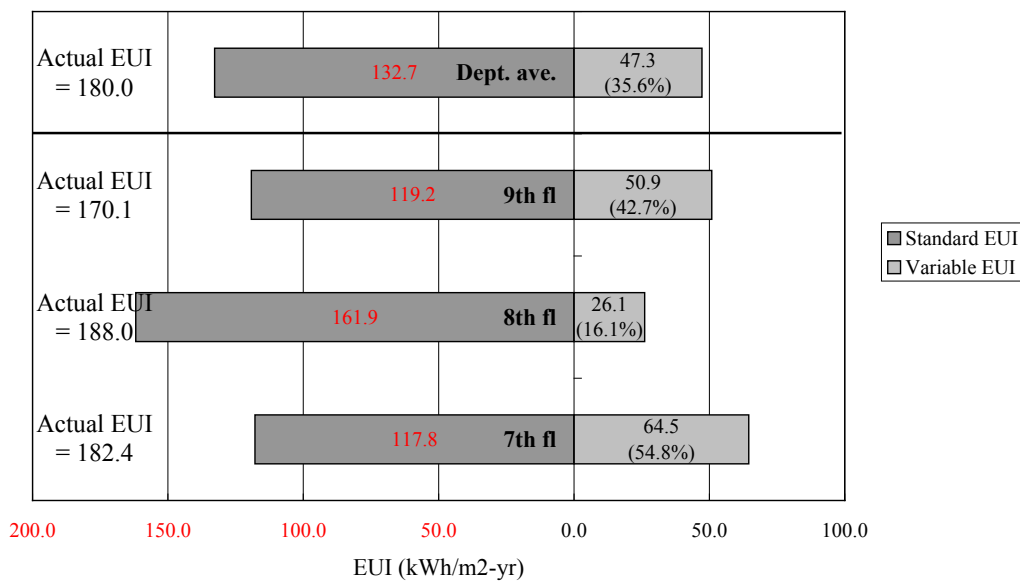
The ‘energy efficiency indices’ of the Department and the three floors were obtained by calculating the ratios of its ‘actual EUIs’ to its ‘standard EUIs’. The energy efficiency of the Department was assessed at two levels:

1. Assessing the energy efficiency of the department: As shown in Table 6 and Figure 3, the EEI of the Department is 135.6%, indicating that ‘existing operation conditions’ have resulted in an energy consumption level 35.6% higher than that operating under ‘standard operation settings’. In other word, there is a 35.6% energy saving potential, if the ‘existing operation conditions’ can be changed to the ‘standard operation settings’.
2. Assessing and comparing the energy efficiency of the three floors: As shown in Table 6 and Figure 3, there are large variations in the ‘energy efficiency indices’ among the three floors. The EEI of the 8<sup>th</sup> floor is 116.1%, much less than those of the 7<sup>th</sup> and 9<sup>th</sup> floors

(154.8% and 142.7%). It is concluded that although the 8<sup>th</sup> floor consumed more energy (highest EUI), it is considered more energy efficient than the other two floors (lower EEI, less energy saving potential). On the contrary, although the 7<sup>th</sup> and 9<sup>th</sup> floor consumed less energy (lower EUI), they are not as efficient because their EEI are as high as 154.8 and 142.7 %. There are 40~50% of energy saving potential on both floors.

**Table 6: Various energy consumption estimates for the Department of Architecture**

	Annual energy consumptions (kWh/yr)	Actual EUI (kWh/m <sup>2</sup> -yr)	Standard EUI (kWh/m <sup>2</sup> -yr)	Variable EUI (kWh/m <sup>2</sup> -yr)	Energy efficiency index
7 <sup>th</sup> fl.	203,900	182.4	117.8	64.5	154.8%
8 <sup>th</sup> fl.	207,920	188.0	161.9	26.1	116.1%
9 <sup>th</sup> fl.	195,070	170.1	119.2	50.9	142.7%



Total / Ave	606,890	180.0	132.7	47.3	135.6%
-------------	---------	-------	-------	------	--------

**Figure 3: The ‘standard EUIs’ and ‘variable EUIs’ for realizing the energy consumption characteristics and energy saving potential of the three floors in Department of Architecture**

### 5.5.2 Energy analysis – By type of equipment

The ‘Actual EUIs’ and ‘standard EUIs’ of the three floors in the Department of Architecture were broken down by three major types of equipment (lighting, miscellaneous equipment, and HVAC). As shown in Table 6 and Figure 4, HVAC system consumed almost half of the ‘actual EUI’ (around 48.9%), whereas the lighting system and miscellaneous office equipment consumed similar amount of energy (25.8 and 25.3% respectively).

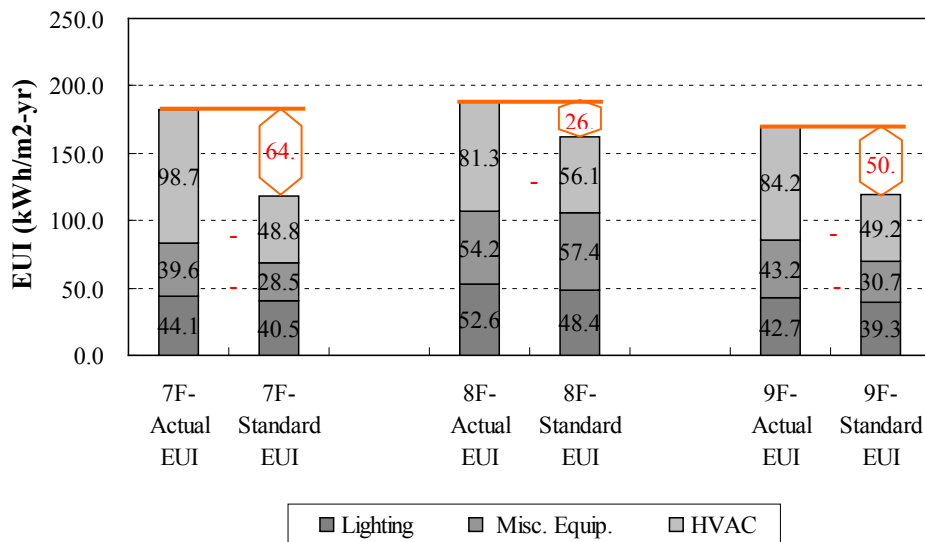
For each floor, the comparison of its ‘actual EUI’ breakdown and ‘standard EUI’ breakdown shows the energy saving potentials for each type of equipment. As Figure 4 shows, ‘HVAC’ is identified as the major energy saving target on all three floors (potential energy savings of 49.9,



25.2 and 35.0 kWh/m<sup>2</sup>-yr); and ‘miscellaneous office equipment’ the secondary energy saving target on the 7<sup>th</sup> and 9<sup>th</sup> floors (potential energy savings of 11.1 & 12.5 kWh/m<sup>2</sup>-yr).

**Table 6: The ‘actual EUIs’ and ‘standard EUIs’ broken down by floor and by the type of equipment in the Department of Architecture**

	‘Actual EUI’ (kWh/m <sup>2</sup> -yr)				‘Standard EUI’ (kWh/m <sup>2</sup> -yr)			
	Lighting	Equipment	HVAC	Total	Lighting	Equipment	HVAC	Total
7 <sup>th</sup> fl.	44.1 (24.2%)	39.6 (21.7%)	98.7 (54.1%)	182.4 (100.0%)	40.5 (34.4%)	28.5 (24.2%)	48.8 (41.4%)	117.8 (100.0%)
8 <sup>th</sup> fl.	52.6 (28.0%)	54.2 (28.8%)	81.3 (43.2%)	188.0 (100.0%)	48.4 (29.9%)	57.4 (35.5%)	56.1 (34.6%)	161.9 (100.0%)
9 <sup>th</sup> fl.	42.7 (25.1%)	43.2 (25.4%)	84.2 (49.5%)	170.1 (100.0%)	39.3 (33.0%)	30.7 (25.8%)	49.2 (41.2%)	119.2 (100.0%)
Total / Average	46.4 (25.8%)	45.6 (25.3%)	88.0 (48.9%)	180.0 (100.0%)	42.5 (32.1%)	38.6 (29.2%)	51.1 (38.7%)	132.7 (100.0%)



**Figure 4: The energy saving potentials of the three major types of equipment on the 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> floors of the Department of Architecture, NTUST**

**5.5.3 Sensitivity analysis**

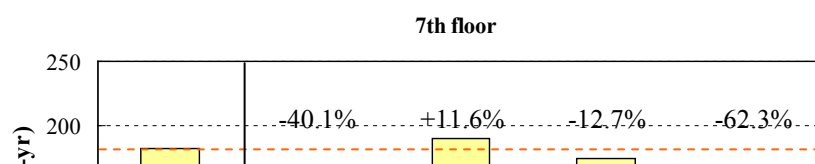
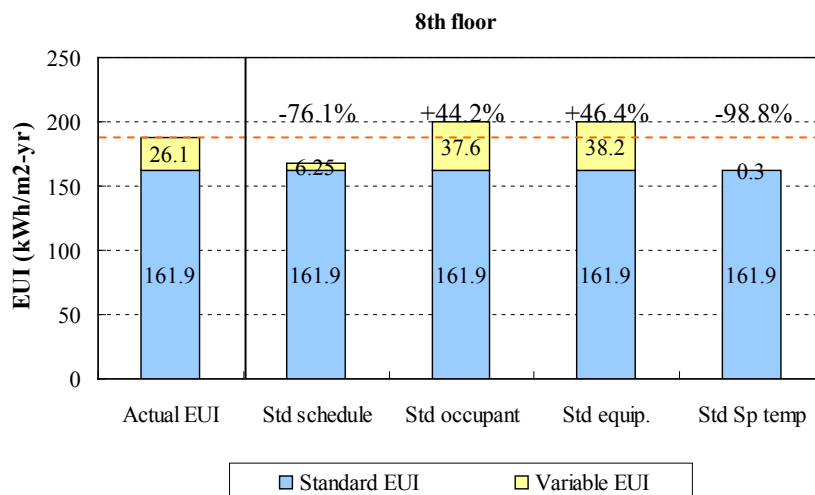
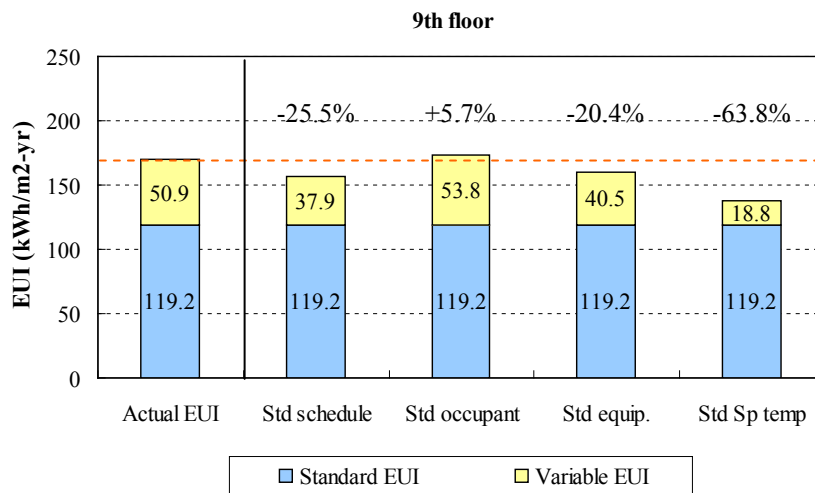
Four sets of ‘standard operation settings’ of all types of spaces, i.e. standard occupancy schedule, standard occupant density, standard equipment density and standard set point temperature, were inputted set by set to the eQuest to generate new energy consumption estimates for all three floors. Figure 5 shows the resulting energy consumption estimates of each set of standard operation settings on all three floors. It is found that major energy saving effects can be achieved by moving towards ‘standard set point temperature’ on three floors (62.3, 98.8, and 63.8% energy reduction). Secondary energy saving effects can be achieved by moving towards ‘standard occupancy schedule’ on three floors (40.1, 76.1, and 25.5% energy saving potential). The numbers in the ‘existing operation’ conditions (Figure 4) and ‘standard

operation settings’ (Figure 5) were compared to identify the ‘types of spaces’ and the ‘settings’ yielding the largest energy saving potentials for each floor.

### 5.6 Step 6: Recommendations

Based on the analytical results shown in Section 5.5 and 5.6, this research presents the following summary and energy saving recommendations to the Department of Architecture:

1. The ‘actual EUI’ of the Department is 180.0 kWh/m<sup>2</sup>-yr, almost 50% higher than the national average EUI for universities (120.8 kWh/m<sup>2</sup>-yr). It is suggested that actions be taken to reduce its energy consumption to its ‘standard EUI’ level (132.7 kWh/m<sup>2</sup>-yr).
2. The ‘actual EUI’ of the 7<sup>th</sup> floor is 182.4 kWh/m<sup>2</sup>-yr, close to the department average. However, it has the lowest ‘standard EUI’ (117.8 kWh/m<sup>2</sup>-yr) and highest EEI (154.8%), indicating that it has a large potential for energy saving (54.8%). It is advised that its energy consumption be reduced to its ‘standard EUI’. The energy saving recommendations temperature (28 °C)’; (2) the *Design Studio* and *Service* spaces operate under their ‘standard occupancy schedule (shorter hours)’; (3) the *Faculty Office* spaces operate with ‘standard equipment density (lower density)’. These are expected to result in major reduction in energy consumed by HVAC and miscellaneous office equipment.



**Figure 5: The results of sensitivity analyses on the energy consumptions of the 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> floors of the Department of Architecture**

3. Although the 8<sup>th</sup> floor has the highest ‘actual EUI’, it also has the highest ‘standard EUI’. Its EEI is 116.1%, indicating that it is more efficient than the other two floors and there is a 16.1% of energy saving potential. It is advised that its energy consumption be reduced to its ‘standard EUI’ (161.9 kWh/m<sup>2</sup>-yr). The energy saving recommendations are: (1) *Research Lab* spaces operate under its ‘standard set point temperature (28 °C)’; (2) *Faculty Office* and *Service* spaces operate with their ‘standard occupancy schedule (shorter hours)’. These are expected to result in major reduction in energy consumed by HVAC.
4. The 9<sup>th</sup> floor has the lowest ‘actual EUI’ (170.1 kWh/m<sup>2</sup>-yr). However, its EEI is as high as 142.7%, indicating that it also has a large potential for energy saving (42.7%). It is advised that its energy consumption be reduced to its ‘standard EUI’ (119.2 kWh/m<sup>2</sup>-yr). The energy saving recommendations are: (1) *Research Lab* and *Design Studio* spaces operate under their ‘standard set point temperature (28 °C)’; (2) *Research Lab* and *Service* spaces operate under their ‘standard occupancy schedule (shorter hours)’; (3) *Faculty Office* spaces operate with its ‘standard equipment density’. These are expected to result in major reduction in energy consumed by HVAC and miscellaneous office equipment.

## 6. Conclusions

In Taiwan, individual departments within universities, typically occupying a portion of a building on campus, are facing great challenges when managing the energy performance of their facilities. This research has proposed the Building Energy Management Support System (BEMSS) to assist these departments in performing their energy management tasks. The underlying concepts of the BEMSS are to classify the spaces within a department into several ‘types of spaces’, to establish ‘standard operation settings’ for each type of space to further generate the ‘standard energy consumption’ estimate as the energy benchmark, and to define the ratio of actual energy consumption to standard energy consumption as the energy efficiency

index to indicate the energy efficiency of the department and its facility. The system architecture of the proposed BEMSS consists of three parts: the input module (receiving data of existing climate and building infrastructure, existing operation conditions and standard operation settings), energy prediction module (eQuest, generating actual and standard energy consumptions), and the output module (yielding energy consumptions by floor and by equipment, energy efficiency index, sensitivity analysis results and identified problem areas). The Department of Architecture of NTUST was used as a case to demonstrate how the BEMSS functions.

This research has contributed to the research field of ‘energy and buildings’ by developing the BEMSS to effectively assist departments in universities in estimating the energy consumptions, establishing the energy benchmark, analyzing and diagnosing the energy efficiency, and identifying the problem areas of the departments. The limitations of this research are that the operation of the BEMSS requires some learning effort and could be time consuming. It is suggested that future studies be conducted on establishing an energy prediction model that is easy to use and accurate in prediction energy consumptions.

## Acknowledgement

The authors would like to thank the National Science Council of the Executive Yuan of Taiwan for sponsoring this research work (Project No. NSC 99-2221-E-011-086).

## References

- Bohdanowicz, P. and Martinac, I. (2007) “Determinants and benchmarking of resource consumption in hotels – Case study of Hilton International and Scandic in Europe.” *Energy and Buildings* **39**: 82-95.
- Chung, W., Hui, T.V. and Lam, Y.M. (2006) “Benchmarking the energy efficiency of commercial buildings.” *Applied Energy* **83**: 1-14.
- Deng, S.M. and Burnett, J. (2000) “A study of energy performance of hotel building in Hong Kong.” *Energy and Buildings* **31**: 7–12.
- Hatamipour, M.S., Mahiyar, H., and Taheri, M. (2007) “Evaluation of existing cooling systems for reducing cooling power consumption.” *Energy and Buildings* **39**: 105–112.
- Haji-Sapar, M., and Lee, S.E. (2005) “Establishment of energy management tools for facilities managers in the tropical region.” *Facilities* **23**: 416-425.
- Lee, W.L., Yik, F.W.H., and Burnett, J. (2007) “Assessing energy performance in the latest versions of Hong Kong Building Environmental Assessment Method (KH-BEAM).” *Energy and Buildings* **39**: 343-354.

Poel, B., Cruchten, G.V. and Balaras, C.A. (2007) "Energy performance assessment of existing dwellings." *Energy and Buildings* **39**: 393–403.

Sun, H.S. and Lee, S.E. (2006) "Case study of data centers' energy performance." *Energy and Buildings* **38**: 522–533.

Tu, K.-J., Lai, J.-F. and Lin, C.-H. (2010) "Strategies and Critical Issues of Building Energy Management on University Campus: Case Study of NTUST." *Journal of Property Management* **1**: 55-64.

Zhu, Y. (2006) "Applying computer-based simulation to energy auditing: A case study." *Energy and Buildings* **38**: 421–428.



# BIM server for HVAC energy consumption simulations: new data structure and interfaces for a popular application

Sérgio Leal Ferreira<sup>1</sup>; João Roberto Diego Petreche<sup>1</sup>; Brenda Chaves Coelho Leite<sup>1</sup>

<sup>(1)</sup> Escola Politécnica da Universidade de São Paulo - USP, Brazil

corresponding author: sergio.leal@poli.usp.br

## Abstract

There is a widely known, non-commercial, and widely used application for energy consumption in building simulations called EnergyPlus. Its primary interface is the IDF Editor, where the user loads data fields, arranged in a particular vision of the data structure, and has some feedback about the data consistence. The EnergyPlus simulation results are very reliable and satisfactory but it is common to find difficulties in the IDF interface and lots of problems and impossibilities are reported by regular users. Most of the problems are related with the geometrical data, but there are many others related with the usability or with the interface itself, such as some “copy and paste” impossibilities.

HVAC is the main energy consumption issue in common buildings. This work proposes a new structure for HVAC data, with the use of a Database Management System (DBMS), and also proposes new interfaces to be used jointly with EnergyPlus. These interfaces have the advantage to allow adjustments to their visions and capabilities according the user's needs, i.e., for the same data structure there are lots of possible interfaces and they are selected according to the user's particularities. Another main advantage is the data control, consistence and redundancies checking. The data structure and interfaces proposed are based on experts' opinion, and on researches into EnergyPlus application in HVAC simulations.

There are no decisive conclusions, once this work is under development and the first step of the research was only the proposition of the new structure and interfaces, it thus lack tests and user's opinion. The proposition is proving an efficient and quite different interface from the IDF Editor. At least, it is a good alternative to users, and to the energy simulation research community.

The need of flexible interfaces to work jointly with EnergyPlus or any other energy simulation program is addressed. This is essential for the popularization of these simulations in the building lifecycle design phase and operation phase, once the architect or the system operator are not simulation experts, i.e., simulation results will help them to reach higher performance levels in their work but they do not know, or need to know, all its implications.

**Keywords:** Interface, Energy Building Simulation, EnergyPlus

## 1. BIM Interfaces and FM

FM is a wide building management field and there is a point in this field where decisions must be made to enhance facilities system effectiveness, correct initial settings assumptions or even confirm that the system is working with the right setpoints. Parameters to define enhancements, correctness or confirmations often come from engineering manuals and standardization organization compiled data. Discussions about these parameters must be conducted once they represent, in most cases, an average, a minimum necessary or simply a value between legal range limits, and this is not sufficient to reach a better system performance. Experimental and simulation data must be the basis to define the parameters, but experimental data are not easily available or easily manipulated. On the other hand, good simulation tools are validated by experimental data, and this leads to the use of good simulation tools that produce good parameters to reach better facilities performance.

Simulation is not a simple job and it is absolutely necessary that information used in the simulation process is very carefully provided and handled to guarantee the best result possible. The major function of a simulation tool interface is to provide the best way to acquire the right information at the adequate level of results desired and adequate user expertise. A FM operator needs not know every aspect of a simulation tool, but he needs its feedback and he knows the main necessary data to be supplied to the simulation tool. The interface goal, in this scope, is to present the proper view of the simulation tool to the FM operator and guide him, step by step, through an input data logic as near as possible to his system conception.

## 2. The need of flexible interfaces

The IDF Editor is the tool that comes with the EnergyPlus simulation program for creating input data files (idf). This tool is conceived to organize and display the collection of all available objects together, and it is up to the user to identify the objects that will be needed for the simulation.

These objects, more than 500 at the current version of Energy Plus, are arranged within 50 groups, according to a classification that is not very useful to the user, unless he already knows in which groups to look for. So as to improve this interface, new classification groups, needed by the user according to the complexity of the simulation contexts are proposed here.

As it stated by Clarke (2001) for the ESP-r program, an adaptive interface that is able to change as a function of the inherent users has some requirements:

1. A problem is composed of domains: Premises, HVAC, Air movements, Electrical, and Control. The interface should be flexible enough to support incremental and random order definition of domains.



2. Any domain can have levels of abstraction (e.g. Zoning sizes and complexity, HVAC system capabilities, forms and fabrics definitions, etc.). The interface must support replacement of abstraction as the modeling and simulation process evolves.
3. Portions of a domain can need to be enhanced to allow considering special cases, as such higher discretization level of panel layers are needed to assess condensation risks. The interface must support improvements in modeling resolution.

These requirements of a flexible interface correspond to needed abstractions, as seen by an expert's point of view. However, the users, as design professionals, only need to have access to all objects available for modeling and simulation, and do not want to be seen as specialists in building simulation programs. There is no need to know, for example, about models discretization, yet they must be aware of the possibility of moisture formation, and the physical nature of the condensation processes involved.

Therefore, some developer proposed interfaces for the EnergyPlus, such as the eQuest (the Quick Energy Simulation Tool) are conceived to be intuitive enough to be used by ALL design team members. This interface first requires the most general information about the building design, and proceeds into progressively deeper details.

The IDF Editor lacks a classification of the objects based in the application contexts, such as those in the forms of the web-based service for generating idf files called "Energy Plus Example File Generator". In this web service, there are two methods for entering the information in the building model: Simple or Detailed. In the Simple model, there is less input, since it uses default values for the parameters based on regulations. After obtaining a baseline model, the user can switch from the Simple to the Detailed model without loss of the input data. There could be models as those within the IDF Editor, and also different groups for classifying the objects, based on common application tasks, such as load calculation, geometry checking, diagramming of HVAC loops, etc.

Organization and display of the objects do not need to be unique, in fixed groups. There could be an "Application Menu" in the IDF Editor, so that the user could switch between models, facilitating creation and editing objects.

The code of the EnergyPlus simulation program is structured in modules, which makes the development and maintenance of the code more reliable. The developers of each code module have to follow instructions on how to describe the input data for the module objects, as is seen in the "Module Developer's Guide" and the "Interface Developer's Guide" in the EnergyPlus Documentation.

There is an opportunity to improve the usability of the program, since the code developers could be asked to classify the objects in their modules, in an existing group of classes, made of application models. This application models could be previously established by the community of users, or even by the IDF editor developers themselves.

The authors of this paper propose a data restructuring of the objects as shown in Figure 1, in which 1 in the left link can be changed to infinite, so that the classification of objects into various groups is possible.



*Figure 1 - Groups, Objects and Attributes*

Most interface developers only create GUIs, and some developers make the use easier by creating and displaying groups of objects different from those in the IDF Editor. We believe that a dynamic reclassification of objects into different groups, made by the user during the modeling process, is an important step toward the use of BIM tools as the base for the development of building simulation interfaces.

### 3. The user approach to the Interface design

Interfaces help users to communicate with the computational logic of the machines to achieve a result by processing information. The procedure is to input data, process them, and present results, with interactions along the way. The best interface is the easiest to complete this cycle accurately and as quick as possible, and one of the main pursued properties is the conformity with the user's thought, and with the way he communicates.

Even though in the engineering field people are used to technical language, with their particular signs and hard logics, to achieve a satisfactory level of productivity, friendly interfaces are paramount. Additionally, computer applications are becoming more and more complex, with a number of data and relationships that make it difficult to handle this complexity and size without a substantial help.

However, to implement better interfaces, technological difficulties need to be overcome: the power of machine processors, the availability of appropriate programming tools, etc.

Some computational applications were created at a time with not many resources, and the focus was to reach a precise and relatively quick result, even in an input/output hard environment. In a number of cases, these applications are still been used, and the user environments have changed and evolved less than they could and much less than they should.

Based on these assumptions, we have analysed the IDF Editor Interface and propose a new one. To attain this target, initially the structure of the IDF Editor interface, its positive and negative points, the conveniences and difficulties of work with it were identified. There are identified also points where a simple or, at least, a common enhancement will signify a very important gain in productivity, in precision, and in reliability of the building energy simulation, particularly linked with the HVAC themes.

### 3.1 Analyzing the IDF Editor Interface

IDF Editor groups the objects in a particular view. It does not classify the objects. The interface leads the user to think of inputting data sequentially, but this is not what really happens because objects necessary for simulation, even a very simple one, are scattered in the groups, not necessarily in a sequence.

There is a very good way to duplicate objects, with the same attributes, so one can change only some attributes to create a new one, but this process is not through the common “copy/paste” method, which is almost “forbidden” in this interface, but by pressing a “Dup Obj” button. There are copy and paste buttons but with limited functionality.

The consistency check of input data is made automatically only when the user is closing the application, or when he remembers to press “Control+R” or goes to the menu and finds the appropriate shortcut.

There are serious difficulties with input data associated with other objects (called object-lists), for example: to define the object WeatherProperty:SkyTemperature it is necessary to previously define the RunPeriods and the ScheduleNames objects, which are in distinct groups. RunPeriods objects are in the same group as the WeatherProperty:SkyTemperature objects (**Location and Climate** group) and the ScheduleNames objects are in the **Schedule** group, which is the next group in the list. Also to be mentioned is the possibility of the data to participate in more than one object-list, which the user knows through the “Object and Attributes Comments”, i.e. it is not done by the interface with a combobox for presenting the options, but by the user who searches the objects in other places of the “Groups and Objects” area of the IDF Editor. See Figure 2.

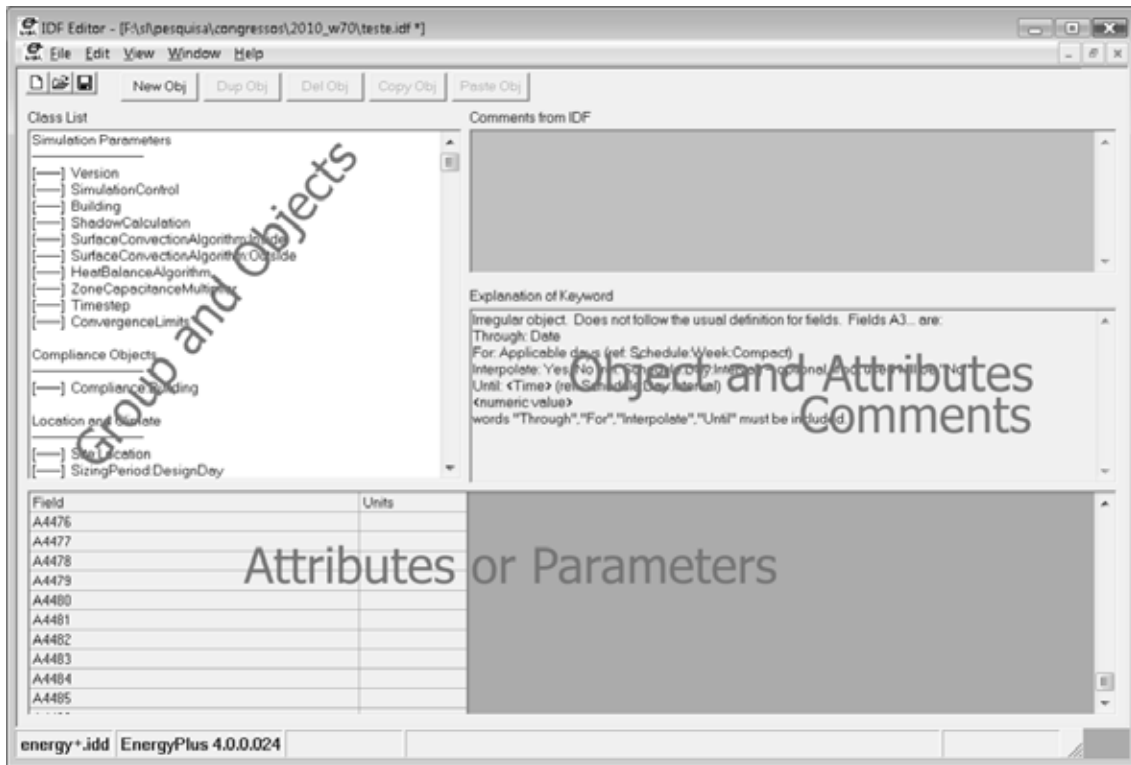


Figure 2: IDF Editor Screen

### 3.2 Users view of HVAC project/simulation sequence

Table 1 displays an example of the survey results on the common ways the users can face a HVAC project, and what they think to be the best work sequence.

This is one possible approach, which has been assumed in this research to test the flexible interfaces proposed.

The information structure proposed has to give the basis to the interfaces to be capable of reflecting, as near as possible, any sequence surveyed; but the interface tests will initially be performed with some of them, especially those related to the HVAC project.

**Table 1: Sequential steps for establishing an Indirect Expansion Air-Conditioning System Project of expert Designers**

1.	Preparation of the preliminary building architecture design with the participation of the air-conditioning system designer.
2.	Preliminary heat load calculation. The following data are necessary at this stage:
2.1	Simplified building geometry.
2.2	Specification of construction materials and coatings containing the physical properties of each material and thickness of each element (wall, ceiling, floor, glass, door, etc.).
2.3	Building orientation.
2.4	Activity type and occupants distribution in the space.

2.5	Electrical equipment list (with each power) and their location.
2.6	Lighting: number of lighting points, luminary type, light bulb type and power .
3.	Feedback to architectural design for adjustments and recalculation of the heat load.
4.	Initial sizing of the major refrigeration equipment and air handling units based on the heat load calculated.
5.	The choice of the type of air-conditioning system most compatible with the building architecture design. The decision is made from the comparison of the capabilities of the equipment and the type of building.
6.	Decision about the control type.
7.	Having chosen the system type, proceed to the equipment list indicating the types and capabilities of each. This listing is considering four loops:
7.1	Condensation: cooling tower or fan, valves, actuators, sensors, etc.
7.2	Refrigeration: compressors, pumps, heat exchangers, condenser coil, valves, actuators, sensors, etc.
7.3	Air cooling: air handling unit (fan and coil), ducts (pre-sized), dampers, filters, actuators, sensors, etc.
7.4	Air Distribution: diffusers, return grilles.
8.	Location of the air-conditioning equipment in the building project.

## 4. Flexible Interface Construction

The DBMS entity-relation approach was adopted in order to create the interface structure due to two main reasons: reliability and consistence checking.

The goal is to give the user an opportunity of arranging the current 539 objects, and of manipulating the more than 10,000 possible parameters of the EnergyPlus in sets of **functional objects**, particularly linked with a phase or stage of the HVAC project, or any activity sequence fit for the energy simulation.

## 5. Input Background: Input Data Dictionary – IDD

After the analysis of the interface front, its back, the Input Data Dictionary was the next job. This Dictionary depicts the way the IDF Editor is configured, with the data and references, to admit the attributes, and check their validity. It is also the source of information presented by the IDF Editor to guide the user. New releases of EnergyPlus present deep changes to this Dictionary, but not necessarily the interface. It is an ANSI text file with rules and formats structured to be legible by a computer program. Here is an excerpt of it:

```
\group Thermal Zones and Surfaces
GlobalGeometryRules,
  \required-object
  \unique-object
  A1, \field Starting Vertex Position
  \required-field
  \note Specified as entry for a 4 sided surface/rectangle
  \note Surfaces are specified as viewed from outside the surface
  \note Shading surfaces as viewed from behind. (towards what they are shading)
  \type choice
  \key UpperLeftCorner
  \key LowerLeftCorner
  \key UpperRightCorner
  \key LowerRightCorner
```

A2, \field Vertex Entry Direction  
 \required-field  
 \type choice  
 \key Counterclockwise  
 \key Clockwise

This file is not free of errors, once there are no other checking tools or any processor than the IDF Editor, and this editor almost merely presents the reading information. It is possible to write a checking program and this will be one of the purposes of the work in progress.

## 5.1 Rules and format: translate into DBMS

Some rules and formats of the data were summarized in tables, as shown in Table 2. In these tables (field, object and group level comments), there are two columns on the right for analysing particularities of the data fields, which are important in the translation of the data into a DBMS.

*Table 2: field rules and formats*

Field-level comments:

Comment	Description	Database type	Multipliable
\field	Name of field (should be succinct and readable, blanks are encouraged)	Data	No
\note	Note describing the field and its valid values	Data	Yes
\required-field	To flag fields which may not be left blank (this comment has no "value")	Field property	No
\begin-extensible	Marks the first field at which the object accepts an extensible field set. A fixed number of fields from this marker define the extensible field set, see the object code \extensible for reference.	InputProcessor information	No
\units	Units (must be from EnergyPlus standard units list). EnergyPlus units are standard SI units.	Data	No
\ip-units	IP-Units (for use by input processors with IP units). This is only used if the default conversion is not appropriate.	Data	No
\minimum	Minimum that includes the following value	Field property	No
\minimum>	Minimum that must be > than the following value	Field property	No
\maximum	Maximum that includes the following value	Field property	No
\maximum<	Maximum that must be < than the following value	Field property	No
\default	Default for the field (if N/A then omit entire line)	Field property	No
\deprecated	This field is not really used and will be deleted from the object. The information is gotten internally within the program.	InputProcessor information	No
\autosizable	Flag to indicate that this field can be used with the Auto Sizing routines to produce calculated results for the field. If a value follows this, then that will be used when the "Autosize" feature is flagged. To trigger autosizing for a field, enter Autosize as the field's value. Only applicable to numeric fields.	InputProcessor information	No
\autocalculatable	Flag to indicate that this field can be automatically calculated. To trigger auto calculation for a field, enter Autocalculate as the field's value. Only applicable to numeric fields.	InputProcessor information	No
\type	Type of data for the field: • integer	Field property	No

	<ul style="list-style-type: none"> <li>• alpha (arbitrary string),</li> <li>• choice (alpha with specific list of choices, see \key)</li> <li>• object-list (link to a list of objects defined elsewhere, see \object-list and \reference)</li> </ul>		
<b>\retaincase</b>	Retains the alphabetic case for alpha type fields	Field property	No
<b>\key</b>	Possible value for "\type choice" (blanks are significant) use multiple \key lines to indicate all valid choices.	Field property / Data	Yes
<b>\object-list</b>	<p>Name of a list of user-provided object names that are valid tries for this field (used with "\reference") see Zone and BuildingSurface:Detailed objects below for examples.</p> <p>** Note that a field may have only one \object-list reference.</p> <p>** If it must reference more than one object-list, then a composite object-list should be created which contains all valid references.</p>	Data	Yes
<b>\reference</b>	<p>Name of a list of names to which this object belongs used with "\type object-list" and with "\object-list" see Zone and BuildingSurface:Detailed objects below for examples:</p> <p>Zone, A1, \field Name \type alpha \reference ZoneNames</p> <p>BuildingSurface:Detailed, A4, \field Zone Name \note Zone the surface is a part of \type object-list \object-list ZoneNames</p> <p>For each zone, the field "Name" may be referenced by other objects, such as BuildingSurface:Detailed, so it is commented with "\reference ZoneNames" Fields that reference a zone name, such as BuildingSurface:Detailed's "Zone Name", are commented as "\type object-list" and "\object-list ZoneNames"</p> <p>** Note that a field may have multiple \reference commands.</p> <p>** This is useful if the object belongs to a small specific object-list as well as a larger more general object-list.</p>	Data	No

**Object-level comments:**

Comment	Description	Database type	Mutipliable
<b>\memo</b>	Memo describing the object	Data	Yes
<b>\unique-object</b>	To flag objects which should appear only once in an idf (this comment has no "value")	Field property	No
<b>\required-object</b>	To flag objects which are required in every idf.(this comment has no "value")	Field property	No
<b>\min-fields</b>	Minimum number of fields that should be included in the object. If appropriate, the Input Processor will fill any missing fields with defaults (for numeric fields). It will also supply that number of fields to the "get" routines using blanks for alpha fields (note – blanks may not be allowable for some alpha fields).	InputProcessor information	No
<b>\obsolete</b>	<p>This object has been replaced though is kept (and is read) in the current version.</p> <p>Please refer to documentation as to the dispersal of the object.</p> <p>If this object is encountered in an IDF, the InputProcessor</p>	InputProcessor information	No

	will post an appropriate message to the error file. usage:\obsolete New=>[New object name]		
<code>\extensible:&lt;#&gt;</code>	This object is dynamically extensible -- meaning, if you change the IDD appropriately (if the object has a simple list structure -- just add items to the list arguments (i.e. BRANCH LIST). These will be automatically redimensioned and used during the simulation. <#> should be entered by the developer to Signify how many of the last fields are needed to be extended (and EnergyPlus will attempt to auto-extend the object). The first field of the first instance of the extensible field set is marked with <code>\begin-extensible</code> .	Object property	No
<code>\begin-extensible</code>	See previous item, marks beginning of extensible fields in an object.	InputProcessor information	No?
<code>\format</code>	The object should have a special format when saved in the IDF Editor with the special format option enabled. The options include SingleLine, Vertices, CompactSchedule, FluidProperties, ViewFactors, and Spectral. <ul style="list-style-type: none"> <li>• The SingleLine option puts all the fields for the object on a single line.</li> <li>• The Vertices option is used in objects that use X, Y and Z fields to format those three fields on a single line.</li> <li>• The CompactSchedule formats that specific object.</li> <li>• The FluidProperty option formats long lists of fluid properties to ten values per line.</li> <li>• The ViewFactor option formats three fields related to view factors per line.</li> <li>• The Spectral option formats the four fields related to window glass spectral data per line.</li> </ul>		No

**Group-level comments:**

Comment	Description	Database type	Multipliable
<code>\group</code>	Name for a group of related objects	Data	No

After reading the IDD, the data dictionary, and making the opportune parsing, it was possible to generate tables of a DBMS, and produce the relationships necessary to establish the database, the basis of the new interface. Figure 3 shows the relationship graphics. This process was hard and plenty of errors arose due to the lack of the IDD error checking program mentioned before. Here are some errors found:

- Object-list and `\type` duplicated in AvailabilityManager:HybridVentilation.
- AirflowNetwork:MultiZone:Zone N2 and N3 duplicated
- ElectricLoadCenter:Generators A90 duplicated
- ZoneHVAC:EquipmentList N23 duplicated (change N33 by N23)
- AirflowNetwork:MultiZone:ReferenceCrackConditions N2 `\type` real duplicated
- AvailabilityManager:HybridVentilation A4 `\type object-list` duplicated
- HVACTemplate:System:UnitaryHeatPump:AirToAir N11 `\units W` duplicated.
- MaterialProperty:HeatAndMoistureTransfer:Diffusion N36 minimum duplicated
- HVACTemplate:Zone:PThp N14 `\units W` duplicated.



- MaterialProperty:HeatAndMoistureTransfer:Diffusion `\mimum` duplicated in many places.
- MaterialProperty:HeatAndMoistureTransfer:SorptionIsotherm `\minimum` duplicated in many places.
- AvailabilityManager:HybridVentilation A4 `\required-field` duplicated.
- Dehumidifier:Desiccant:System A2: `\type alpha` and `\type object-list` in conflict, alphanumeric is used in IDF Editor but object-list is defined as ScheduleNames and this seems to be the correct.
- WaterHeater:Sizing A1: `\type alpha` and `\type object-list` in conflict, but this time object-list is used in IDF Editor once this is defined after the `\type alpha` and through `\object-list WaterHeaterNames`.
- WaterUse:RainCollector. Many times the `\type` is in conflict.
- TimeStep A1 a `\note` blank at the end.
- Refrigeration:Condenser:EvaporativeCooled A5 a `\note` blank at the beginning.
- In Refrigeration:WalkIn A3 `\reference` is supposed to be ScheduleNames and there is ScheduleName (without s), losing the reference.
- Mentioned in `\object-list`, but there are no references to them:

autoRDDmeter	HeatingCoilsGasElecDX
autoRDDvariable	LinearQuadratic Curves
autoRDDvariableMeter	NodeNames
Bicubic BiquadraticCurves	QubicCurves
BiquatricQuadraticCubicCurves	RefrigerationSystemNames
CoolingCoilsDXMultiModeandSingleSpeed	WaterStorageTankName
FCExhaustHXNames	

- There are in `\references`, but they are not used. This is not exactly a problem, but, it seems to be advisable to review the references:

AirDistributionUnits	GasEquipmentNames
AirflowNetwork LinkageNames	HeatingCoilsDesuperheater
BaseboardHeatNames	HeatTranBaseSurfNames
BicubicBiquadraticCurves	HotWaterEquipmentNames
BiquadraticQuadraticCubicCurves	HXAirToAirFlatPlateNames
ChilledWaterStorageNames	MicroCHPNames
CoolingCoilsDXMultiMode	NodeLists
CoolingCoilsDXMultiSpeed	OSCNAMES
CurveLinearNames	OtherEquipmentNames
CustomMeterNames	PlantEquipmentLists
DesuperheaterWaterHeater	ProgramNames
ErSubProgramNames	QuadraticLinearCurves
ExteriorFuelEquipmentNames	RefrigeratedCaseCompressorRack
ExteriorWaterEquipmentNames	RefrigerationDetailedSystemNames
Fans	SetpointManagers
FCExhaustHXNames,	StandardReportNames
FluidPropertyTemperatures	SteamEquipmentNames
SurfGroupAndHTSurfNames	VentedCavityNames
WaterHeatingCoilsDesuperheater	ZonePlenums
ZoneControlThermalComfortNames	ZoneReturnAirPaths
ZoneEquipmentLists	ZoneSplitters, ZoneSupplyAirPaths

We do not know the purpose of `\begin-extensible` at object level once the extensibility is applied to fields. Currently there is no object with this flag.

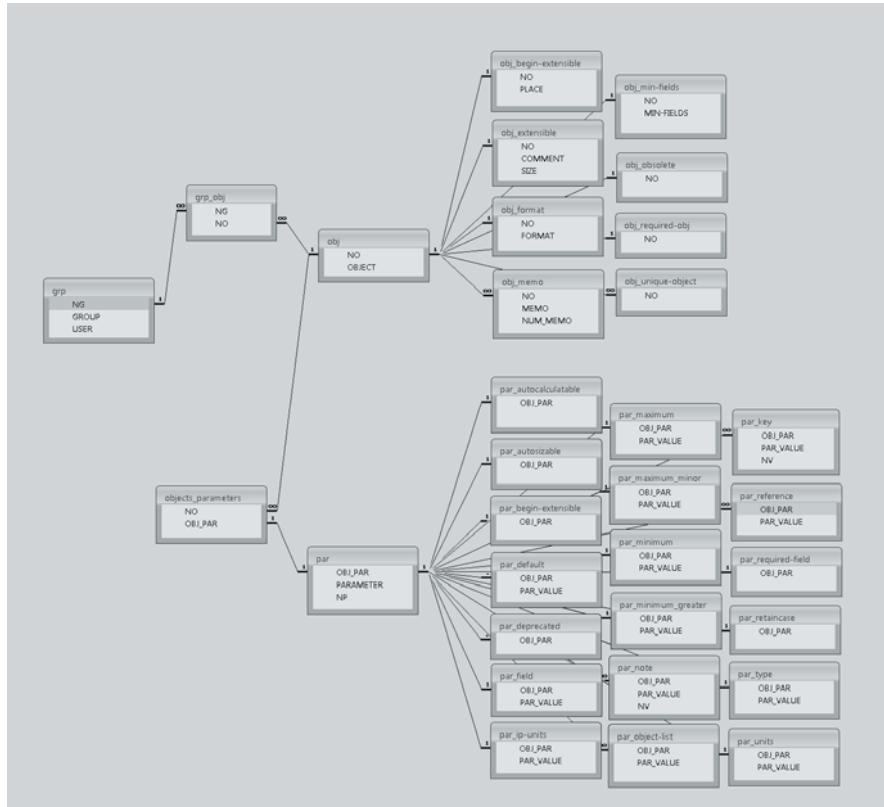


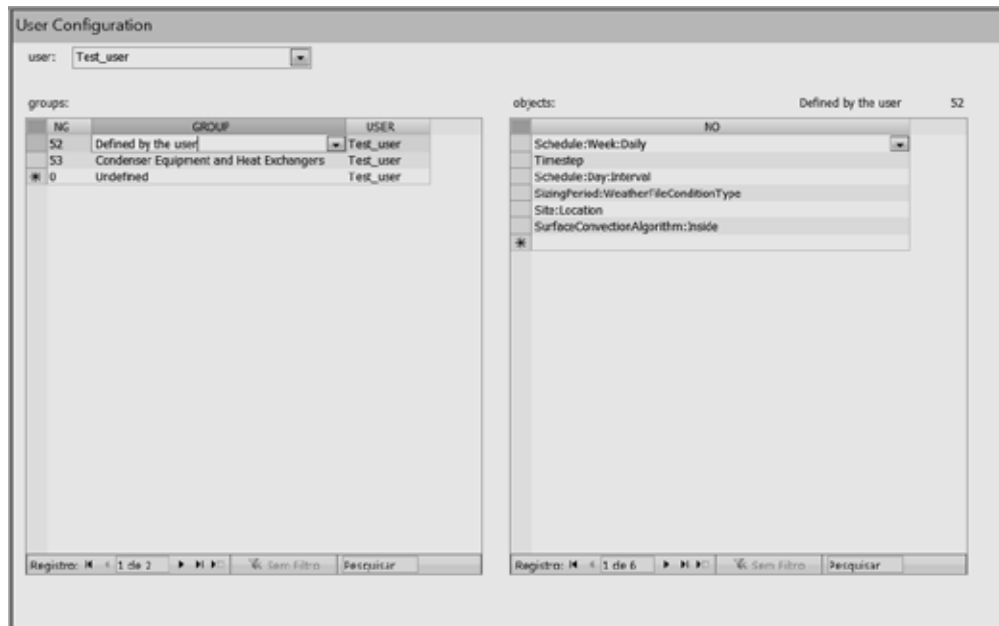
Figure 3: Tables and relationships of the database

## 6. Conclusion

The work is under development and we have already achieved the first interface to be tested, as shown in Figure 4. Much more work will be necessary to reach a functional set of interfaces. Intensive tests will be performed to prove the correct direction and the adjustments of this proposal.

There are no decisive conclusions, once this work is under development and the first step of the research was only the proposition of a new structure and interface, lacking tests and the user’s opinion about them. The proposition is proving efficient and the interface is quite different from the IDF Editor.

This work addresses the need of flexible interfaces to work jointly with EnergyPlus or any other energy simulation program. This is essential for the popularization of these simulations in the building lifecycle design phase and operation phase, once the architect or the system operator are not simulation experts, i.e., simulation results will help them to reach higher performance levels in their work but they do not know, or need to know, all its implications.



*Figure 4: User configuration Interface*

## References

Clarke, J.A. (2001) Energy simulation in building design. Oxford Butterworth-Heinemann.

Energy Design Resources (2010), (available online <http://www.energydesignresources.com/Resources/SoftwareTools/eQUEST.aspx> [last access in 01/05/2010])

INATOMI, Thais Aya Hassan (2008). Analysis of the Energy Efficiency of Air Conditioning System with Underfloor Air Distribution for Office Space in São Paulo City, Using the Computational Model Energyplus. EPUSP - São Paulo, 2008. 87 p.

US Department of Energy (2009). Developer Guide: Interface Developer's Guide – Energy Plus. University of Illinois, University of California, Ernest Orlando Lawrence Berkeley National Laboratory.

US Department of Energy (2010-1). EnergyPlus Example File Creation (available online <http://apps1.eere.energy.gov/buildings/energyplus/cfm/inputs/> [last access in 01/05/2010])

US Department of Energy (2010-2). EnergyPlus (available online <http://apps1.eere.energy.gov/buildings/energyplus/documentation.cfm> [last access in 01/05/2010])



# The water demand management throughout twelve years of the Water Conservation Program of the University of São Paulo

**Gisele Sanches da Silva**

Polytechnic School, University of São Paulo, Brazil  
gisele.silva@poli.usp.br

**Humberto Oyamada Tamaki**

Polytechnic School, University of São Paulo, Brazil  
humberto.tamaki@poli.usp.br

**Orestes Marraccini Gonçalves**

Polytechnic School, University of São Paulo, Brazil  
orestes.goncalves@poli.usp.br

## Abstract

During the twelve years of its existence, the Water Conservation Program of the University of São Paulo - PURA-USP - became a reference as a program of water demand management at university *campus*. The Program represents a change of paradigm from exclusive water offer management to demand management too, more coherent with the modern precepts of facilities management and sustainable development. In addition to the effort to keep up the consumption in low levels and to the establishment of a structured system for the demand management, the PURA-USP has met its objectives of developing methodology. According to the line of system thinking, throughout this period, technological activities (elimination of leaks, replacement of conventional sanitary appliances and minimization of wastes in processes), mobilization activities (program spreading, awareness campaigns and trainings) and water demand management activities have been accomplished. The main result of the PURA-USP is the reduction of 52% of the water demand (from 137,881 to 66,507 m<sup>3</sup>/month). This becomes even more expressive considering growth of 13.7% of population and 17.7% of built area. Besides this significant reduction, changes were also noticed in the building systems, in administrative and building maintenance routines, in the awakening to the water conservation in a broader sense and in the behavior of the users. As for the financial impact, the accumulated economic net benefit was of US\$ 110 millions. Finally, fulfilling its objectives of research and extension, there were accomplished 9 academic works, 36 articles and 23 presentations at national and international events. In this way, it can be concluded that the PURA-USP has promoted the sustainable use of water in four dimensions: environmental, economic, social and cultural.

**Keywords:** water conservation, demand management, water sustainable management

## 1. Introduction

According to Antonioli (2003), in the last decade, great technological progress of the buildings and its systems and significant increase of complexity and interdependence of the elements in the built space were recorded: “The support offered by these elements to the users started having growing strategic importance for the development of activities”. The systems have been obliged to operate at the highest level of flexibility and reliability, according to the requirements imposed by criteria of performance and quality, considering the concerns with the sustainable use of resources. He states that the facilities management represents the most promising hope for the sustainable use of natural resources and appropriate management of the environmental impacts, caused by construction, operation and maintenance of the buildings. It will not be able to adapt to the requirements of the post-industrial society unless the facilities management be done with the participation of individuals professionally trained and with high sense of social responsibility.

Referring to systems that use water, Gonçalves (2002) says that society has taken the issue of water scarcity, which has required the building systems in response to this one more need of society: no longer it is enough to meet user in sufficient quantity and quality so that he develops his activities according to his comfort level, it is necessary to reduce the water volume desired.

Between the 70's and 80's, practices of water conservation, case studies and, following the line of system thinking, Water Conservation Programs (PURAs) arose, given the demand of structuring actions at the level of building systems. In 1996, the São Paulo State Water Utility Company (SABESP), in agreement with the Polytechnic School of University of São Paulo (EPUSP) and the Institute for Technological Research (IPT) has started the PURA. The Program introduced itself in the change of the paradigm of exclusive water offer management to one for demand management too, more coherent with the sustainable development. In 1997, the Water Conservation Program of the University of São Paulo - PURA-USP - has started.

## 2. The implementation of the PURA-USP at the CUASO

The USP, founded in 1934, is the largest public university in Brazil, being responsible for 28% of scientific production of the country. USP has 40 teaching and research Units, 229 undergraduate courses offered to approximated 56 thousand students and 230 graduate programs containing 22 thousand attending students. USP develops its activities in seven *campi*, distributed in six cities in the state of São Paulo, other than the capital city where the University City Armando de Salles Oliveira (CUASO) - is located. CUASO has a total area of 3.65 km<sup>2</sup> in which can be found buildings of different ages (mostly of the 60's and 70's), built according to the technical and building cultures as well as the availability of resources of each period. Since their construction, most of the building systems haven't undergone any significant interventions, and it can be found many types of conceptions, installations and state of preservation. Despite the age and diversity of the plumbing systems, no efforts were made for maintaining or modernizing the systems, in a rational, systematic and structured way, with proper technical support and information recording. As for the maintenance, the teams are small and there are no preventive routines.

According to Silva (2004), for the achievement of results, a PURA must be permanent, structured and inserted into the formal structure of the institution, include planning, pre-implementation, implementation, post-implementation and, throughout all its development, water demand management. In this way, the PURA-USP was created by means of an agreement between USP and SABESP: the University undertook itself to keep payments of water and sewage charges up-to-date and to implement the PURA in exchange for a concession of a discount of 25 % on the charges. In institutional terms, in 2001, the Rector of USP released two Ordinances - GR n° 3290 and GR n° 3291 - about the creation and accountabilities of the PURA-USP, having the purpose of establish guidelines, propose actions, evaluate and manage the water use. After signing the agreement, the planning of the actions has started:

- *Surveying motivation:* the excessive costs of water supply and sewage disposal (US\$ 1.93 million/month, in 1997, considering all the *campi* of USP), the interest of the University in promoting research and the interest of SABESP to operate a PURA to allow a greater availability of water for the Metropolitan Region of São Paulo.
- *Determination of aims:* besides reducing the water demand, the PURA-USP had as goals to maintain the reduced demand, to implement a structured system for the water demand management and to develop a methodology that could be applied to other places.
- *Diagnosis of the situation:* in 1998, the CUASO had fixed population - 54,886 people, built area - 739,073 m<sup>2</sup>, buildings - about 200, building mains (external networks) - 36,837 m, storage tanks - 467, sanitary appliances - 19,181, and mean water demand - 137,881 m<sup>3</sup>/month. The water supply is provided by SABESP mains. The CUASO besides having wide open areas, lots of built area, very large population and water demand, it has a great diversity of uses - schools, laboratories, hospital, lodging, restaurants, sports club, museums, offices, green areas.
- *Program organization:* an organization for work was adopted comprising USP Rector, PURA-USP Commission and PURA-Unit Commissions (one in each Unit, composed by one professor, one administrative employee and one maintenance employee).

The implementation of PURA-USP was carried out in two phases: Phase 1 (7 Units - 1998 and 1999), first aiming at the largest water consumers (more than 50% of the *campus*) that presented different use typologies and Phase 2 (21 Units - 2000 and 2001). Since 2002, PURA-USP has started actions at Units external to the *campus*, while still maintaining permanent activities at the CUASO. The execution of PURA-USP comprised:

- *Stage 1 - General diagnosis:* deepening of the survey of characteristics of the institution, occupancy, constructions, building systems and water uses.
- *Stage 2 - Physical losses reduction:* updating of the registries and elimination of leaks in building mains and in storage tanks.

- *Stage 3 - Consumption reduction at water use points:* elimination of leaks at use points and substitution of conventional appliances for water saving models, adopting guidelines that comply with the standards, quality programs and users' requirements (e.g. self-closing faucets and valves for urinals, low flushing toilets).
- *Stage 4 - Characterization of habits and rationalization of water-consuming activities:* surveying users' habits in activities that take place in kitchens, laboratories, gardens and in general cleaning and in places where there is specific use of water. Information on more efficient procedures is provided in order to minimise waste without losing quality of use.
- *Stage 5 - Program spreading, awareness campaigns and trainings:* preparation of advertising materials, creation of *e-mail* (pura@poli.usp.br) and a page on the Internet (www.pura.poli.usp.br), training sessions and the participation in technical events.

The Facility Manager's Guide to Water Management of the Arizona Municipal Water Users Association ratifies that an effective plan is one that fully outlines not just how much water is being used, but how it is used and by whom. As water management techniques, the Guide cites reducing losses, reducing the amount of water used by equipment or processes and reusing the water that would be discarded. The Guide confirms the importance of the communication of actions to all levels of personnel, because to be successful, a management plan should consider the human side, like water using habits. At last, the Guide alerts that facility managers need to look at managing water use so that they comply with the laws - water conservation measures must be consistent with public health - and make cost-effective decisions (AMWUA, 2008).

### 3. Water demand management at the CUASO

At the post-execution phase, in order to guarantee the reduced levels of water demand, the permanent character of Stages 4 and 5 shall be established, as well as the water demand management. It goes beyond the mere follow-up of consumption and includes, besides the data survey, the evaluation of control parameters and the system feedback in the form of elimination of a leak or revision of processes according to the intervention procedures (Tamaki, 2003).

#### 3.1 Data survey

Besides the water consumption data (like readings and flow rate profiles), which presupposes the control of information such as the register of water connections and the characteristics and conditions of each meter box and water meter (location, type, dimensions and capacities, places supplied), there is the survey of supplementary data - population, built area, existing appliances and the activities that are carried out - that are used for the determination of control parameters. Antonioli (2003) highlights the importance of the information: "It can be stated that nowadays the information represents the most important input for the activities developed at the built environment, so for the organization as for the facilities management itself".



For the demand management at the CUASO, Tamaki (2003) presents besides simple instruments, such as water bills and *in loco readings*, more sophisticated ones:

- *Submetering*: installation of more water meters (about 60 units), besides the ones used by the SABESP for billing purposes, which allows greater correspondence between demand and consuming unit, more precise location of leaks and charging the water used by private entities.
- *Remote Reading*: according Tamaki et al. (2005), the system adopted is a digital field bus system, including electronic meters (about 120 SABESP units, with nominal diameters ranging from 20 to 100 mm and nominal flows from 1.5 to 60 m<sup>3</sup>/h, respectively); communication network and remote reading management center. The remote reading works on data collection (*Figure 1, left*) - more reliable for collecting more data in real time, besides detecting anomalies faster (e.g. leaks) - and on determination of control parameters, such as the flow rate profiles. The program receives data from each meter at every five minutes, what allows the generation of the detailed profiles, from which points of maximum flows (*a*) and minimum flows (*b*) can be seen, thus showing possible anomalous consumptions (*Figure 1, right*).

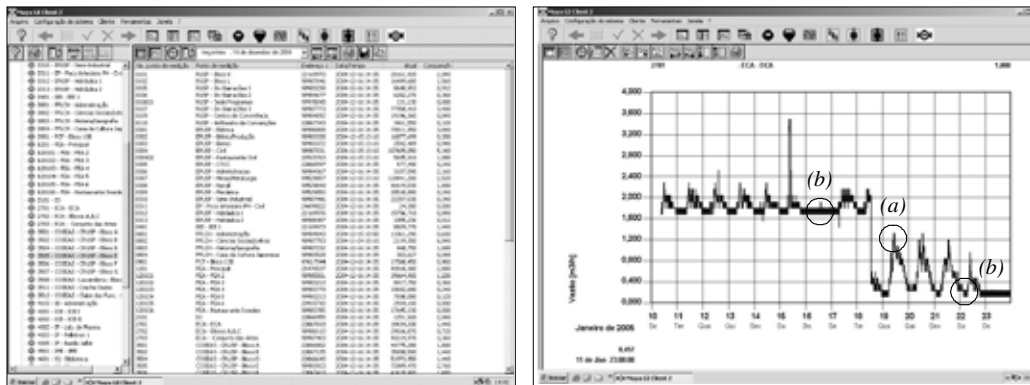


Figure 1: Use of a remote reading software for management

### 3.2 Evaluation of control parameters

The time-based evaluation of control parameters, such as monthly demand, daily *per capita* demand and flow rate profiles, allows not only to alert a situation of consumption anomaly, but also the assessment of impacts of the interventions of the PURA-USP. These data can still be used in other ways like demand forecasting for new buildings, respecting the use typologies. Each one of these parameters is evaluated with a different periodicity at the CUASO. The follow-up of water meters profiles (*Figure 1, right*) is performed everyday in order to identify possible consumption abnormalities, such as leaks. Monthly, meter readings and consumption calculations are checked with the SABESP, in order to see possible mistakes. Each two months, the Finance Department of USP sends to the PURA-USP a worksheet with the billed consumptions by the SABESP, for an additional conference. At last, yearly, the daily *per capita* water consumption is calculated, using the consumption values and the fixed population data.

Silva et al. (2009) show the evolution of daily per capita water demand, between 1998 and 2007. Considering the demands recorded in 2007, there is a wide range of values that represent the great

diversity of water uses at USP (Figure 2). It is verified that the Units can be grouped in characteristic ranges according to the water use typology: *human use (H)* - up to 40 L/cap/day (use in pantries, restrooms and for cleaning); *mixed use (M)* - 41 to 100 L/cap/day (human use plus use in laboratories); *laboratorial use (L)* - 101 to 200 L/cap/day (intensive use in equipments and processes); and *other use (O)* - above 201 L/cap/day (intensive use in facilities services - PCO, hospital - HU, residential buildings, day care and restaurants - COSEAS and sports club - CEPEUSP). However, not always the demands of the Units follow the expected range to its use typology, which can be due to characteristics or conditions of the systems (e.g. growth of built area), maintenance staffs or variations in the uses (conferences, renovation, etc.). The correct assessment of the demands requires much knowledge of the Units.

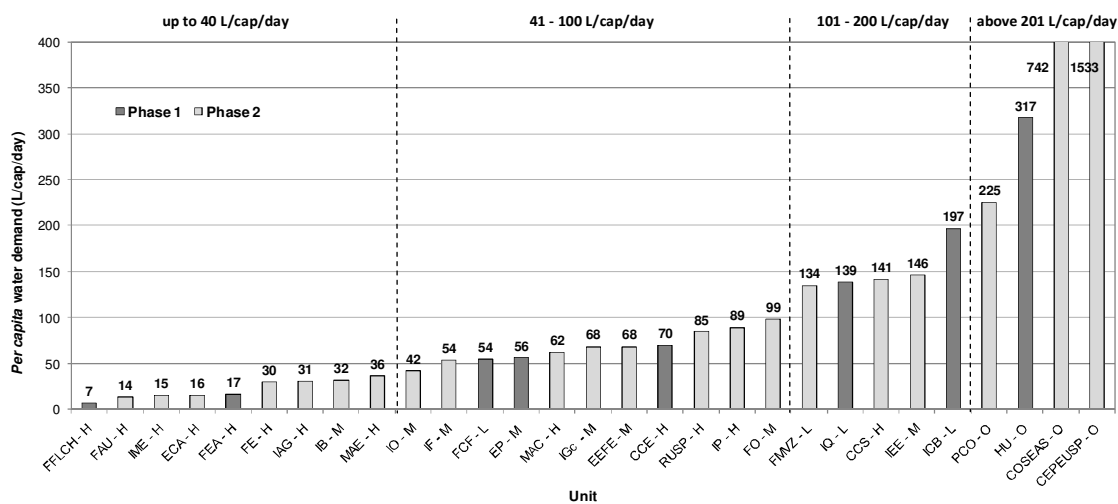


Figure 2: Per capita water demand of the Units of the CUASO in 2007 <sup>(1)(2)</sup>

<sup>(1)</sup> FFLCH - School of Philosophy, Literature and Human Sciences; FAU - School of Architecture and Urbanism; IME - Institute of Mathematics and Statistics; ECA - School of Communications and Arts; FEA - School of Economy, Administration and Accounting; FE - Education School; IAG - Institute of Astronomy, Geophysics and Atmospheric Science; IB - Bioscience Institute; MAE - Museum of Archeology and Ethnology; IO - Oceanographic Institute; IF - Institute of Physics; FCF - School of Pharmaceutical Sciences; EP - Polytechnic School; MAC - Contemporary Art Museum; IGc - Institute of Geosciences; EEFE - Physical Education and Sport School; CCE - Electronic Computer Center; RUSP - Rectory of USP; IP - Institute of Psychology; FO - School of Dentistry; FMVZ - School of Veterinary Medicine and Zootechny; IQ - Chemistry Institute; CCS - Social Communication Coordination; IEE - Electrotechnical and Energy Institute; ICB - Institute for Biomedical Sciences; PCO - CUASO Operations Services; HU - University Hospital; COSEAS - Social Assistance Coordination; CEPEUSP - USP Sports Center.

<sup>(2)</sup> H - Human use; M - Mixed use; L - Laboratorial use; O - Other use.

In other Units, the fixed population (students, professors and employees) shows low correlation with the water usage and, consequently, with the demand. These cases denote the need of adoption of other consuming agents. For instance, some of the *per capita* demands in 2007: 1,710 L/bed/day, at University Hospital (HU); 82 L/student/day at School of Application (of FE); and 191 L/habitant/day at the Residential Buildings for Students (of COSEAS).

Besides having many *per capita* demand values, it can be verified that the variation during these ten years was quite distinct to each Unit: from the 29 Units considered, 24 showed reduction (up to 76%), but 5 presented increase of the values (up to 65%), some of which are related to the increase of the built area, which reinforces the necessity of the system approach of the demands.

Considering all the Units of the *campus*, the reduction of the demand, allied to the increase in population, resulted in a reduction of 46% to the total daily *per capita* water demand, from 113 to 61 L/cap/day. Finally, Silva et al. (2009) conclude that the *per capita* water demand at the

CUASO, throughout the ten years evaluated, has established itself at this new level and has maintained this value in a consolidated manner since 2004. The authors state that for a new reduction to happen, new structural intervention will be necessary in the systems, including the regeneration and modernization of large water networks of the CUASO (Figure 3).

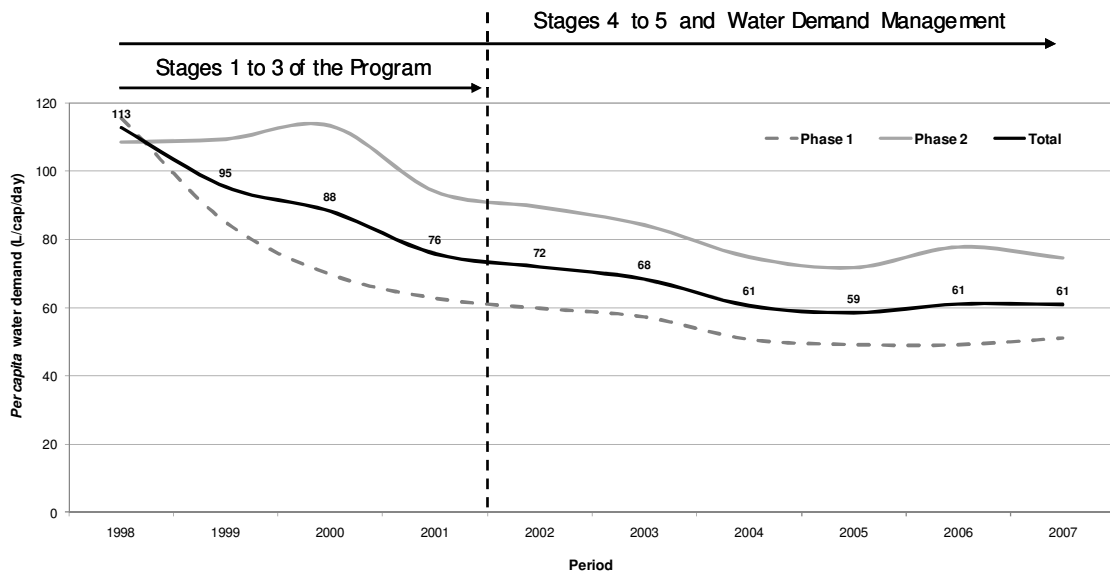


Figure 3: Evolution of the per capita water demand of the CUASO - 1998 to 2007

### 3.3 Intervention procedures

In order to conclude the cycle of the demand management, it should be considered the establishment of procedures and responsibilities in case of anomalies (Figure 4).

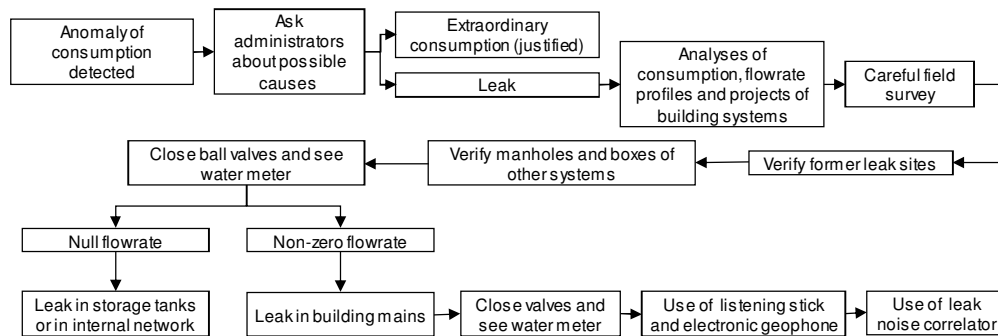


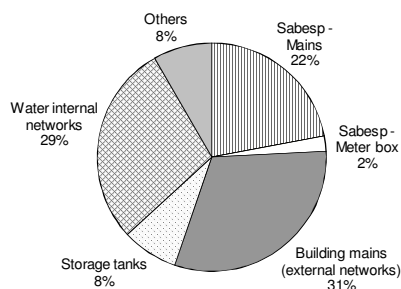
Figure 4: Procedures in case of anomalies

From the comparison between the water consumption and flow rate profiles and the historical data, situations of abnormality are detected. Based on these control parameters, the PURA-USP sends to the Unit a "Notice of high consumption", which includes graphics and the values wasted. Contacting the Unit, it can be verified if the increase is justified by any activity like reservoir cleaning, events, building restoration or not. The Unit then performs an initial survey.

The experience shows that most of the leaks are noticeable in a careful inspection, preferably in a quieter time, observing the wet grass, depression on the ground, floor stained or stewed, sounds of

water in manholes or inspection boxes. Locations near tree roots and connections should be surveyed. If the leaking point is at the external network, the Unit asks the CUASO Operation Services to eliminate it. If the leak is not visible, the PURA-USP helps to localize it using non-destructive methods. This procedure has speed of elimination of leaks: previously it took up to two months to be noticed, and now it can be almost in real time.

The PURA-USP also records the occurrence of leaks in order to check the more recurrent problems, the materials that show more defects, etc. The elimination of non-visible leakages had a very significant result, showing the importance of the substitution of stretches of water networks and the use of a real time monitoring system. Between August 2001 and March 2009, 277 leakages occurred, being 31% of them at the building mains - external networks (*Figure 5*).



*Figure 5: Leaks at the CUASO - August 2001 to March 2009*

However, according to Silva et al. (2007), it is not enough to eliminate quickly the leaks; it must be worked to minimize their occurrence, previous to the operation of the building systems. For that, the factors that most influence the performance of the networks should be systemically evaluated: *quality of the project* - to specify materials compliant with technical standards and whose manufacturers are participants of the Brazilian Program of Quality and Productivity of the *Habitat* (PBQP-H), to design accessible networks, including control points, provide submetering, avoid direct feed from the public mains, optimize the topology of the network; and *quality of execution and maintenance* - the execution must follow the project and changes must be recorded, the "good technique" should be noticed, using correct procedures for the materials. For maintenance, it should also be used "compliant" materials and followed the "good technique". Many leaks are caused by improper execution of pipelines or badly executed repairs, due to the failure of professionals' educational process and the lack of training.

Antonioli (2003) ratifies that the most appropriate moment to start the activities of facilities management is at the conception of the building, contributing to eliminate faults that come from the design. These faults arise basically from the lack of communication among the disciplinary teams, as well as from the little knowledge they have about how the future users of the building will use the elements contained therein. Neither any considerations comprising maintenance are taken during the design stages. Therefore, the potential facilities management could only be maximized when this activity is aggregated to the building since its conception stage.

## 4. The results of the PURA-USP

Twelve years on, since PURA-USP on CUASO was implemented, besides reduction in water consumption, other results could be attained (Silva, 2004):

- *Changes in the systems of cold water supply and sanitary appliances:* up-to-date registry of networks, storage tanks and water meters; restorations and adequacy of networks; restoration and modernization of sanitary appliances, including replacement for saving models - that bring an increase in functionality, uniformity of models and application of quality concepts.
- *Changes in the routine of building maintenance:* training of teams; reduction of calls and loss of materials; and creation of a feedback cycle between water managers and maintenance staffs, with consequential fast elimination of leaks.
- *Changes in administrative routines:* creation of patterns for acquisition of water saving appliances (descriptions, standards and quality programs); and closer relation with administrative staff, which enables helping with issues relating to water and its conservation.
- *Changes in design parameters:* among the recommendations of the Program, the installation of saving appliances both for retrofitted and new buildings has been widely adopted.
- *Technological development of appliances:* through partnerships with manufacturers, when a design problem occurred systematically, a technician could be called and the design revised. Still, tests were conducted with innovative appliances (e.g. toilets with dual flush systems).
- *Introduction of alternative water sources:* introducing alternatives water sources should be encouraged, however, appropriate care must be taken to avoid compromising both the populations' health and development of activities and cause environmental unbalances. The use of well and rain water and the reuse of water lack studies and legislation. Its safe application depends not only on technical solutions but also on procedures and accountabilities for maintenance and management of the systems.
- *Users' behavioural changes:* end users were receptive to adoption of water saving appliances. A striking change in user habits is also seen in attitudes like the introduction of a system for water recirculation and notices warning about leakages. In order to guarantee the continuity of the changes, it is important to inform the user about the results attained.

The evolution of CUASO's water demand allows us to testify as the greatest impact of PURA-USP its expressive reduction (*Figure 6*). Even after the conclusion of Stages 1 to 3 of the Program (in 2001), further reduction could be observed, which confirms the importance of the permanent character of the Program and mainly of the water demand management. Between 1998 and 2009, the CUASO's demand had a reduction of 52%, ranging from 137,881 to 66,507 m<sup>3</sup>/month. These data become even more significant when considered the increase of 13.7% of the fixed population and 17.7% of the built area in the CUASO in this same period.

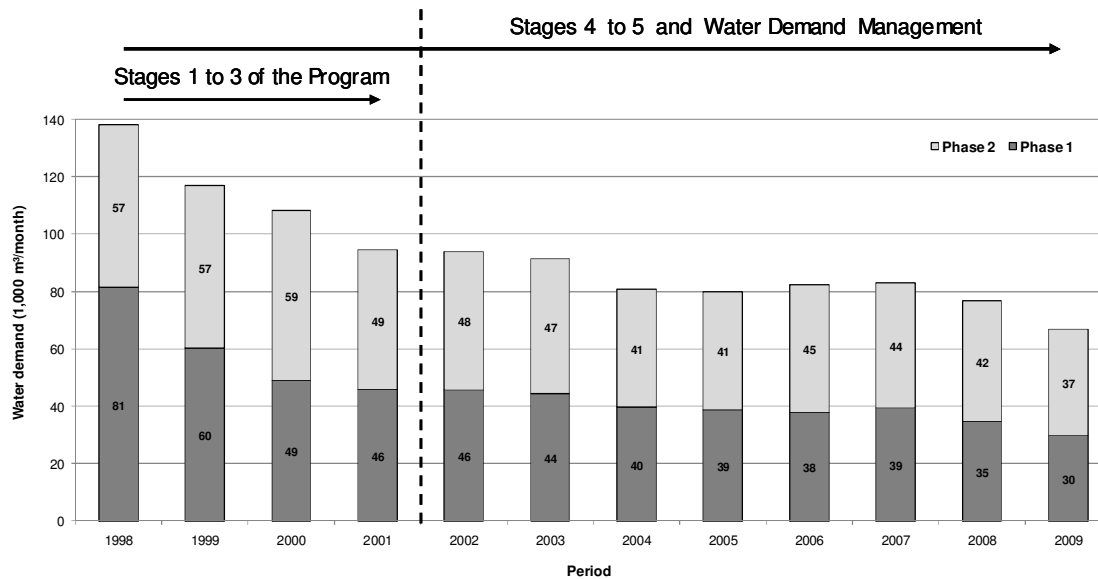


Figure 6: Evolution of water demand of the CUASO - 1998 to 2009

As for the financial impact, there is expressive difference between the US\$ 23.2 millions that should have been expended with water and sewage services, in 2009, and the US\$ 9.5 millions that were effectively expended (considering all USP). The accumulated economic net benefit was of US\$ 110 millions in these twelve years.

Finally, fulfilling its objectives of research and extension, in the scope of PURA-USP there were concluded 1 doctoral thesis; 3 master level dissertations; 6 supervised internships; 8 articles in periodicals; 2 articles in books; 12 articles in conference proceedings; 14 articles in newspapers, magazines, radio or television; 23 presentations in national and international events (mostly scientific); and 47 participations in events (some of them, mounting stands).

## 5. The sustainable management of water at the CUASO

Sustainability has been object of many researches in the last decade. In Brazil, according to Silva, V.G. (2007), there are efforts to establish sustainability indicators, but to the country move forward in their development, it must be defined a consensual methodology, collect data and define national indicators, creating a robust database to be kept updated and accessible.

Kalbusch (2006) compares different tools to assess sustainability of office buildings on hydraulic and sanitary systems and on water use. Silva et al. (2008) made a parallel between the indicators cited in Kalbusch (2006) and the actions of the PURA-USP at the CUASO, concluding that are addressed: the definition and control of targets for water consumption, adoption of metering and monitoring systems, adoption of submetering, detection and control of water losses, limiting pressures, adoption of saving appliances, training and awareness campaigns for maintenance teams, user education for not to waste water and use of alternative water sources for watering. But, it is necessary to measure values or assign concepts for the indicators to assess how

sustainable is the use of water at USP. It would be necessary an assessment tool specific for university *campi* to consider the diversity of uses of the buildings.

Degani (2009) shows characteristics of facilities management practiced in brazilian buildings and identified good practices in the search of sustainability. It was realized that sometimes the introduction of simple routines such as visual inspections of the hydraulic systems and even the observation of the users behavior, can benefit as important as automation systems. It was also found that the inadequacy of the organizational structure reflects in the informality and in lack of routines and recording of information that are important for the performance of the building. According to the authoress “The management model of sustainability is, therefore, an effective way to integrate the sustainability objectives into the daily routine of facilities managers, through a systematic of management and identification of key parameters to be controlled. It is a form of guarantee of permanence and of improving the performance of buildings facing the environmental, social and economic issues related to the use, operation and maintenance.”

Considering the results of the PURA-USP, in another approach, Silva et al. (2008) concluded that the program has promoted the sustainable use of water in four dimensions: *environmental* - reducing water consumption and, consequently, the sewage generated; *economic* - reduction of expenditures on water and sewage services, and consequent use of savings in teaching, research and extension - core business of the University; *social* - providing water to other consumers in the Metropolitan Region of São Paulo; and *cultural* - changes in thinking design, operation and maintenance of the buildings, and mainly, how to make use of water.

## 6. Final Considerations

After twelve years of implementation, the PURA-USP has fulfilled its objectives and corroborated with the core business of the University of São Paulo: the water demand was halved; there is a structure that performs permanently the water demand management (with well-defined procedures and responsibilities); and the development of methodologies, also permanent, have been transferred to society. With a systemic view on cold water building systems, performance required by users and impacts to the environment, the PURA-USP, by means of technology, mobilization and management actions has become a reference on how to make the facilities management of water in a sustainable way. Not longer the University of São Paulo only teaches, research and transfer to society the concepts of facilities management and sustainability, but practice them in its systems.

## 7. References

AMWUA - Arizona Municipal Water Users Association (2008) *Facility Manager's Guide to Water Management*, Phoenix, USA. (available online: [www.amwua.org/business\\_library.html](http://www.amwua.org/business_library.html) [accessed on 02/06/2010]).

Antonioli P E (2003) *Estudo Crítico sobre Subsídios Conceituais para Suporte do Planejamento de Sistemas de Gerenciamento de Facilidades em Edificações Produtivas*, 241p., São Paulo, Brazil: EPUSP.

Degani C M (2009) *Modelo de Gerenciamento da Sustentabilidade de Facilidades Construídas*, 205p., São Paulo, Brazil: EPUSP.

Gonçalves O M (2002) *Notas de aula da disciplina PCC-2465 Sistemas Prediais I*, São Paulo, Brazil: EPUSP (available online: [www.pcc.usp.br/Graduacao/pcc465](http://www.pcc.usp.br/Graduacao/pcc465) [accessed on 16/03/2002]).

Kalbusch A (2006) *Critérios de Avaliação de Sustentabilidade Ambiental dos Sistemas Prediais Hidráulicos e Sanitários em Edifícios de Escritórios*, 162p., São Paulo, Brazil: EPUSP.

Silva G S (2004) *Programas Permanentes de Uso Racional da Água em Campi Universitários: O Programa de Uso Racional da Água da USP*, 328p., São Paulo, Brazil: EPUSP.

Silva G S et al. (2007) “Eliminação de Vazamentos em Redes Externas no Contexto de Programas de Uso Racional da Água - Estudo de Caso: USP” *Proceedings of X Simpósio Nacional de Sistemas Prediais*, 12p., 2007, São Carlos, Brazil: ANTAC.

Silva G S et al. (2008) “O PURA-USP e o Uso Sustentável da Água na USP” *Proceedings of I Encontro Latino Americano de Universidades Sustentáveis*, 10p., 2008, Passo Fundo, Brazil: UPF.

Silva G S et al. (2009) “The evaluation of the *per capita* water demand of the University of São Paulo throughout ten years of the Water Conservation Program of the USP” *Proceedings of 35<sup>th</sup> International Symposium Water Supply and Drainage for Buildings CIB W062*, 13p., Dusseldorf, Germany: FBSEE.

Silva V G (2007) “Indicadores de sustentabilidade de edifícios: estado da arte e desafios para o desenvolvimento no Brasil” *Revista Ambiente Construído*, v. 7, n. 1: 47-66, Jan-Mar 2007, Porto Alegre, Brazil.

Tamaki, H O (2003) *A Medição Setorizada como Instrumento de Gestão da Demanda de Água em Sistemas Prediais - Estudo de Caso: Programa de Uso Racional da Água da USP*, 151p., São Paulo, Brazil: EPUSP.

Tamaki H O et al. (2005) “The Application of Remote Reading of Water Meters at University Campi Regarding Water Conservation Programs - Case Study: USP” *Proceedings of 31<sup>st</sup> International Symposium Water Supply and Drainage for Buildings CIB W062*, 14p., Brussels, Belgium: BBRI.



## Session 9 - Maintenance and Maintainability

Prof. Dr. Keith Jones<sup>1</sup> & Prof. Dr. Eduardo Toledo Santos<sup>2</sup>

<sup>1</sup>University of Greenwich - Eltham-London/UK

<sup>2</sup>EPUSP Escola Politécnica, University of São Paulo - MBA/USP FM - São Paulo/Brazil

<p><b>The contribution of the pedestal paving system to building maintainability</b>  BERNARDES, Mauricio; BARROS, Mercia Maria S.B.  University of São Paulo, Brazil</p>	643
<p><b>Facilities Management for Building Maintainability: A Research Framework</b>  LAU, Wai Kin; HO, Daniel Chi Wing  The University of Hong Kong</p>	655
<p><b>Feedback of architectural projects with base in studies of pathological manifestations in buildings of structural masonry</b>  CARLINO, Alex Elias; MACENA FONTENELLE, Maria Aridenise  UNICV - Universidade de Cabo  UFSCar - Universidade Federal de São Carlos</p>	671
<p><b>Residential condominium study in João Pessoa city - Brazil concerning to maintenance</b>  MEIRA, Alexsandra Rocha<sup>1</sup>; BATISTA, Ana Paula da Silva<sup>2</sup>; FUZARI, Dayelly Gonçalves<sup>3</sup>  <sup>1</sup>Federal Institute of Education, Science and Technology of Paraíba, Brazil  <sup>2</sup>Federal University of Campina Grande, Brazil  <sup>3</sup>Norberto Odebrecht, Angola</p>	683
<p><b>Maintenance in educational facilities - three public schools in São Paulo, Brazil</b>  FRANÇA, Ana Judite Galbiatti Limongi; ORNSTEIN, Sheila Walbe  Faculty of Architecture and Urbanism, University of São Paulo, Brazil</p>	697
<p><b>Maintenance costs of condominiums in João Pessoa - Brazil</b>  MEIRA, Alexsandra Rocha; SANTANA, Djanice Silva de; SILVEIRA, Durwal Albuquerque da  Federal Institute of Education, Science and Technology of Paraíba, Brazil</p>	709



# The contribution of the pedestal paving system to building maintainability

**Mauricio Bernardes**

University of São Paulo  
Building Technology and Management Program  
Dept. of Civil Engineering  
Brazil.  
[mabernardes@uol.com.br](mailto:mabernardes@uol.com.br)

**Mércia Maria S. B. de Barros**

University of São Paulo  
Building Technology and Management Program  
Dept. of Civil Engineering  
Brazil.  
[mercia.barros@poli.usp.br](mailto:mercia.barros@poli.usp.br)

## Abstract

The pedestal paving system technology appears as an alternative that can both increase the performance and the economical efficiency of the building. This technology may turn the process of planned maintenance easier and cheaper, as well as the detection and repair process of developing problems of plaza/roof terrace waterproofing systems at an early stage to prevent any spreading of damage. In order to reach those benefits, it is essential to have technical information about the pedestal paving system to support the stage of design and the stage of technological selection, making the alternative selected suitable to the user's requirements, based on life cycle cost approach. Founded on the information above, the aim of this paper is to systematize and critically analyze the main characteristics of the technology that regulates the selection, design and production stages. Based on the state of the art of the pedestal paving system, the main characteristics which may influence building maintainability are discussed, using a qualitative approach. Findings from this study can provide companies with information on pedestal system technology benefits to reduce building life cycle cost. It occurs as a result of the higher building adaptability provided by the technology, reducing the probability of functional obsolescence of roof and plaza assemblies. In addition, the use of the pedestal system optimizes maintenance activities due to easy surface removal/reset, minimizing damage and waste.

**Keywords:** Maintainability, life cycle cost, adaptability, pedestal paving system.

## 1. Introduction

The pedestal paving system can be considered an interesting solution to pave waterproofed plaza decks and roof terraces due to the potential reduction of the whole life cost of a building. It is a technology that allows access to the hydraulic and electrical systems that may be installed in the drainage void, as well as access to the waterproofing system, facilitating the maintenances required by these systems. In addition, it is possible to prevent the early deterioration of the wearing course, which is normally object of problems such as efflorescence, cracks and uneven surface, resulting mainly from the substrate movement. It also enables more freedom for layout changes in external areas and may turn the areas adaptable to change of possible uses, by the execution of supplementary hydraulic and electrical installations. These possibilities allow reducing the chance of functional obsolescence of buildings, increasing their added value. Therefore, it is possible to use this technology as an element of marketing differentiation.

The technology has to be properly applied, that is, duly designed, executed and used, so that the advantages of its use can come to fruition. In this context, the study herein aims to present and discuss this constructive technology, especially in terms of maintainability and reduction of the whole life cost of a building. The study is based on an extensive bibliographical revision with a focus on the main functions of the pedestal system, complemented by a field study (Bernardes, 2009) comprising the analysis of six buildings in operation, in which the technology was applied, and also interviews with the undertakings managers and technology suppliers.

## 2. Characterization of the Pedestal Paving System

In the course of utilization of roof terraces and waterproofed plazas, surfacing functions were assigned to the protection layers of the waterproofing membrane, being used to pave: ceramic, rock, and pigmented cementitious slabs, among other types of wearing course. The history of application of such surfaces comprises the use of different methods, with records of failures (CBD 1966; Gomes 1968). This situation encouraged systemic studies, especially in cold weather countries, to analyze the cause of failures, e.g., the study by Schild et al. (1978) in which, among other things, the concern with the integrity of the mortar bed used to set pavers and slabs can be observed.

In those countries where an increasing utilization of a solution called Protected Membrane Roof (PMR) or Up Side Down (USD) took place, proposals were made for wearing surfaces made with sand-set and with pedestal-set paving units. With these non-adhered solutions, the amount of water retained over the waterproofing membrane could be drained quicker, without causing damages to the wearing course (GRIFFIN and FRICKLAS, 1996). In doing so, the Digest 75 (CBD, 1966) stated that proper systems of roof terraces drainage are fundamental, because most terrace surfacing can be displaced by water or frost action.

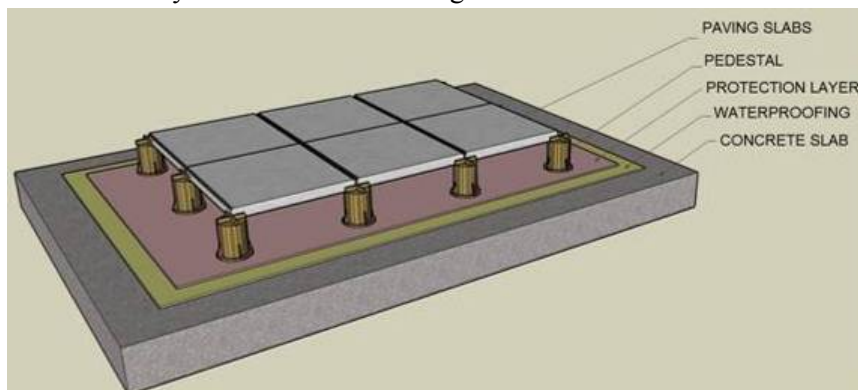
In addition to this concern, other drivers may have propitiated the development of paving methods with sand bed and, later, with pedestals, as for example, the accessibility to installations, equipment and subsurface layers of the roof and plaza deck system, recognized by Griffin and Fricklas (1996) as an advantage of the non-adhered solutions.

The concept of the pedestal-set method dates from the Roman Empire. In the old Roman thermal bath located in the English City of Bath, the environment heating of the so-called west baths and east baths was provided by the blowing of heated air from under a layer of paving slabs which had their corners set over layers of broken paving pieces (Fig.1).



*Fig.1 – Ruins of the floor elevated by stacked flagstones from the Roman thermal bath in the city of Bath (Bernardes and Barros, 2009).*

Today the pedestal system is described as a system in which the paving slabs have their corners placed on typically plastic pedestals, resulting in a level deck and in the concealment of slope, which helps the drainage of stormwater through the open joints existing among those slabs (ICPI, 2008). Normally the pre-manufactured pedestals are conceived to allow height adjustment in order to achieve a levelled surface, besides transferring the loads coming from the paving slabs to the substrate (CSTC 1985). According to the AFNOR NF P 84-204-1-1 (2004), the pedestal system has the role of protecting the waterproof layer while creating a surface for people circulation. The system is illustrated in figure 2:



*Figure 2 – Paving slabs on pedestal*

Nowadays the pedestal system for pedestrian circulation is a plaza deck and roof terrace surfacing more applied than the type bedded in sand or in mortar (Griffin and Fricklas (1996); LES CAHIERS TECHNIQUES DU BÂTIMENT (2007)). The elements and the main functions of the pedestal system for the circulation of people are described in Table 1, based on Bernardes and Barros (2009):

*Table 1 – Elements of the pedestal system and their main functions.*

ELEMENT	MAIN FUNCTIONS
PAVING SLABS	To form a safe circulation surface
	To enhance the esthetical value of the environment
	To help the mechanical waterproof protection
	To allow easy access to the lower layers and to the installations of the drainage void
	To shade roof tops
PEDESTALS	To give support and stableness to the wearing surface
	To guarantee the spacing among paving slabs
	To adjust the surface level
	To correct variations of quote and tilting in the substrate
	To distribute tension on the substrate
JOINTS	To hold the system perimetraly
	To allow stormwater drainage
	To allow small movements of paving slabs
	To allow the cooling of the drainage void air
	To allow the substrate water drying
DRAINAGE VOID	To drain effectively and quickly the water resulting from rain and snow melting
	To allow the flow of several installations
	To allow the temporary retention of intense rain waters

Several materials can be used for the system manufacturing. Concrete is largely applied to paving slabs, besides stone, wood and ceramic slabs.

Granite slabs in pedestal systems were advocated by Hunderman and Gerns (ca.2000) as components used for the recovery of the roof terrace of the Kennedy Center for the Performing Arts, due to their lower susceptibility to freeze-thaw damages and their lower propensity to deformations.

As to the pedestals, there are a large number of models all over the world. The products they are made of vary a lot, too, the most common being polymers such as polypropylene, polyethylene, PVC, polycarbonate and expanded polystyrene.

### 3. The Influence of the Pedestal System in the Reduction of the Whole Life Cost of a Building

The main aspects benefitting the whole life cost reduction of a building through the use of the pedestal system are: durability, maintainability and obsolescence, which are addressed below.

#### 3.1 Durability

The ASTM C981 (2005) addresses the importance of sufficient drainage for plaza systems and highlights that it must be able to minimize the saturation cycles of the wearing surface and its substrate, as some materials used in the wearing surface absorb water and can deteriorate when subjected to the freeze-thaw cycling.

As stated by Griffin and Fricklas (1996), in a roof terrace, the advantage the pedestal system has over the sand-set system is that it fosters a quicker and more effective drainage. In addition, the first allows ventilation drying of subsurface areas, whereas the second does not. It is believed that such characteristics of the pedestal system wearing surface allow an enhancement of the paving system life cycle, which can obviously be considered as added value to owners since, according to Chew et al. (2004), these owners have required more durable buildings.

Ruggiero and Rutila (1990) also emphasized the importance of the efficient drainage propitiated by the pedestal system through the joints among the paving slabs, accounting for preventing problems associated to the freezing of support beds used in other laying techniques. The authors claim that plazas historically presented problems resulting from the lack of drainage within the system components, resulting in long-term deterioration of waterproofing membrane and wearing surface.

Another point for the durability of the paving surfaces with the use of the pedestal system is mentioned on the AFNOR NF P 84-204 -1 (2001) when it emphasizes that in roof terraces, this technology minimizes the thermal shock of the waterproofing layer. It is clear that this also happens in the plazas. According to Wong et al. (2003), the roofing materials shielded from direct exposure to solar radiation and not submitted to intense temperature variations would be more durable. A longer roofing system service life would mean fewer roof replacements and hence, the reduction of maintenance and replacement costs.

#### 3.2 Maintainability

Dunston and Williamson (1999) define optimal maintainability as being: “The design characteristic which incorporates function, accessibility, reliability, and ease of servicing and repair into all active and passive system components”, that minimize the costs included and maximize the “benefits of the expected life cycle value of a facility.”

According to Silva et al. (2004), in the last decades, researches realized the importance of maintainability of the buildings in order to reduce costs and achieve better functioning of facilities. In addition, they emphasize that the lack of attention to the matter of maintainability during the design and construction phases has hampered and made the maintenance process more expensive.

Not foreseeing proper and sufficient space so that maintenance works can be performed and, to design permanent fixtures - which should be removable at the performance of maintenance - are design failures that jeopardize the building maintenance process (Assaf et al., 1996). A research made by Chew et al. (2004) in Hong Kong, revealed that up to 40% of maintenance faults were related to design. Assaf et al. (1996) mention studies in which some building defects are considered to be associated with the lack of accessibility to services.

According to Ruggiero e Rulita (1990) and AFNOR NF P 84-204 -1 (2001), the use of the pedestal system can ease the temporary removals of the wearing surfaces (Fig.3), which strongly contributes to its maintainability.



***Fig.3 – Simulation of maintenance in a pedestal system with granite slabs in a commercial building in the city of São Paulo (Bernardes, 2009).***

For this to be possible, it is the designer's duty to limit the weight of the paving slabs, allowing safe handling by means of manual processes, using proper tools or mechanized techniques in order not to cause injuries to employees. In Brazil, for example, the paving slabs typically commercialized are 35kg in weight and dimensions are of approximately 60 x 60 x 4 cm (concrete paving slabs), being handled with a fixture similar to the one shown in figure 3.

According to Ruggiero and Rulita (1990), the use of wearing surfaces that are disassembled with relative ease results in more serviceable systems. They add that, ideally, in order to enable



the maintenance and trouble shooting of system components, the wearing surface must consist of small modular components that facilitate temporary removals and reinstallation, being this an important characteristic of the pedestal system.

Barret et al. (1988), MacElroy and Winterbottom (2000) and ICPI (2008), emphasize the ease of maintenance and repair of the waterproofing system as an advantage of the utilization of the pedestal system in relation to other methods. The ICPI (2008) adds that after repairs, the components can be reinstalled without evidence of movement and that the replacement of the paving slabs, when damaged, is made easier. Hunderman and Gerns (ca.,2000) highlight that, additionally, there is simplicity in the maintenance of the drainage system.

The Digest 75 (CBD,1966) had already stated that the plenum formed with the use of pedestal systems can have enough space to allow maintenance works, without disturbing the surfacing. The waterproofing ease of maintenance was also an argument so that the Headquarters - Department of the Army (1993), recommended the application of pedestal systems in plazas.

Reroofing is an operation that causes inconveniences. Comparatively, rewaterproofing is an economic disaster, because a waterproofing membrane is far less accessible than a roof membrane (Griffin and Fricklas 1996). The research made by Bernardes and Barros (2009) identified that in one of the buildings the expense with the repair of an earth-covered membrane was around seven times the initial cost of waterproofing.

Upon the potential maintenance costs with the application of adhered surfacing, it is evident the importance of more and more using the concept of maintainability applied to the parts of the building, so that the investment in maintenances are rationalized and the life-cycle cost (LCC) is reduced, even if it results in higher initial costs. As stated by Dunston and Williamson (1999), designers must be able to demonstrate that cost increments in the design stage and construction, due to designing for maintainability, can be offset by reduced maintenance costs.

### 3.3 Obsolescence

Another favourable aspect for the reduction of a building LCC by the application of the pedestal system is the possibility to use the drainage void space for placing several building installations systems, e.g., fire extinction hydraulic systems, garden faucets, lighting circuits (fig.4), rain water pipe deviations in apartment rooftop, among others installations that are still to come. This benefit, resulting from the use of the pedestal system, allows higher flexibility in the use of spaces, then reducing the risk of buildings functional obsolescence (Bernardes 2009).



*Fig.4 – Installation embedded in the drainage void area of a pedestal system in a commercial building in the City of São Paulo (Bernardes 2009).*

As stated by Allehaux and Tessier (2002), when the capacity to perform the function to which an element was conceived for is reduced, such element turns to be functionally obsolete. They also add that in office buildings the greatest causes for this occurrence are related to building services and especially to technical installations design. For them, besides reducing the market value of the office buildings, the functional obsolescence of these systems is considered one of the main causes of their obsolescence. For the evaluation of this type of obsolescence, the authors identified several aspects, among them the compliance with user's needs, flexibility and maintainability.

It is added that a part of a building, when considered functionally obsolete, will have achieved the end of its service life and, from then on, it will have to rely on an onerous modernization process in order to return to its functionality. This process, many times, implies the replacement of materials and components and their final disposal counts on desirable and increasingly environmental restrictions.

In the initial brief to designers, building owners should prioritize systems that benefit the maintainability while reducing the potential of the building functional obsolescence, which is recognized with the utilization of the pedestal system, able to foster higher adaptability to the roof terrace/plaza decks and to the building installations placed in the drainage void, meeting the changes in user's needs.

#### **4. Life-Cycle Cost (LCC)**

According to Lounis et al. (1998), life cycle cost (LCC) analysis is “a method of assessing the economic performance of a project or project alternatives over a designated study period, and encompasses all relevant costs including the costs of designing, purchasing/leasing,

constructing/installing, operating, maintaining, repairing, replacing, and disposing of a particular building or system”, at the end of its life. In addition, Wang N, et al (2009) state that the life cycle assessment is the best way to merge the long-term environmental and economical evaluations of building designs.

As stated by Griffin and Fricklas (1996), although the pedestal system has a more complex design and execution, and probably presents higher initial cost, it allows easier access for maintenance and repair of subsurface components. As a result, there is the possibility to reduce the building operational cost making the system economically more attractive.

The WBDG (2007) helps the evaluation of the importance to reduce a building operational cost when it states that, viewed over a 30-year period, the operation and maintenance costs account for approximately three times the initial building costs (earlier design, development, construction, and manufacturing activities).

According to the BRE (2000)<sup>1</sup> apud Chew et al. (2004), the LCC concept must take into account other factors such as: the life expectancy of a building component and energy efficiency. Regarding the energy efficiency concept, Gomes (1968) emphasized that the use of the pedestal system is recommended in a roof terrace when the aim is to enhance its thermal performance, because this system provides shade and a ventilated plenum above the waterproofing, which minimizes its superficial temperature. For the author, the action of the solar radiation over the roof terrace is reduced by the insulation provided by the ventilated plenum of the pedestal system. As a result, the cooling costs of the building are believed to be lower.

As stated by Bernardes (2009), the initial cost of a pedestal system in Brazil, if compared to adhered surfacing alternatives of roof terraces and plazas, is normally superior for a same type of surfacing material. However, for the author, a lower whole life cost is to be expected to the pedestal system solution when taking into account the expenses with repair and replacement of the waterproofing layer, which occurs with no damage to the wearing surface.

Bernardes (2009), supported by the concepts of ABNT NBR 15575 (2008), suggests, to the typical Brazilian utilizations of the pedestal system, a minimum design life of 20 years for the paving slabs, stating that there would be technical and economic possibilities of estimating 40 years, according to experiences reported in other countries. This minimum period suggested aimed to discipline the commercialization of the system in Brazil, due to the absence of codes of practice, standards and technical regulations, without forgetting the autonomy and obligation of the building owner for deciding on the amount of money that can be spent and the length of life required for a building in the early stages of any building program (Chew et al. 2004).

---

<sup>1</sup> Building Research Establishment (BRE). (2000) “Centre for whole life performance” October 2000, <[http://www.bre.co.uk/whole\\_life/buildingfabric/](http://www.bre.co.uk/whole_life/buildingfabric/)>.

## 5. Conclusions

The study has identified the main functional characteristics of a pedestal system that favours the whole life cost reduction of a building. Emphasis is given to the rationalization of the maintenance process of paving layers and of subsurface installations (maintainability); the adaptability provided to the external spaces upon the user needs alterations, reducing the building functional obsolescence potential; the reduction of operational costs given by the thermal insulation provided; and the increase of service life expectancy of the several elements of the roof terrace/plaza systems, mostly the waterproofing layer. Such issues must be incorporated to the owners' expectations regarding buildings, maximizing investments in a long-term point of view, while reducing the use of other resources, non-renewable and increasingly depleted.

## References

- Allehaux, D., and Tessier, P. (2002). "Evaluation of the functional obsolescence of building services in European office buildings" *Energy and Building*, 34, 127-133.
- American Society for Testing and Materials (ASTM). (2005). "Standard guide for design of built-up bituminous membrane waterproofing systems for building decks." ASTM C 981, Pennsylvania.
- Assaf, B.S., Al-Hammad, A.M., and Al-Shihah, M. (1996). "Effects of faulty design construction on building maintenance." *J. Performance of Constructed facilities*, 10(4), 171-174.
- Associação Brasileira de Normas Técnicas (ABNT). NBR 15575 – edifícios habitacionais de até cinco pavimentos - desempenho. Parte 1-6. Rio de Janeiro, 2008. 251p.
- Association Française de Normalisation (AFNOR). (2001). "Travaux d'étanchéité des toitures-terrasses avec éléments porteurs en maçonnerie - partie 1: cahier des clauses techniques." AFNOR NF P 84-204-1 (D.T.U. 43.1), Paris.
- Barret, J., Bertholon, P., and Marié, X. (1988). *Terrasses Jardins*, Syros Alternatives, Paris.
- Bernardes, M. (2009). "Tecnologia construtiva de piso elevado para áreas externas de edifícios." MS Thesis, The Univ. of São Paulo, Brazil.
- Bernardes, M., and Barros, M. M. S. B. (2009). "Tecnologia construtiva de piso elevado para áreas externas de edifícios." *Boletim técnico PCC 534*, The Univ. of São Paulo, Brazil.
- Canadian Building Digest (CBD). (1966). "Roof terraces." CBD 75, Division of Building Research – National Research Council, Ottawa.

Centre Scientifique et Technique de la Construction (CSTC). (1985). “Les Balcons-Terrasses: Exigences relatives au support et à l’étanchéité – Règles de pose des carrelages et dallages.”, Bruxelles.

Chew, M.Y.L., Tan, S.S., and Kang, K.H. (2004). “Building maintainability – Review of state of the art.” *J. Archit. Eng.*, 10(3), 80-87.

Dunston, P.S., and Williamson, C.E. (1999). “Incorporating maintainability in constructability review process.” *J. Management in Engineering*. 15 (5), 56-60.

Gomes, R.J. (1968). “Coberturas em terraço.”, Informação técnica – Edifícios – ITE 01 - Laboratório Nacional de Engenharia Civil - LNEC, Lisboa.

Griffin, C.W., and Fricklas, R.L. (1996). *Manual of low-slope roof systems*. 3rd edition, McGraw-Hill, New York.

Headquarters, Department of the army, Technical Manual TM 5-805-14 – Roofing and Waterproofing, May 1993. (available online <http://www.usace.army.mil/publications/armytm/tm5-805-14/entire.pdf>. [accessed on 02/05/2008]).

Hunderman, H., Gerns, E. Renovation of the roof terrace plaza at the Kennedy Center for the performing arts. (available online <http://www.unesco.org/archi2000/pdf/gerns.pdf>. [accessed on 06/05/2008]).

Interlocking Concrete Pavement Institute (ICPI). (2002). “Concrete paving units for roof decks.” ICPI Tech Spec 14, revised in April 2008. (available online <http://www.icpi.org/techspecs/index.cfm?id=33&tech=14> [accessed on 02/05/2008]).

Les Cahiers Techniques du Bâtiment (2007). “Couverture: les protections de terrasses accessibles.” 272, 69-73.

Lounis, Z., et al. (1998). “Towards Standardization of Service Life Prediction of Roofing embranes” roofing Research and Standards Development: 4th. Volume, ASTM STP 1349, T. J. Wallace and W.J. Rossiter, Jr., Eds., American Society for Testing and Materials.

MacElroy, W.P., and Winterbottom, D. (2000). “Up on a pedestal.” *Landscape Archit.*, 79, 66-69 and 78-80.

Ruggiero, S.S., and Rutila, D.A. (1990). “Principles of design and installation of building deck waterproofing.” In: *Building deck waterproofing*. Laura E. Gish - Philadelphia. ASTM Special Technical Publication: 1084, 5-28.

Schild, E. et al. (1978). *Structural failure in residential building: flat roofs, roof terraces, balconies*, Crosby Lockwood Staples Frogmore, London.

Silva, N., et al. (2004). “Improving the maintainability of buildings in Singapore”. *Building and Environment*. 39, 1243-1251.

Wang, N., Chang, Y.C., and Nunn, C. “Lifecycle assessment for sustainable design options of a commercial building in Shanghai.” *Build. Environ.* (2010), in press, doi:10.1016/j.buildenv.2009.12.004

Wong, N.H., et al. (2003). “Life cycle cost analysis of rooftop gardens in Singapore”. *Building and Environment*. 38, 499-509.

Whole Building Design Guide (WBDG) - National Institute of Building Sciences - (1996) “Sustainable building technical manual - Green Building Design, Construction, and Operations” (available online <http://www.wbdg.org/design/lcca.php?print=1> [accessed on 05/05/2010]).

# Facilities Management for Building Maintainability: A Research Framework

**Wai Kin Lau**

Department of Real Estate and Construction, The University of Hong Kong  
h0519518@graduate.hku.hk

**Daniel Chi Wing Ho**

Department of Real Estate and Construction, The University of Hong Kong  
danielho@hkucc.hku.hk

## Abstract

Building maintenance is a necessary evil in organisations with built assets. It can only be ameliorated, but not eliminated. Even so, more maintenance is anticipated for there is an ageing trend among built facilities. To tackle challenges ahead, building maintainability provides a way out. It is a concept where ease of maintenance is emphasised, however, it is understudied and inadequately considered from Facilities Management (FM) perspectives. The aim of this paper is therefore to review literature to identify research gaps and consult areas in FM to gain insights to improve building maintainability. A research framework of managing for maintainability is proposed in the end.

Literature in building maintenance, building maintainability and FM is systematically reviewed. It has long perceived maintainability of buildings as an inherited characteristic of design and installation and some works have been done to improve it through design. Managerial aspects to achieve building maintainability are, however, generally ignored. The author thereby identifies managing for building maintainability to be the focus in this paper as well as in subsequent studies. Benchmarking, financial management, information management and outsourcing in FM are inquired to see if they offer any opportunities to improve maintainability. Questions are raised in each area that founded the basis of the research framework. They remain unanswered in this paper. As stated in its sister paper, studies in building maintainability are scattered. Managing for maintainability is an area that has not been considered. This paper will fill the research gap in managing for maintainability and contribute to the body of knowledge by considering building maintainability from FM perspectives.

**Keywords:** Benchmarking, Building Maintainability, Financial Management, Information Management, Outsourcing

## 1. Introduction

Building maintenance to some extent is a necessary evil for organisations holding built assets can never get rid of it. One may save a dollar from building maintenance today but it is merely false economy and it can build disastrous consequences. Moreover, the ageing trend of built assets becomes more apparent which means there will be greater needs to maintain in the future. Durability and maintainability, in this sense, are the way outs that may help maintenance, however, designing for a hundred per cent maintenance-free (i.e. perfectly durable) facility is technologically and economically inviable. In this regard, planning, designing and managing for maintainability should be studied to see if there is any scope for reducing costs, enhancing efficiency and improving facilities performance in maintenance. This paper will review literature in building maintainability to identify any gaps from earlier works. Meanwhile, novelties in Facilities Management (FM) are consulted to see if they can give a hand to improve building maintainability. A research framework of managing for maintainability in FM will then be developed. It serves a supplement to the framework developed in a sister paper (Lau and Ho, 2010) where building maintenance management and sustainable development are accentuated.

## 2. Defining Building Maintenance, Building Maintainability and Facilities Management

### 2.1 Building Maintenance

What is maintenance? An answer is provided in the *Oxford Dictionary of English*, that is, “the process of keeping something in good condition”. Building maintenance, more specifically, is defined as “a combination of any actions carried out to retain an item in, or restore it to an acceptable condition” (BS3811:1984). Distinct from the BSI’s definition, the one by the Committee on Building Maintenance included improvement works (DoE, 1972) and CIOB (1990) further explained what constituted “an agreed standard”. Wood (2009) proposed a simpler but more inclusive definition that founded on antecedent definitions. In sum, building maintenance in a broad sense includes daily and routine cleaning, renovation, refurbishment, etc. Along with building maintainability, definitions of the two are provided in Figure 1.

### 2.2 Building Maintainability

In engineering, maintainability is defined as “a characteristic of equipment design and installation expressed in terms of ease and economy of maintenance, availability of the equipment, safety and accuracy in the performance of maintenance actions” (Blanchard and Lowery, 1969; pp1). Maintainability as inherited design characteristic is a deep-rooted thought, and this has been further reiterated in later studies (e.g. Dhillon, 1999). Maintainability may



also be expressed as a probability that an item will be retained in or restored to a specific condition within a given period of time (BS3811:1993; US Department of Defence, 1981), or maintenance will not exceed certain times or maintenance cost will not exceed certain dollars in a given period (Blanchard, Verma and Peterson, 1995), given prescribed procedures are followed.

Contrary to the gradual development in engineering, building maintainability has attracted little attention and a generic definition is absent. Feldman (1975, pp1), who contributed the first study in building design for maintainability, defined it as “the condition of an item or a surface that permits its repair, adjustment or cleaning with reasonable effort and cost”. Not until 25 years later did the subject catch eyes of researchers in Singapore who then defined it as “achieving the optimum performance through the building life span within a minimum life cycle cost” (Chew and De Silva, 2003). In a recent study by Ikpo (2009) who sought to analyse maintainability of public buildings in Nigeria, Smith (1981)’s definition was adopted, that is, “the probability that a failed item will be restored to operational effectiveness with a given period of time when the repair action is performed in accordance with prescribed procedures” (pp19).

With the deep-seated view of maintainability as an inherited design and installation characteristic, the significance of managerial devices towards maintainability is not appreciated. The author thereby defines building maintainability as “features and/or measures that expedite maintenance, leading to improved maintenance efficiency, augmented building performance and best value outcomes.” In a maintainable building, on one hand, fewer resources (i.e. the input) are required to maintain it to an agreed standard, leading to reduced maintenance costs, less required manpower, etc. On the other hand, augmented building performance such as shorter downtime can be achieved (i.e. the output). For the sake of filling the research gap, managing for building maintainability will be focused in this paper.

### **2.3 Facilities Management (FM)**

As a novel discipline that has been developed quickly in recent years, FM is “a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, processes and technology” (IFMA, 2010). FM is evolved from conventional estates and property management and now is a comprehensive management approach that comprised of three aspects, viz FM for business management, FM for management and control and FM for operation and daily works (JFMA, 2006). In other words, a qualified facility manager should be competent in areas such as Corporate Real Estate, Project and Contract Management, Maintenance and Operations, etc (HKIFM, 2010) (Fig 2).

Charged with missions to provide competitive advantage to an organisation’s core business and to achieve best value, FM as a means to better management of facilities reduces costs, improves flexibility, enables delivery of effective and responsive services and creates a better environment (Keith, 1996; Atkin and Brooks, 2009). With FM, shortcomings in current

management can be identified and subsequently rectified to improve efficiency. FM and building maintainability in this sense share similar philosophy – building maintainability is achieved through reformed processes where efficiency is improved, that is, fewer inputs are required to give an even better outcome. So there is no ground not to learn from FM and apply FM principles and processes to improve building maintainability.

### 3. Literature Review

#### 3.1 Building Maintainability – An Overview

The story of Cinderella and the “Little Match Girl” probably represented the respective fate of building maintenance and building maintainability. When Cinderella married the Prince and lived happily ever – “All’s well that ends well”, the “Little Match Girl” finally saw her grandmother and passed away on New Year’s Day. Almost like the “Little Match Girl”, so far building maintainability has been disregarded in its short life.

Building maintainability was born to tackle maintenance problems stemmed from design, and the provision of adequate access was an essential contributor to maintainable building design (Feldman, 1975). Subsequent research in the subject has, however, experienced two decades of glacial period until its importance to attain greater productivity was realised in Singapore (Construction 21 Steering Committee, 1999). Gaining knowledge and benchmarking maintainability were identified as prioritised issues (De Silva et al., 2004). Defects in wet areas and façade were analysed afterwards, with design, materials, construction and maintenance identified as maintainability significant factors (Chew and De Silva, 2003; Chew and Tan, 2004; Chew, Tan and Kang, 2005). Underpinned by research findings, grading systems were developed to predict maintainability and thus assist decision-making (Chew, De Silva and Tan, 2004a; 2004b). Not only Singapore but building maintainability has also attracted attention in Nigeria where maintainability analysis of public buildings at the design phase may make mandatory (Ikpo, 2009). When achieving optimum performance and minimum life cycle cost are targeted at in the Singaporean researches, repair time is concerned in Nigeria. Accessibility, maintenance manuals, available technology, economic index and reliability are five identified facets that may affect Mean Time to Repair (MTTR) in the proposed maintainability evaluation framework. Apart from building design and benchmarking, the planning and design processes should be reviewed for they largely influence building design and hence maintainability. When buildings were designed, maintenance related factors were inadequately considered (Arditi and Nawakorwit, 1999). With a view to learn from past successful projects to reduce total project cost, Dunston and Williamson (1999) proposed to integrate maintainability into Constructability Review Process (CRP). Similar work was done by Meier and Russell (2000) who developed a model process to implement maintainability with corporate-level programme as the start. Regardless of previous works on building maintainability, managerial aspects in maintainability have not been investigated.

### 3.2 Maintenance Management and Building Maintainability

In one of his famous quotes, Thomas Edison (1847-1931) said, “Genius is one percent inspiration, ninety-nine percent perspiration.” By the same token, buildings can hardly be maintainable unless they are managed and maintained in a maintainable way. To quest for more effective maintenance management for maintainability, issues including maintenance standard, maintenance resources and maintenance strategies should be examined and some works have been done in a sister paper (Lau and Ho, 2010). In summary, setting maintenance standard involves multi-criteria decision making and it suffers from the inability to justify. Although a framework was proposed by Then (1996) to help describing the standards, maintainability was not addressed in his model. What we need is a model that can expedite and justify the setting such that an optimal standard is specified. Much the same problem of unjustifiable decision does occur in planning and assigning resources to maintenance activities (Then, 1996; Van Winden and Dekker, 1998), where complains against inadequate maintenance resources are constantly made (DES, 1985; SCALA, 1993; Shen, 1997). Such misallocation may also be caused by the discrepancies in maintenance between strategic and operational level (Lee and Scott, 2009), or alternatively, between employers and consultants. What we need is a mechanism that enables timely acquisition as well as optimal allocation of resources. Notwithstanding various maintenance strategies are available and innovations such as planned preventive maintenance (PPM) and Just-in-time (JIT) maintenance are seen, little knowledge is in what strategy suits which maintenance works most. What we need to know is the appropriate strategy for a particular type of tasks that results in a maintainable outcome. Further to effective maintenance management, it is believed that novelties in FM can greatly facilitate maintenance and achieve maintainability. These novelties will be examined in the following paragraphs.

## 4. Facilities Management and Building Maintainability

### 4.1 Benchmarking

As a tool to identify and gain insight from industry best practices, benchmarking is a continuous, systematic process of measuring and comparing against external organisations (i.e. competitors) that leads to improvements or even superior performance (Atkin and Brooks, 2009; Camp, 1989; Langston and Lauge-Kristensen, 2002). It is in general a simple process that comprises of following steps which roughly follow Deming’s PDCA process – (1) identify subject (2) plan study – what and who to measure (3) collect information (4) analyse findings and determine gap (5) set goals for improvement (6) implement new order (7) monitor the process for improvement (Atkin and Brooks, 2009; Watson, 2007). Having said that the benchmarking process is uncomplicated, it has to be objective and some expressed concerns about the confidentiality and secrecy between competitors in benchmarking (Park, 1998; Rondeau, 2001). If benchmarking is absent, performance monitoring and then improved efficiency, quality and economic return will otherwise become impossible.

With benchmarking, building maintainability can be ameliorated for it exams and unearths facts about present maintenance processes. On one hand, it assists facility managers who may make reference to findings from benchmarking in planning maintenance. On the other hand, the current best practices in maintenance can be recognised. Thorough examination in the grounds leading to superior performance is however needed before learning and adapting. Because former works in Singapore and Nigeria centred on building designs and pre-occupancy stages when they appraise maintainability, the effects of management are not reflected in their models. In this regard, the author seeks to use benchmark to compare and identify measures in management that will lead to the most maintainable outcomes.

## 4.2 Financial Management

Getting the job done is purely a fantasy if organisational activities are not supported by necessary financial resources. In FM, financial management plays a vital role not only in supporting but also in achieving outcomes that are best value for money. It is regarded by Langston (2003) as a critical ingredient in the effective deployment and operation of facilities for it plans, forecasts, budgets and controls financial resources to ensure they are used wisely. As one of the business units, facility managers in the FM department nowadays may need to prepare budget for new initiatives and routine activities for approval. When managing for building maintainability is concerned, a closer look at financial management of operational budgets is needed.

In literature, insufficient funds for maintenance have been well documented. In addition to the inability to justify the budget and the existence of strategic-operational gap, budget cuts are other problems facing facility managers. Built asset and organisational performance will definitely be affected unless the inadequacy problem is alleviated. Meanwhile, building maintainability can hardly be improved if this problem persists. At the strategic level, changes in mindset that maintenance is an unwelcome cost burden to a value adding process are essential (Jones and Sharp, 2007). Whilst at the operational level, historical data, together with financial and ICT tools, should be better utilised to budget maintenance. Through benchmarking, financial implications of maintenance decisions can be monitored and compared. As a result of these moves, senior management can make certain of the financial position of maintenance and their implications in organisational performance. Further to planning, budgeting and benchmarking, new initiatives in finance should be introduced, for instance, provision of contingencies and sinking funds to set aside respective financial resources for unexpected events and anticipated spending in long-run. All in all, a mechanism that allows timely acquisition and prudent management of financial resources for maintenance is needed.

### 4.3 Information Management

Thanks to the rapid development of Information Technology (IT) in recent years, excellent opportunities are now offered to organisations to better manage information and create knowledge. As “knowledge is power”, effective use of information merits maximised profit, improved quality, reduced cost and minimised uncertainty when an organisation works towards identified goals (Langston and Lauge-Kristensen, 2002). For information management to thrive, information gathered must be relevant, up-to-date and detailed enough. They have to be monitored, interpreted and updated to support decisions and operations to yield optimised performance. While at the same time, computer-based system should be used to facilitate the process. Exchange of information among different applications and between specific facilities is essential, and the Internet provides a perfect communication channel that makes centralised control possible. Underpinned by technological breakthroughs, the next question is how they can help maintenance. Quoting Smith (2003, pp105)’s word, it is about “how, why, where and when technology augments the function or actions of FM to create knowledge.” In the following, several ways in information management that may help achieving maintainability are suggested for discussion.

To begin with, Building Information Modelling (BIM) which is a process that models building life cycle may ease maintenance planning. As BIM builds on historical data and both physical and operational attributes, maintenance information in different stages such as maintenance and repair cycles can be simulated, given maintenance-related information is incorporated in the model. Next, Computer-aided Facilities Management (CAFM) may enhance diagnosability of facilities. In conjunction with sensors connecting to building management systems, real-time monitoring of facility performance becomes possible, and hence faults are easier to detect. It greatly helps facility managers to identify and diagnose failures so as to take proper remedial actions promptly. In the meantime, CAFM tools manage maintenance works schedules, prioritise activities and resolve budget reconciliation (Smith, 2003). In the course of these processes, information generated may serve as reference to later maintenance and future improvements. Building maintenance as a result is better managed and maintenance processes are expedited. In other respect, advances in telecommunication technology also contribute to improve building maintainability. For example, users in an organisation may place maintenance orders over the Internet and maintenance operations may be facilitated through the use of RFID.

### 4.4 Outsourcing; Issues in Procurement

Outsourcing, as defined by Domberger (2002), is “the process whereby activities traditionally carried out internally are contracted out to external providers” (pp12). It is a hot topic in both management and FM where organisations “outsource” non-core services and concentrate on their core business. By outsourcing non-core services, organisations may reap fruit in specialisation, market discipline, flexibility and cost savings, however, costs in transaction, monitoring and control are incurred (Domberger, 2002). Organisations must be aware of the drawbacks when they decide to outsource services for outsourcing may not always result in a

better outcome. As far as achieving building maintainability is concerned, it is not about choosing between retaining maintenance services in-house or outsourcing them but how the decision affects maintenance performance and thus maintainability.

If an organisation chooses to outsource certain activities, procuring services from external service providers will be the next step. In the process of procurement, tender documentations and tendering processes are the two key activities involved. For the sake of achieving maintainability, here comes a few issues. First, what type of contract should be used for a particular maintenance activity? Second, comparing with traditional procurement how does partnering and alliance affect maintainability? Apart from procurement, Service Level Agreement (SLA) which is a statement of intentions set out by the customer is often in place to specify the level of service to be provided (Atkin and Brooks, 2009). In setting SLA, nevertheless, it may encounter similar problems that happen in describing maintenance standard. With regard to building maintainability, we need the SLA to be self-justifiable and reflect the interests of stakeholders to make sure an appropriate level of service is maintained.

Other than the earlier mentioned fields in FM, areas such as Conflict Management, Contingency Planning and Disaster Recovery, Human Resource Management and Space Management may be essential to building maintainability. Notwithstanding that they are not addressed in this paper, it is hoped that later studies will cover these areas.

## 5. The Research Framework

As a matter of fact, building maintenance is mostly undertaken when buildings have been occupied. In other words, advance planning for future maintenance is generally absent. As for building maintainability where ease of maintenance is emphasised, there is a deep-rooted thought of building maintainability as an inherited characteristic of design and installation. As a result, endeavours throughout the years were to design for maintainability whilst managerial aspects for improving maintainability have left unattended. In this connection, building maintainability is redefined as “features and/or measures that expedite maintenance, leading to improved maintenance efficiency, augmented building performance and best value outcome”, and managing for building maintainability will be highlighted to fill the current research gap.

As a novel discipline that has developed rapidly in recent years, the philosophy of FM is somehow similar to building maintainability. By integrating 3Ps to provide competitive advantage and achieve best value outcome, FM pursues cost reduction, efficiency and a better environment. That is exactly the target of building maintainability and therefore experience is gained from some aspects in FM.

Benchmarking, which is a systematic process to measure and compare performance against competitors, is fundamental to achieve building maintainability. With benchmarking, performance of maintenance processes can be evaluated objectively to identify any shortcomings in current arrangement. What we need to know is (1) what are the key

maintainability indicators? (2) how can they be measured? (3) why they behave like that? and (4) what are the good practices in maintenance that leads to enhanced maintainability?

Financial management, which is a process to plan, forecast, budget and control financial resources to achieve best value outcomes, is of vital importance to the effective deployment and operation of facilities. In managing financial resources for maintenance, insufficient funds for maintenance, inability to justify the budget proposal, existence of strategic-operational gap and budget cuts are the challenges that have been well documented. What we need to know is (1) how do those best-of-breed arrange finance for maintenance? (2) how do new initiatives in finance (e.g. sinking fund) influence building maintainability? and (3) how to devise a method that enables timely acquisition and prudent management of financial resources for maintenance?

Information management, which facilitates the use, process and management of information, can reduce cost, improve quality and reduce uncertainty through the use of computer-based systems. Breakthroughs in telecommunication have also promoted exchange of information and control at distance. What we need to know is (1) how BIM may help in planning maintenance for better maintainability? (2) what are the benefits of maintenance in CAFM and how they are reflected in maintainability benchmarks? and (3) how do maintenance profiles and maintenance manuals help maintainability?

Outsourcing, which is a process to contract out non-core services to external service providers, allows organisations to focus on their core business and reap fruits from services provided by third parties who have comparative advantages in their service. We would like to know the difference in maintainability if similar maintenance works are undertaken separately by in-house staffs and contractors. Procurement is the next step if an organisation decides to outsource certain services. In respect of building maintainability, we need to know (1) what type of contract should be used for better maintainability? and (2) what are the effects of partnering and alliance upon maintainability? In Figure 3, a diagram summarising the proposed research framework of managing for building maintainability is provided.

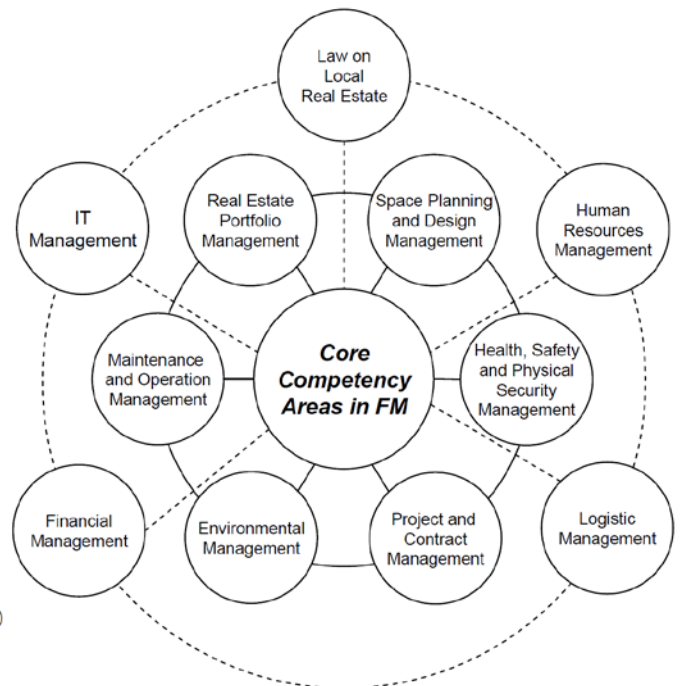
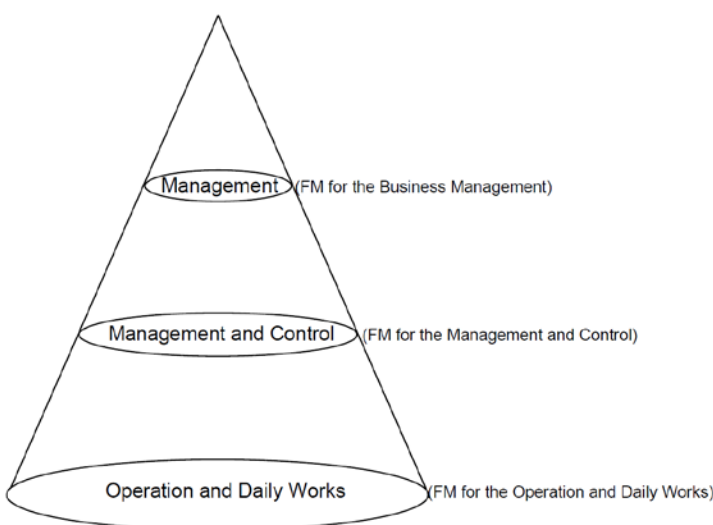
## 6. Conclusion

Building maintenance is no longer a necessary evil if organisations make use of it to improve facility performance and add value – building maintenance is indeed an angel. What is more, facility managers have to get ready for the growing maintenance demand associated with the ageing trend among built assets. Improving building maintainability for these reasons is of critical importance. In the old days, the maintainability concept has long been regarded as an inherited design characteristic and hence managerial aspects in maintainability are neglected. In connection with that, building maintainability is redefined and managing for maintainability is scrutinised.

On account of the philosophy behind managing for building maintainability and FM, four areas in FM are consulted. Benchmarking is an essential tool to improve building maintainability as it measures maintenance performance. More specifically, it serves as the foundation to compare and identify measures in management that result in more maintainable outcomes, and vice versa. Financial management is at the heart of achieving outcomes that are best value for money. Effective maintenance is sometimes, however, restrained by insufficient funds and even budget cuts. We need to figure out a method that enables timely acquisition and prudent management of financial resources for maintenance. Information management is an innovation that management and exchange of information are made easy. Use of computer-based systems in maintenance processes nowadays is more common. We need to go further to see how certain applications in information management may help achieving building maintainability. Outsourcing is the procuring of non-core activities such as maintenance services from contractors, while at the same time organisations can focus on their core business. We need to know how the outsourcing decision affects building maintainability. In the research framework provided, question raised in this paper are consolidated. Answers to these questions are believed to be the clues to manage for maintainability. They will be addressed shortly in subsequent studies.

### 7. Acknowledgement

The author would like to thank the financial support provided by the RICS Education Trust Student Travel Bursary Award and the Committee on Research and Conference Grants (CRGC), HKU, with utmost gratitude.





**Building Maintainability Redefined -**

**Building Maintainability:**

**“features and/or measures that expedite maintenance, leading to improved maintenance efficiency, augmented building performance and best value outcomes”**

**Feldman (1975)**

“...the condition of an item or a surface...permits its repair, adjustment or cleaning with reasonable effort and cost.”

**NUS**

“achieving the optimum performance through the building life span within a minimum life cycle cost”

**Maintainability in Engineering:**

**Blanchard and Lowery (1969)**

“...a characteristic of equipment design and installation expressed in terms of ease and economy of maintenance, availability of the equipment, safety and accuracy...”

**Dhillon (1999)**

“...the measures taken during the development, design and installation of a manufactured product that reduce required maintenance, manhour, tools, logistic cost, skill levels, and facilities, and ensure that produce meets the requirements for its intended use.”

**BS3811:1993; Smith (1981); US DOD (1981)**

“a characteristic of design and installation...expressed as the probability that an item will be retained in or restored to a specified condition within a given period of time, when maintenance is performed in accordance with prescribed procedures and resources.”

any actions limited to all technical and administrative actions; an acceptable condition is a condition that can perform required function

defined scope of works, i.e. every part of the building...the idea of sustaining the value of the facility is introduced

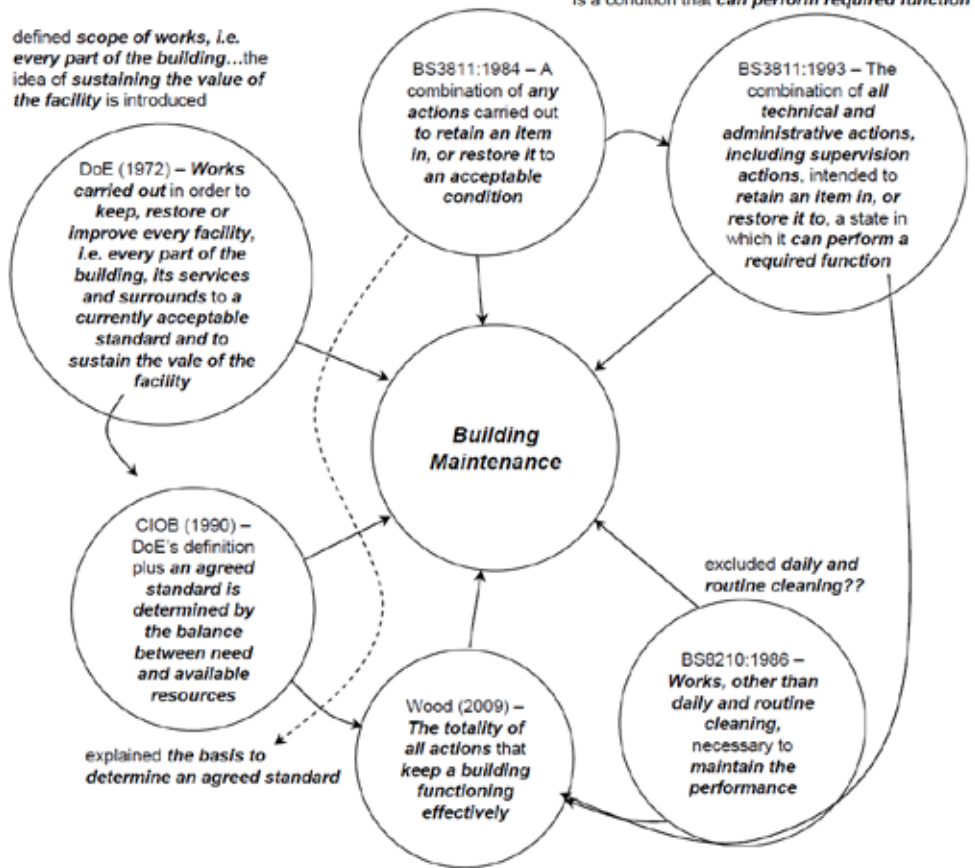


Figure 1: Definitions of building maintenance and building maintainability

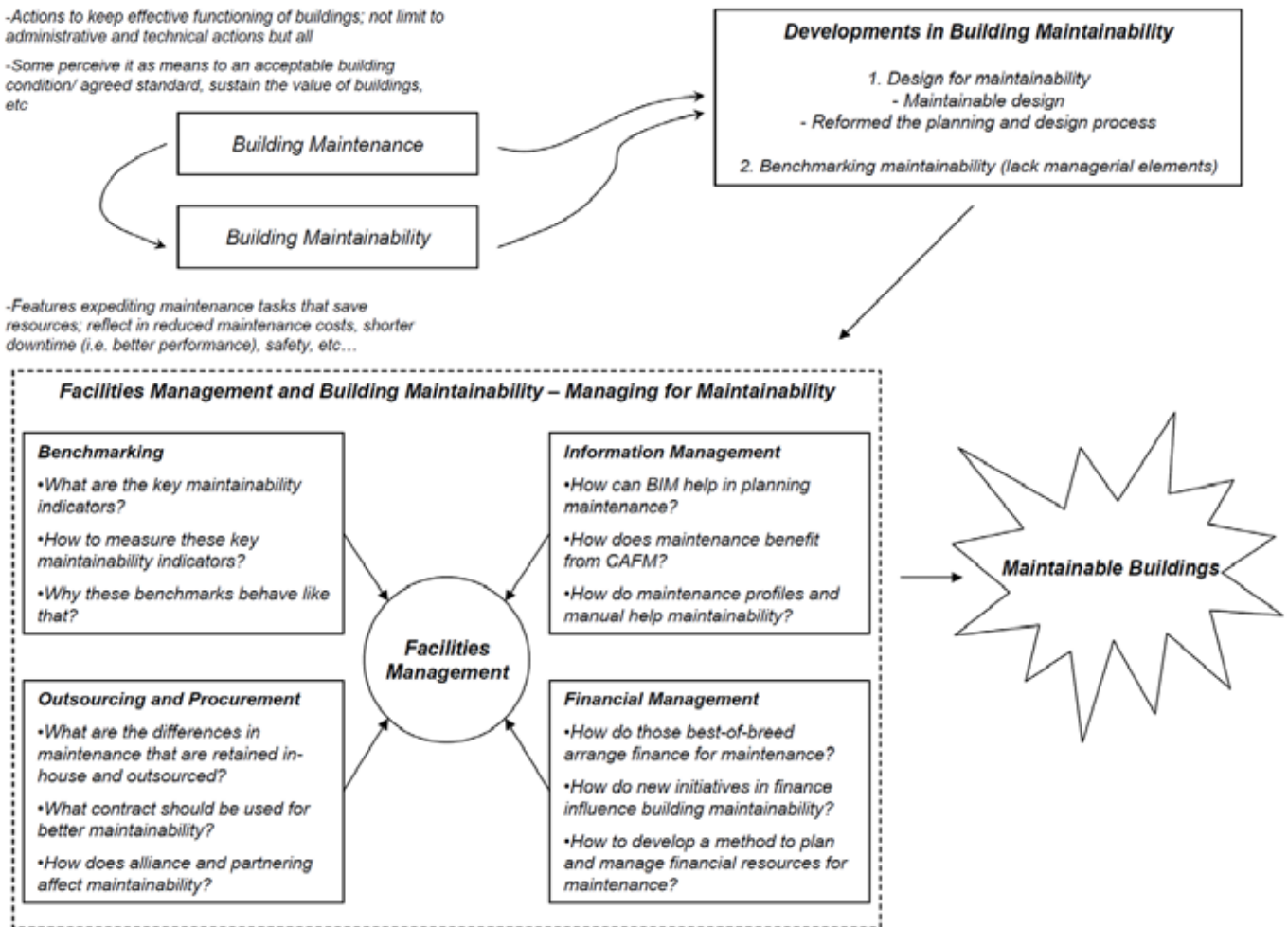


Figure 3: Proposed research framework for managing for maintainability

## References

- Arditi D and Nawakorawit M (1999) "Designing Buildings for Maintenance: Designers' Perspective." *Journal of Management in Engineering* **5**(4): 107-116.
- Atkin B and Brooks A (2009) *Total Facilities Management*, 3rd edition, Chichester, UK, Wiley-Blackwell.
- Blanchard B S and Lowery E E (1969) *Maintainability: Principles and Practices*, New York, McGraw-Hill.
- Blanchard B S, Verma D and Peterson E L (1995) *Maintainability: A Key to Effective Serviceability and Maintenance Management*, New York, Wiley.
- British Standard Institute (1984) *Glossary of Maintenance Management Terms in Terotechnology*, BS 3811, London, HMSO.
- British Standard Institute (1986) *Guide to Building Maintenance Management*, BS 8210, London, BSI.
- British Standard Institute (1993) *Glossary of Terms used in Terotechnology*, BS 3811, Milton Keynes, BSI.
- Camp R C (1989) *Benchmarking: the Search for Industry Best Practices that Lead to Superior Performance*, Milwaukee, Wis, Quality Press.
- Chartered Institute of Building (1990) *Maintenance Management: A Guide to Good Practice*, 3rd edition, Ascot, CIOB.
- Chew M Y L and De Silva N (2003) "Maintainability Problems of Wet Areas in High-rise Residential Buildings." *Building Research and Information* **31**(1): 60-69.
- Chew M Y L, De Silva N and Tan S S (2004a) "Artificial Neural Network Approach for Grading of Maintainability in Wet Areas of High-rise Building." *Architectural Science Review* **47**(1): 27-42.
- Chew M Y L, De Silva N and Tan S S (2004b) "A Neural Network Approach to Assessing Building Façade Maintainability in the Tropics." *Construction Management and Economics* **22**(6): 581-594.
- Chew M Y L and Tan S S (2004) "A Multivariate Approach to Maintenance Prediction of Wet Areas." *Construction Management and Economics* **22**(4): 395-407.

Chew M Y L, Tan S S and Kang K H (2005) "Contribution Analysis of Maintainability Factors for Cladding Facades." *Architectural Science Review* **48**(3): 215-228.

Construction 21 Steering Committee (1999) *Construction 21: Reinventing Construction*, Singapore, Ministry of Manpower and Ministry of National Development, SNP.

Department of Education and Science (DES) (1985) *Maintenance and Renewal in Education Buildings – Needs and Priorities, Architects and Building Group*, Design Note 40, London, Department of Education and Science.

Department of the Environment (1972) *Research and Development Bulletin: Building Maintenance – The Report of the Committee*, London, HMSO.

De Silva N, Dulaimi M F, Ling F Y Y and Ofori G (2004) "Improving the Maintainability of Buildings in Singapore." *Building and Environment* **39**(10): 1243-1251.

Dhillon B S (1999) *Engineering Maintainability: How to Design for Reliability and Easy Maintenance*, Houston, Tex, Gulf Pub. Co.

Domberger S (2002) *The Contracting Organization: A Strategic Guide to Outsourcing*, New York, Oxford University Press.

Dunston P S and Williamson C E (1999) "Incorporating Maintainability in Constructability Review Process." *ASCE Journal of Management in Engineering* **15**(5): 56-59.

Feldman E B (1975) *Building Design for Maintainability*, New York, McGraw-Hill.

HKIFM (2010) 11 Areas of Core Competency, (available online [http://www.hkifm.org.hk/public\\_html/core.html](http://www.hkifm.org.hk/public_html/core.html) [accessed on 15/5/2010])

IFMA (2010) *What is FM*, (available online [http://www.ifma.org/what\\_is\\_fm/index.cfm](http://www.ifma.org/what_is_fm/index.cfm) [accessed on 15/5/2010])

Ikpo I J (2009) "Maintainability Indices for Public Building Design." *Journal of Building Appraisal* **4**(4): 321-327.

JFMA (2006) What is FM? (Available online <http://www.jfma.or.jp/en/whatsFM/index.html> [accessed on 15/5/2010])

Jones K and Sharp M (2007) "A New Performance-based Process Model for Built Asset Maintenance." *Facilities* **25**(13/14): 525-535.

Keith A (1996) *Facilities Management: Theory and Practice*, London, E & FN Spon.

Langston C and Lauge-Kristensen R (2002) *Strategic Management of Built Facilities*, Oxford, UK, Butterworth-Heinemann.

Langston C (2003) "Financial Management", in Best R, Langston C and G de Valence (eds.), *Workplace Strategies and Facilities Management: Building in Value*, Oxford, Butterworth-Heinemann, pp. 164-176.

Lau W K and Ho D C W (2010) "A Theoretical Framework for Building Maintainability Studies", *Proceedings of the First International Conference on Sustainable Urbanization*, 15-17 December 2010, The Hong Kong Polytechnic University, Hong Kong. (under review)

Lee H H Y and Scott D (2009) "Overview of Maintenance Strategy, Acceptable Maintenance Standard and Resources from a Building Maintenance Operation Perspective." *Journal of Building Appraisal* 4(4): 269-278.

Meier J R and Russell J S (2000) "Model Process for Implementing Maintainability." *Journal of Construction Engineering and Management* 126(6): 440-450.

Park A (1998) *Facilities Management: an Explanation*, Basingstoke, Hampshire, Macmillan.

Rondeau E P (2001) "Benchmarking", in Teicholz E (ed.), *Facility Design and Management Handbook*, New York, McGraw-Hill.

SCALA (1993) *Maintenance Expenditure 92*, Society of Chief Architects of Local Authorities, November.

Shen Q (1997) "A Comparative Study of Priority Setting Methods for Planned Maintenance of Public Buildings." *Facilities* 15(12/13):331-339.

Smith D J (1981) *Reliability and Maintainability in Perspective – Technical, Management and Commercial Aspects*, London, Macmillan Press.

Smith S (2003) "Information Management", in Best R, Langston C and G de Valence (eds.), *Workplace Strategies and Facilities Management: Building in Value*, Oxford, Butterworth-Heinemann, pp. 104-127.

Then D S S (1996) "A Conceptual Framework for Describing Built Assets Maintenance Standards." *Facilities* 14(7/8): 12-15.

US Department of Defence (1981) *Definition of Terms for Reliability and Maintainability*, MILSTD-721C, Washington, DC, Department of Defence.

Van Winden C and Dekker R (1998) "Rationalisation of Building Maintenance by Markov Decision Models." *The Journal of the Operational Research Society* 49(9): 928-935.

Watson G H (2007) *Strategic Benchmarking Reloaded with Six Sigma: Improve Your Company's Performance Using Global Best Practice*, Hoboken, N. J., John Wiley & Sons.

Wood B (2009) *Building Maintenance*, UK, Wiley-Blackwell.

# Feedback of architectural projects with base in studies of pathological manifestations in buildings of structural masonry

**Fortes, Ernesto Silva**

UNICV – Universidade de Cabo  
ernestofortes@hotmail.com

**Fontenelle, Maria Aridenise Macena**

UFSCar – Universidade Federal de São Carlos  
aridenise.macena@gmail.com

**Carlino, Alex Elias**

UFSCar – Universidade Federal de São Carlos  
acarlino@ufscar.br

## Abstract

The present work has how I aim to study the pathological demonstrations of the student dwellings of an Institution of Superior Teaching - IST in the city of San Carlos, in the south-east of Brazil, in order to produce subsidies for feedback of the process of project. A bibliographical study carried out on pathologies is in constructions structural masonry. The case study was carried out through documentary analysis, semi-structured questionnaire and photographic registers in six residential buildings of students, in an Institution of Superior Teaching – public IST, built in structural masonry of emptied blocks of concrete with different ages. It happened also glimpsed with the residents and with the engineer who supervises the works of the above-mentioned IST. The bibliographical studies carried out on the pathological demonstrations detach the project how principal cause and the fissures as the fault of bigger incidence in the masonry. The results of the fulfilled case study converge with the result presented in the literature. It was noted that there is a significant potential of improvement in the retro-food of the project from the learnt lessons of maintenance, durability and useful life of this type of construction what it is going to influence considerably the costs of maintenance. The preparation of a manual of the user can contribute also to the most appropriate use of the constructions.

**Keywords:** Projects, durability, pathologies, structural masonry

## 1. Initial Considerations

The engineering came to use the term pathological manifestations to study in the constructions the occurrence of flaws and their defects that alter the balance pre-existing or idealized.

Having knowledge of the Pathology of Buildings is indispensable for everyone who works in construction, ranging from one worker to the engineer and architect. According Verçoza (1991), when known problems or defects that a building can come and present their causes, the chance of making mistakes decreases greatly. The quoted author mentions that this knowledge is even more important as the professional responsibility in the construction / work.

Liechtenstein (1985) considered a problem as any pathological situation in which a building or part thereof during a certain time of their life no longer has the performance for which it was designed. Generally the problem is identified through demonstrations or pathological symptoms as manifested by structural or functional changes in the building or the affected party, represented the warning signs of defects encountered.

As Helene (1992) the pathology can be understood as part of engineering that studies the symptoms, mechanisms, causes and origins of the defects of civil constructions, in other words, is the study of the parts that make up the diagnosis of the problem.

The pathological problems with rare exceptions have external manifestations characteristic, from which we can deduce the nature, origin and mechanisms of phenomena involved, so you can estimate their likely consequences. Regarding the recovery of pathological problems, the author quoted, says that the fixes will be more durable, more effective, easier to perform and much cheaper the earlier they are implemented. As already mentioned by that author a proper diagnosis indicates the stage of origin, since for each source of the problem is a pathological appropriate therapy, even if the phenomenon and the symptoms are the same. She also emphasized that "the identification of the origin of the problem also identified for legal purposes, those who committed the fault. So if the problem originated in the design phase, the designer has failed, when the source is in the quality of the material, the manufacturer missed if in the application stage, it is failure of manpower and supervision or construction were omitted if the stage of use, is the failure of the operation and maintenance. "

Cánovas (1988) argues that conditions in the execution may be a consequence of the pathology of the project, having a close relationship between them, that does not mean that the pathology of the project is null, the implementation would be as well. Not always with quality projects disappear execution errors. These will always exist, although, admittedly, can be minimized if the execution is carried out following a good design and an intense supervision.

Melhado and Agopyan (1995) consider that a project should include information targeted to the specifications of the product to be built, but also on strategic media, physical and technological requirements needed to run their construction process.

For this, they propose that memory is incorporated into a constructive organizational structure of enterprises, containing a collection of technical information and construction details, which will be supplemented until it becomes a source of reference to date and adequate to the needs of businesses.



Seeking to close the information loop, also defend the structure of a bank of information available to designers, feeding the input data for development of new projects, containing prescriptions or recommendations for the specification of materials and services, and alternative types of construction details and others.

The proposal to organize a constructive memory is that memory will be supplemented in addition to registration procedures and technical events that occur during the construction phase also address the operational phase and use the buildings constructed with the record of maintenance work done during the security and data collected by the PDB - Post-Occupancy Evaluation.

With the feedback represented by the information provided by contractors, with the knowledge acquired during the professional activity in the design and development of various projects, the designers begin to depend only on data on projects, from the period after use, when appropriate the solutions adopted and the choices and specifications for materials and components of the building can actually be verified and proven.

A systematic evaluation of the Post-Project can fill the gap, causing designers to focus on within their own perception, also take into account the post-use phase in which issues relating to maintenance are clearly evidenced.

Montero et al. (1999) emphasize the importance of this procedure when they say that as the basis of experience it is recommended that designers in general, they usually lose touch with their works, once opened, conduct periodic visits to completed works, including the recording of data on their performances for statistical purposes in order to feed back processes new building projects.

This database will ensure the constructability of new projects within the process of technological development.

As described by the Construction Industry Institute, constructability is defined as " the optimal use of knowledge of construction techniques and experience in planning, design, procurement and field operation to achieve the overall objectives of the enterprise" (Franco, apud Grilo 1992, 1999).

This definition reinforces the importance of feedback of information between the various actors involved in the initial stages of development, the consolidation of the goals, especially the professionals responsible for design and construction stages (Melhen and Agopyan, 1995, Grilo, 1999).

The pathological manifestation can also be a consequence not only of poor or improper maintenance, but also due to the lack or ambiguity in performance evaluation that focused on this aspect during the project.

## 2. Conceptual Approach

For Souza and Ripper (1998), Pathology of Structures is a new field of Constructions Engineering that deals with the study of the origins, forms of manifestation, consequences and mechanisms of occurrence of failures and the systems of degradation of the structures.

Ioshimoto (1988) classifies pathological manifestations in: moisture, covering displacement, fissures and trines.

For Cavalheiro (1992), there are four reasons for the appearance of defects:

- Technological evolution of materials, construction systems, which make the structure more flexible, enabling the emergence of pathologies due to better absorption performance of movements, without causing collapse;
- Speed of construction, or quality control inadequate or inexistent;
- Poor training of professionals;
- Disability Standards on the subject and also inexistent or inadequate maintenance.

As the concept of costs of external flaws proposed by Hammarlund and Josephson (1992), the causes of the flaws originating from the pathological problems are related to: design, implementation, quality of material and use of building / use (post-use).

The origins of pathological manifestations, according Verçosa (1994), may be awarded in the following order of proportion to these steps:

- Project - 40%
- Implementation - 28%
- Materials - 18%
- Bad Use - 10%
- Bad planning - 4%

Apicer (2000), affirm that due to the large number of solutions at pathological manifestation is warranted to study the behavior of masonry structural and don't structural mechanisms that lead to the emergence of problems pathologies. This enables the best possible diagnosis and the application of these preventive measures, based on scientific knowledge and their solutions for their resolution.

According to Coelho (2008) should identify and distinguish the pathologies inherent in the structural behavior (aspects of design and construction) and pathologies inherent in the behavior of masonry as a material, disease stems from the interaction block - mortar, with emphasis in the mechanism of formation of fissures of thermal origin.

As the same author the masonry walls being one of the most important subsystems present in buildings especially the exterior walls separating the inner and outer means they are targets of little care for the role they play in construction.

Putting this to the lack of tradition in research, teaching and carefully detailing masonry represent a major obstacle, since they are one of the subsystems where there are major discrepancies in performance and therefore pathological manifestations, affirms the referred author.

Hammarlund and Josephson (1992) consider the main aspects that contribute to the origin of pathological problems in masonry as: project, aspects of an economic, quality of materials and work hand and construction practices.

According to Coelho (2008) most of the anomalies observed in the masonry, the result of construction practices that do not meet the uniqueness of this subsystem, not the way to provide interaction between this and the other adjacent subsystems.

As telling examples of these construction practices, refer to the following aspects as Hammarlund and Josephson (1992):

- Connections masonry / structure normally do not exist or are poorly resolved. Often there is no mechanical connection, but did not adopt together;
- In structural terms the influence of the walls is, in general, despised;
- The pavements and concrete structures are often "excessively" crumple to serve as support to masonry walls, although most of the time within the limits laid down regulations for the purpose. The deformation of the support and / or the structural element may produce superior mechanical actions in the masonry walls that may enhance the appearance of cracking;
- Singular points of walls, for example, around openings are usually seen as a current area of cloth or are poorly resolved;
- The finishes are often selected without technical evaluation and applied very quickly;
- The facades are defined by architectural options that normally don't take into account the impact of rainwater, the quality of work hand and the need for durability;
- Speed of execution of the buildings, where construction of masonry walls, follows the pace of evolution similar to the structure.

The pathological manifestations in masonry may result from intrinsic flaws of its constituent materials (blocks or bricks, mortar, adhesives, etc.), in the improper storage of these materials on site (exposure to rain, sunlight or contaminants), failures implementation and design deficiencies.

In terms of pathology, there is as aggravating the fact that problems often interrelate: through fissures, for example, water penetration occurs, causing leakage, efflorescence and / or mildew, which results in movements of hygroscopic materials that turn will incur the formation of new fissures, among others.

The correct diagnosis of the anomalies is the key to the establishment of corresponding preventive measures and the decision on the likely corrective procedures, that at first they will only be efficient in the measure in that if it gets to combat the cause of the problems indeed.

Thomaz (1989) and Helene (1988) consider that in relation pathologies in structural masonry interests to identify and distinguish between pathologies inherent structural behavior (aspects

related to the design / construction) and the behaviour of masonry as a material (depending on the characteristics of materials, construction techniques, the type of section, etc.).

However, the pathologies in structural masonry manifest, usually, as a combination of these aspects, sometimes difficult to assign them a specific origin (Thomaz, 1989).

As those same authors the main pathologies of the masonries, as structural material, frequently link with:

- Low tensile strength;
- Compressive strength very dependent on the volume of voids and in the case of walled compound, the degree of containment of vestments;
- Poor resistance to cutting;
- Mechanisms of brittle fracture.

As Thomaz (1989) and Helene (1988), the pathologies in walls, as a structural element, are related to phenomena of instability, local or global, associated, usually, to:

- Deficient structural integrity (weak connection among structural elements);
- Weak plaster section of wall;
- Excessive slenderness;
- Inadequate bracing;
- Reduced ductility.

Those factors explain because the fissures constitute a quite common pathological state in masonry structures.

According Grimm (1988) the fissures can be considered as more frequent cause of flaw of acting of the masonry. The fissures, however, affect aesthetics, user comfort, the tightness of construction, in other words, the conditions of service no longer met.

Grimm (1988), Page (1993) and Thomaz (1998), ranking the leading causes of fissures in masonry as: external effects, volumetric changes of materials and interaction with other structural elements.

Considering the different mechanical and elastic properties of the constituents of the masonry, and according to the active requests, the fissures may occur in the joints of laying (mortar vertical or horizontal) or section of the masonry components.

As Thomaz (1989) the cracking in walls of structural masonry can be caused by several factors as mentioned above, but the most relevant are the fissures caused by:

- Thermal movements;
- Drive thermal roof slab on the walls;
- Hygroscopic movements;
- Performance of overloads;

- Settlement of foundation;
- Retraction of cement-based products;
- Deformation of reinforced concrete structures.

The study of literature on the pathological manifestations in buildings, masonry bearing walls and provided a better understanding of the subject and base the case study, described below.

### 3. Case Study

This research presents a survey of the pathological manifestations and their causes, held in 2009 in six buildings (housing) of students with three floors of an Institution of Superior Teaching - IST - public in the city of San Carlos.

The case study was conducted through documentary analysis, semi-structured questionnaire and photographic records in six residential buildings for students, an Institution of Superior Teaching - IST public, built in masonry of hollow blocks of concrete and ceramic with different ages. It was also conducted interviews with residents and the engineer who supervises the work of that IST.

During the surveys of the buildings was the observation of pathological problems of construction and the listing of them, taking care to identify flaws that undermine the performance of the buildings studied in what refers to the stability, aesthetics and housing conditions of the same.

#### 3.1 Characterisation of the Buildings

The table 1 summarizes the year of construction, area and building system used in each building for student housing, called this study of building A, B, C, D, E and F.

*Table 1 - Synthesis regarding denomination, year of construction and area of the buildings*

Building	Year Built	Area (m2)	Building System
A	1996	800	Structural masonry with block of covered concrete
B	1997	800	Structural masonry with block of covered concrete
C	1999	846	Structural masonry with block of covered concrete
D	2003	800	Structural masonry with block of covered concrete
E	2008	945	Structural masonry with apparent ceramic block and varnishing
F	2009	900	Structural masonry with apparent ceramic block and varnishing

This table shows a change in the constructive system in structural masonry with concrete block covered for the same system being the apparent ceramic block and varnishing.

### 3.2 Analysis of the Results

The model proposed by Thomaz (1989) used in this study to classify the causes of pathological manifestations during the data collection carried out during August and September 2009 is presented in Table 2.

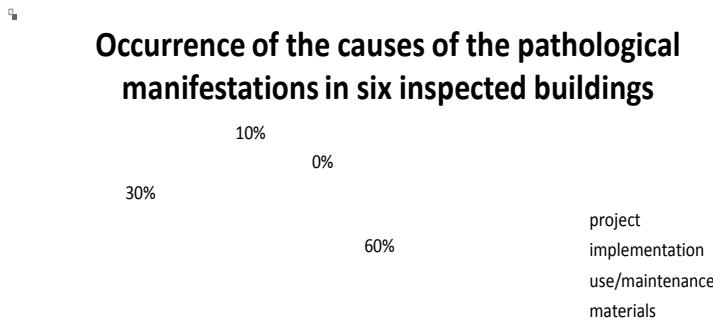
*Table 2 - Pathological manifestations and classification of possible causes in the buildings studied.*

Description of the main problems encountered in the modules	Causes	Modules					
		A	B	C	D	E	F
<b>Roof/ facade</b>							
Sewer vent pipe internal to the attic, without exceeding the roof	E	x		x			
Gutter absence in the roof causing fissures and mold in the inferior part of the facades of the building	P	x	x	x	x		
Absence of drip pan and sill	P	x	x	x	x		
<b>Facades/outdoors</b>							
Fissures in the covering of mortar of the facade walls, causing the block mapping	P	x	x	x	x		
Efflorescence	E					x	
White spot due to poor hydration of lime	E					x	x
Vertical fissures in the cloths of the facade walls, dividing her	P	x		x			
Horizontal fissures in the walls of the facade, located in line with the flagstones cover	P	x	x	x	x		
Posting in the encounter between the walls of the facade and sidewalk (repression)	E		x	x	x		
Horizontal fissures in the area of lintel and sill of the doors and windows	P	x	x	x	x		
Fissures assigned in the facades of the walls close to flagstone, close to the earthy floor and the roof	P	x	x				
Absence of gutter on the roof causing fissures and mold on the bottom of the facades of the building	P	x	x	x	x		
Mold on the stairs caused by exposure to rain and moisture	P	x	x	x	x		
Corrosion of exterior windows	U	x	x	x	x		
Lack of cushion causing possible fissures	P					x	
<b>Apartments / indoor area</b>							
Trim inverted landings (cemented smooth and / or ceramic)	E	x	x	x	x	x	x
Flaws in the grouting and sealing along the drain	E	x	x	x			
Gradual irregularities in coatings for floors and walls	E	x					
Mold on the walls of the bathroom and wardrobe due to moisture	P	x	x		x		
Infiltration of water in the roofs of the kitchen and bathroom	E	x	x		x	x	
Posting of the floor covering ceramic	U		x	x			

Posting paint because of moisture in the bottom of the walls	U			x	x		
Hydraulic installations							
Leak in the siphons of kitchen sinks and bathroom	U			x			
Clogged drains, causing water leakage	E	x	x			x	x
Legend: E - failures from the quality of implementation; P - from failures of design quality; U - failures from use and / or maintenance; M - faults from quality materials;							

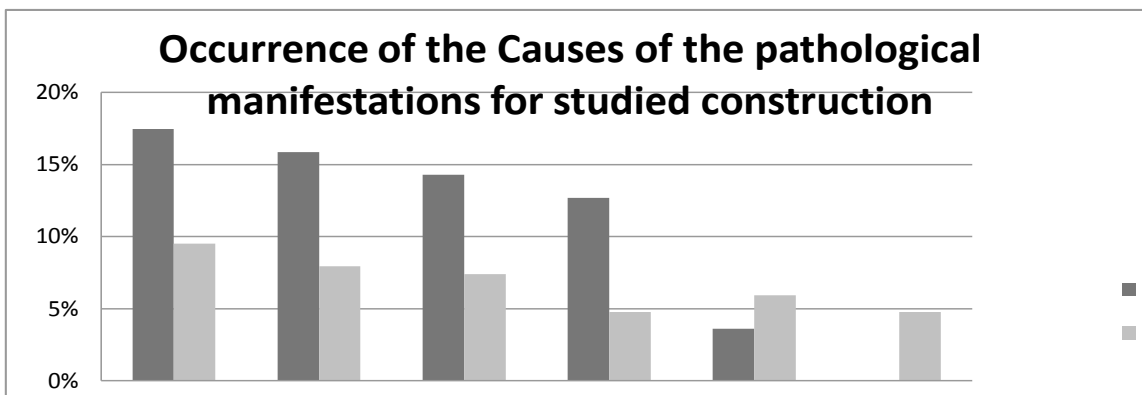
Of pathologies has been listed, as shown in Figure 1, the percentage of occurrences of the causes of the modules in the total surveyed, or how many times the pathological manifestations from design flaws, implementation, use / maintenance and materials occurred in six buildings of the institution.

The Figure 1 shows that most of the causes of pathological manifestations of the buildings studied are from design flaws and implementation.



**Figure 1: Percentage of occurrence of pathological manifestations in six buildings surveyed**

The figure 2 evidence the relationship among the identified pathological manifestations with the constructive system and age of the studied constructions.



**Figure 2: Percentage of occurrence of the causes of pathological manifestations in each building inspected.**

Considering the reduction of pathological manifestations in more recent buildings, it is possible that a relationship exists between the age of the building and the appearance of flaws, as shown in Figure 2.

Trim inverted landings (cemented smooth and / or ceramic) is a pathological manifestation that went into all the buildings studied.

## 4. Final Considerations

The bibliographical studies performed on pathological manifestations highlight the project as the main cause and the fissures as the failure of higher incidence in masonry. The results of case study converge with the results presented in the literature. It fits to stress that the execution was also a significant cause of the occurrences of the identified pathological problems, as mentions the literature Trim inverted landings (cemented smooth and / or ceramic) is one example. It is possible that the failures originated from the implementation are related to the lack of improvement in manpower and insufficient quality control of construction companies.

The lack of communication between the different parts that go into designing a building is also one of the causes of the emergence of most pathological problems in buildings.

It was observed some constructive solutions that reduce the occurrence of failures in newer buildings, like the use of rails, sill and drip pan. However, it was noted that there still exists a potential for significant improvement in the feedback of the project from the lessons learned from maintenance, durability and lifetime of this type of construction that will influence considerably on maintenance costs. The development of a user manual can also contribute to a better use of buildings.



## References

- Apicer (2000) *Associação Portuguesa da Indústria de Cerâmica. Manual de Alvenaria de Tijolo*, Coimbra.
- Cánovas M. F. (1988) *Patologia e terapia do concreto armado*; tradução de M. Celeste Marcondes, Beatriz Cannabrava. São Paulo: PINI,
- Cincotto M. A. (1983) *Patologias das argamassas de revestimento: análise e recomendações*. São Paulo, IPT, (Série Monográfica 8)
- Falcão Bauer Luís Alfredo (1990) *Controle total da qualidade ou falência da indústria da construção civil*, São Paulo.
- Falcão Bauer Luís Alfredo (1994) *Materiais de construção*, Rio de Janeiro, LTC Editora - 53 edição V.2 - capítulo 30 p. 929.
- Hammarlund Y. e Josephson P.E. (1992) *Cada erro tem seu preço*. In: Revista Técnica traduzido do artigo: *Sources of quality failures in Building published by Management Quality an Economics in Buildings*, pp. 671-680. Técnica 32, ano 1: Editora Pini, São Paulo.
- Helene P. R. L.(1988) *Corrosão em armaduras para concreto armado*. Concreto. 2ª ed. – São Paulo: PINI, 213 p.
- Helene P. R. L.(1988) *Manual para Reparo, reforço e Proteção de Estruturas de Instituto de Pesquisas Tecnológicas*.
- Ioshimoto E. (1998) *Incidência de manifestações patológicas em edificações habitacionais. Tecnologia de edificações*, São Paulo. Pini, IPT – Instituto de Pesquisas Tecnológicas do Estado de São Paulo, Coletânea de trabalhos da Div. de Edificações do IPT. p.545-48.
- Klein D. L. (1999) *Apostila do Curso de Patologia das Construções*. Porto Alegre, - 10º Congresso Brasileiro de Engenharia de Avaliações e Perícias.
- Lichtenstein N. (1985). *Patologia das construções. Procedimento para formulação de diagnósticos de falhas e definição de conduta adequada a recuperação de edifícios. Dissertação de mestrado*. São Paulo, Escola Politécnica. 191 p. (pp. 8-35 e 150-155)
- Pereira M. F. P. (2005) *Anomalias em Paredes de Alvenaria sem função Estrutural*. Dissertação de Mestrado em Engenharia Civil, Universidade do Minho, Guimarães.
- Perez, A. R. (1988) *Humidade nas Edificações: recomendações para a prevenção de penetração de água pelas fachadas*. Tecnologia de Edificações, São Paulo. Pini, IPT – Instituto de Pesquisas Tecnológicas do Estado de São Paulo, Colectânea de trabalhos da Div. de Edificações do IPT. p.571-78.
- QUALIFORM. (1987) *Gérer la Qualité sur le Chantier: introduction à une réflexion*. Paris.

Souza V.C.M.e Ripper, T. *Patologia, recuperação e reforço de estruturas de concreto*. São Paulo: Pini, 1998.

Thomaz E. (1989) *Trincas em Edifícios: causas, prevenção e recuperação*. São Paulo: Pini, EPUSP, IPT, 1989.

Thomaz E. (1990) *Patologia*. In: *Manual Técnico de Alvenaria*. São Paulo: ABCI/Projeto, 280p.

Verçoza, E. J. (1991). *Patologia das Edificações*. Porto Alegre. Editora Sagra: 172p.

## Residential condominium study in João Pessoa city - Brazil concerning to maintenance

**Alexsandra Rocha Meira**

Federal Institute of Education, Science and Technology of Paraíba - Brazil  
alexrmeira@uol.com.br

**Ana Paula da Silva Batista**

Federal University of Campina Grande - Brazil  
annapaulabatista@yahoo.com.br

**Dayelle Gonçalves Fuzari**

Norberto Odebrecht - Angola  
dayfuzari@hotmail.com

### Abstract

Maintenance condominium studies are still limited in national setting and more specifically in Joao Pessoa City. This paper aims to offer a contribution to the area, by performing a study on residential condominiums maintenance in the city, including a survey, both as in terms of typology and action strategy as concerning to interventions frequency. The survey was developed in ten residential condominiums. To conduct it, we used structured forms, with 16 variables, as following: electric installations, telephone installations, fire-fighting installations, water installations, concrete structures, masonry, coating, painting, carpentry, locks, hardware, glassware, deck, waterproofing, urbanization, garden conditions and garbage deposits. The analysis, conducted by variable and by condominium, showed that all condominiums use both corrective and preventive maintenance strategy; but performance still prevails after problem appearances.

**Keywords:** maintenance, performance, condominium.

## 1. Introduction

Studies on maintenance began to be carried out incipiently in some European countries at the end of the 50's. Consequently, in 1965 the importance of researches focused on maintenance aspects was recognized through the establishment of the Maintenance Building Committee by the Construction Ministry and British Government and Public Service (SEELEY, 1987).

From that period on, the issue has got increasing worldwide prominence and, in 1979, aiming to strengthen the study area, it was created the working group W70 from CIB (International Council for Research and Innovation in Building and Construction), which is one of the major sources of research in the area.

In national terms, the interest for maintaining started up almost at the end of the 80's, with the work of Cremonini (1989), Dal Molin (1988), Helene (1988), Ioshimoto (1988) and Lichtenstein (1986), concentrating primarily in statistic of pathological manifestations and their causes and origins, in material and component durability studies, and in works aiming improvements at initial stages of the constructive process. Later, researches were also conducted with emphasis on maintenance systems applied to non-residential buildings (LOPES, J. 1993; LOPES, B. 1998) and, more recently, we can highlight the work of Meira (2002), whose focus points for maintenance management.

Concerning to Brazilian ruling on this matter, there are, in general, the standards NBR 14037 (Manual of operation, use and maintenance of buildings - content and recommendations for preparation and presentation) and NBR 5674 (Building Maintenance Standards).

Being concerned to a very broad subject, that involves many aspects, the Building Maintenance can be classified in several ways, as we can attest as following, according to (JOHN, 1989): (a) depending on the type of maintenance: conservation, repair, restoration or modernization; (b) according to the origin of the building problems: avoidable or unavoidable; (c) related to the adopted maintaining strategy: preventive, corrective or maintenance engineering; (d) according to the activity implementation schedule: routine, periodic or emergency.

A group of scholars, by dealing with maintenance, focused on the hypothesis that certain physical characteristics of the dwellings can facilitate their maintenance, make it more difficult or even influence in the decision to hold such activity or not.

Littlewood & Munro (1996), by examining causes of lack of maintenance in the industry of own houses from Scotland, identified a number of factors that can form the basis for the decision to achievement or not of repair and improvement works. Authors conducted a broad study and found, among other things, that the building ages exert strong influence on their conditions, it means, lack of maintenance probability increases sharply with age.

More specifically, Galster & Hesser (1982) associated high expenses maintaining houses built in the period before 1940. In the model presented by Shear (1983), it is not possible to predict

the effects of building age, but it is clear the greatest number of adjustments and maintenance services in older units. He concluded that the most new units, as well as those that have no leaks and cracks suffer fewer changes and replacements.

Littlewood & Munro (1996) also supported in the variables related to the neighborhoods to explain the lack of maintenance in housing units in Scotland. Again, neighborhood characteristics were essential and the authors showed that people are encouraged to carry out more repair works where there is evidence of repair and improvement activities in neighborhoods.

Thus, the current study aims to offer a contribution to the area, carrying out a research on the maintenance adopted in residential condominiums in Joao Pessoa.

## 2. Methodology

The work was developed in residential condominiums in Joao Pessoa City, capital and most populous municipality of Paraiba state. The city is the third oldest in Brazil, with 423 years of foundation. According to Brazil survey in 2006 by IBGE, it has an area of 211.00m<sup>2</sup> and 612081 inhabitants.

Among 63 existing neighborhoods in this city, we chose to study specifically Jaguaribe and Tambau neighborhoods. The first one is an old neighborhood of the capital, where there is predominance of horizontal buildings and a small concentration of condominiums, which are usually older than 10 years and small sized (up to 3 floors). The later is considered a noble neighborhood of the capital, with a considerable number of multi-storey constructions. This growth is intensified in recent years with the emergence of great number of new condominiums, in detriment of few old buildings, and the newer buildings generally larger sized (more than four floors).

All condominiums should be residential, multi-storey with at least 5 (five) years of age. Based on these criteria, it was selected a randomly sample of 10 (ten) condominiums, 05 (five) located in Jaguaribe and 05 (five) in Tambau.

To conduct this research it was prepared three research instruments: an interview form and two inspection ones. The former was structured in order to obtain information about the structure of condominiums, in terms of maintenance, as well as their planning and costs of services performed in the buildings.

The two inspection forms were based on 16 variables, which are: electric installations, telephone installations, fire-fighting installations, water installations, concrete structures, masonry, coating, painting, carpentry, locks, hardware, glassware, deck, waterproofing, urbanization, garden conditions and garbage deposits. Theses variables were selected based on the study realized in Meira (2002).

It was considered all variables with equal weights, regardless of the importance of each one in constructive terms, severity of problems detected or maintenance costs. This research is not aimed at analyzing technical aspects, in which case it would be important to evaluate differently variables and problems.

One of the inspection forms helped in the description of the state of each mentioned variables. Moreover, we tried to identify an action strategy, in terms of maintenance of each variable, it means, if the condominium used a preventive or corrective maintenance.

The other inspection form described the basic characterization of buildings and carried out the analysis of their maintenance performance state, based on collected data in the first inspection form. This analysis used the scale and the criteria presented in Table 1.

Table 1. Scale used for classification of maintenance performance state of variables.

Classification	Scale	Criterion
Poor	0-1	Totally degraded.
Bad	2-3	Many degraded parts, more than 70%.
Regular	4-6	Several degraded parts, about 50%.
Good	7-8	Few degraded parts, less than 30%.
Great	9-10	Almost nonexistent or nonexistent degradation

The interview form was fulfilled by researchers in each condominium, with trustees, and the survey ones were fulfilled only by researchers through visual inspections at the place of study. Guardians and employees also helped in obtaining information about the studied variables.

With the data collected through the second survey form, it was classified maintenance performance state of variables, according to the scale proposed in Table 01. With the classification for each variable, which could transpose its performance level in each condominium, the results were arranged in Tables, which will be presented later, and final averages were developed for each variable and studied condominium (in this work only the study by variable is presented). Subsequently, the results obtained through this classification were assessed intended to improve the sight of the situation.

### 3. Building characteristics

Studied buildings showed general characteristics represented in Table 2.

Table 2. Features of condominium studied in Joao Pessoa City

Condominiums <sup>1</sup>	Age (years)	Area built (m <sup>2</sup> )	No. of Floors	No. of Blocks	No. of Apartments	Patterns <sup>2</sup>
01	15	1412	03	02	13	Normal
02	15	2291	03	02	22	
03	12	3263	03	03	35	
04	18	1296	03	01	09	
05	17	2970	03	03	33	
06	10	1.770	06	01	24	High
07	09	1708	07	01	14	
08	25	2744	07	01	14	
09	18	6771	10	01	40	
10	11	1600	07	01	07	

Note:

1. Jaguaribe neighborhood: from Buildings 01 to 05; Tambaú neighborhood: from Buildings 06 to 10.

2. Classification adopted by the Municipal decree No. 1522 from December 18<sup>th</sup>, 1985, based on the criteria: location, built area and technical specifications.

#### 4. Maintenance in the condominiums

Through interviews conducted with the condominium trustees, it was obtained information on the structure of the condominiums, in maintenance terms, as well as their planning and the cost of performed services.

Among studied condominiums, 90% claimed to do any kind of planned maintenance. Planning and budget availability factors were strongly coupled, when taking administrators to conduct any kind of maintenance in the studied condominiums. It appeared that essential components for condominium functioning received priority in the budget, thereby maintaining its regular maintenance, even though not through continuous maintenance, while other components received intervention, with the goal of restoring performance, or, even the modernization, which can be a corrective action in some cases. The modernization is usually decided by condominial meeting, in which the majority of residents accept the realization, because this will lead to increase the incoming budget, making it considerable.

It was identified the existence of user manual, operation and maintenance in the buildings in 40% of all cases studied. To them, respective governments said follow all recommendations contained in the documents.

In all condominiums in Jaguaribe neighborhood there were interruptions in the intercom system due to lack of maintenance. In Buildings 03 and 05 intercom systems were, at the time of the

search, without running for over a year. This fact risked great part of installations and required the replacement of equipment and spinning, and the hiring of a specialized team and a planned maintenance. It resulted in high cost for the condominium, to restore the minimum performance of the system. The intercom was the component with a greater demand for corrective services in all buildings, followed by the electronic gate. Only the administration of the Building 06 said performs corrective and preventive maintenance on the intercom through a company previously hired.

Regarding maintenance costs, it was asked about the most representative items in each condominium. In terms of costs, 70% of respondents said that painting and coating were those leading to greater spending. In all buildings in Tambaú neighborhood, the lift was also responsible for a portion of considerable cost of maintenance.

The hiring of companies or external technical teams by condominium was observed more frequently in relation to intercom, electronic gates, pumps and lifts. For intercom, it was observed a hiring in 100% of condominiums. In all buildings in Tambaú neighborhood, the maintenance of lifts was performed by hired companies, with monthly preventive maintenance. There was greater importance to the maintenance of this item because residents worry about both security and ease.

Concerning to the item reservoirs, among the respondents, 60% said undertake the maintenance planning. Regarding the cleaning of reservoirs, 50% of the buildings do it with a frequency of up to 06 (six) months; the rest adopted a frequency between 06 (six) months and 01 year. According to NBR 5626 (1998), "as an attitude of health protection, it is essential to have cleaning and disinfection made once every year."

Regarding the general strategy of administrations, in maintenance terms, all condominiums used the strategy of both corrective and preventive maintenance. However, what prevailed was still the action after the problem appearance. It was also illustrated that corrective maintenance, in some situations, was held so late, causing aggravation of existing problems, making maintenance costs more expensive.

## **5. Analyses focused on variables**

Based on data collected in survey formularies, and according to the criteria presented in Table 1, it is elaborated the averages of maintenance performance state of the 16 (sixteen) studied variables, as shown below.



Table 3. Result of Maintenance Performance State in Studied Buildings

Studied variables	Buildings										Average for Variable
	01	02	03	04	05	06	07	08	09	10	
	Maintenance performance state										
Electric installations	7	8	6	7	4	9	9	8	7	8	7,30
Telephone installations	8	9	2	7	2	8	8	9	7	8	6,80
Fire-fighting installations	5	4	6	3	4	8	8	7	7	8	6,00
Water installations	5	7	4	5	3	9	9	8	6	6	6,20
Concrete structures	8	9	6	7	6	8	9	8	6	6	7,30
Masonry	8	9	6	4	4	7	9	9	7	7	7,00
Coating	6	7	-	3	8	8	9	7	7	4	6,56
Painting	5	8	4	4	2	7	9	7	5	6	5,70
Carpentry	8	8	7	7	6	-	-	6	8	8	7,25
Locks	7	8	7	7	7	8	9	9	6	7	7,50
Hardware	7	9	7	7	7	8	9	9	6	7	7,60
Glassware	8	8	7	7	7	8	9	7	8	9	7,80
Deck	9	8	7	7	5	9	9	9	7	-	7,78
Waterproofing	7	6	3	5	3	6	8	7	5	6	5,60
Urbanization	6	8	4	5	3	8	9	8	7	6	6,40
Garden conditions and garbage deposits	7	6	4	3	2	8	9	9	8	8	6,40
General average of the state of variables											6,82

According to the averages of variables, some has more prominence, as follows.

Waterproofing received the lowest average (Table 3) between these variables: 5.60, which corresponds to regular classification state (Table 1). Figure 1 shows a lack of aluminum cover in gutters, shingles and bargeboards, a fact that is helping infiltration and percolation in slabs and walls of barrels of buildings 04 and 05. Conducting in a good sealing in the building, it is possible to avoid moisture excess in parts of it and, consequently, proliferation of pathogenic microorganisms.



Figure 1. The view from Building 04 deck - Lack of impermeable cover in several parts of the deck.

Painting was the second variable with the lowest average (Table 1) of maintenance performance state (5.70). Among the environments analyzed with damaged painting, it prevails the stairs, due to constant resident courses and, in some cases, lack of handrail to avoid contact with the wall. The existence of infiltrations also contributed to painting wear. Buildings that have painted facades require maintenance more often than those with ceramic material, because they have wear resistance and durability before the action of storms, technical characteristics that painting does not have. Figure 2 presents painting detachment and wear located in front of Building 05.



Figure 2. Building 05 facade with painting wear.

In relation to water installations, only one condominium presented bad maintenance performance; five, regular; two good; and two great; according to Tables 1 and 2. The procedures for maintenance of cold water building installation should be supplied by the constructor to the user, and the former must provide the inspection at least once a year (NBR 5626,1998). In the field study, it was verified lack of hygiene in barillets in Buildings 01, 02, 03 and 05, especially because of the presence of waste and coating material debris. The barillet of Building 09 was the only one to present identification in distribution columns, facilitating the maintenance and management (Figure 3). The access to barillet in all buildings is facilitated, usually through an opening on the ceiling of the last floor or through the last part of the stairs. Building 06 was the only one that had the filter screen in the bottom reservoir. It was observed in this research carelessness in sealing the covers of the bottom reservoir. Some of these lids can

be seen in Figure 4. There were, in Building 09, in addition to oxidation in the top reservoir lid, pieces of iron that form it, contaminating the water (Figure 5). The maintenance performance state of this variable, for all studied condominiums, corresponds to 6.80 (Table 3), resulting in regular classification (Table 1).



Figure 3. Barillet with identified columns in Building 09, facilitating maintenance operation.

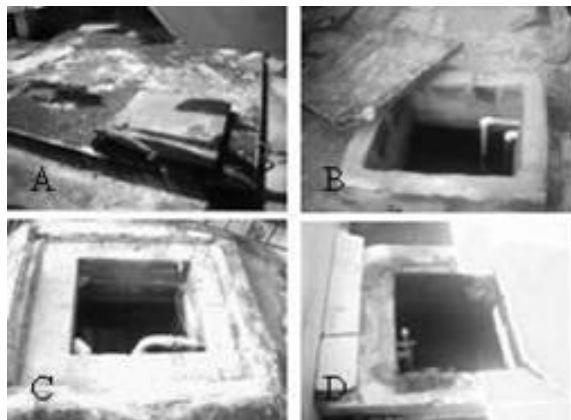


Figure 4. (A) Bottom reservoir in Building 03; (B) Bottom reservoir in Building 05; (C) Bottom reservoir in Building 09; Bottom reservoir in Building 10; all of them without filter screen, with damaged lids exposed to waste and animal entry.



Figure 5. The opening edge of the top reservoir in Building 09 with pieces of iron.

Concerning to fat and septic tanks, many of them were broke and with cracks in the lids, resulting in a bad sealing, a fact that was causing gas exhalation and proliferation of insects. The absence of handles and boxes built on the grounds of the pillars was also a problem observed in this variable, since in the second case, sealing is difficult and, in the first, it is hard to open the inspection container. In Building 03, some septic tanks received reform, since the paving collapse caused its ruin. The cleaning of septic tanks was commonly performed by guardians from the condominiums. Some of them affirmed to use a liquid to kill ticks and mites for disinfect the boxes. Figure 6 show the situation of septic tank in Buildings 05.



Figure 6. Septic tank with breaks and collapse in Building 05.

Telephone installations in Buildings 03 and 05, both in Jaguaribe, received less maintenance performance state in the assessment of this variable (Table 3). They were not working at the time of the search; the former due to lack of maintenance, both preventive and corrective. The latter, it was concluded that the achievement of maintaining intercom did not occur, in order to prevent the action of vandals who used the spinning of connection between intercom and automatic gate to open and have access to the condominium. The other buildings were in good and excellent maintenance performance state, with installations running (Table 1). The average of maintenance performance state of this variable is regular: 6.80. (Table 3).

Maintenance of fire-fighting installations in the condominiums generally was limited to the activity of reloading fire extinguishers, because it is a legislative requirement in Brazil. For the other equipments (boxes, hydrants, hoses and adapters) it was done just a routine inspection, and, even then, not always occurring in all buildings of the sample, generating variations in this variable study in Jaguaribe buildings. There was uniformity in maintenance performance state in Tambaú buildings, as we can see in Table 3.

Fire-fighting installations in Buildings 02, 04 and 05 were extremely degraded. In Buildings 02 and 04, if they need to use the equipments, there will be lack of water, because in the first building, the barillet, in one of the blocks, was broken in the link between the feeder and the record (Figure 7). In the second building there was not the verification steering wheel for the activation of water passage: the found aggravation. In Buildings 04 and 05, occurred the

following problems: lack of fire extinguishers, fire hose cabinet without hose and some of them tied, barrel of fire without identification painting, and also in Building 04, the external fire hose cabinet was sealed (Figure 8).

This building received the lowest average for the entire sample in this variable assessment. In Buildings 02, 03 and 05, the reloading of fire extinguishers was delayed. The lack of demarcation of the area in the fire hose cabinet and fire extinguishers is common to all studied condominiums. The variable fire-fighting installations received an average of maintenance performance state 6.00 (Table 3), corresponding to regular, according to Table 1, it is the third lowest maintenance performance among the sample.

Lack of maintenance specialized in fire-fighting installations occurred mainly due to the fact they are not used continuously, making condominial administrations destine funds for components that, in their view, were more important.



Figure 7. Fire-fighting water supply column broken in Building 02.



Figure 8. Fire hose cabinet without fire-fighting hose in Building 04.

Among the sample, the variables glassware and deck presented the biggest averages of maintenance performance state: 7.80 and 7.78, respectively, according to Table 3, which corresponds to good condition (Table 1). Glassware, despite being a fragile material, was clean and fixed on sash windows. In the electrical installations and fire hose cabinet were missing some protection glasses. There was, however, uniformity in this variable maintenance

performance in the studied buildings (Table 3). Another important factor about the variable glassware, relates to the speed in the replacement of broken parts happens to prevent accidents among residents, which keeps it in good condition. About the deck, second variable with higher average of the maintenance performance state, there was a lack of deterioration or breaks in the tiles that were to undermine their function. Analyzing the positions of the administrations in relation to variables glassware and deck, it was observed that they applied some kind of preventive and / or corrective maintenance continuously.

The variables Urbanization and Garden conditions and garbage deposits had averages of maintenance performance state equal (6.4) (Table 3), which corresponds to regular state (Table 1). The maintenance performance of these two variables in Jaguaribe buildings varied more than in the Tambau neighborhood (Table 3). In urbanization, bad maintenance performance in Building 05 and the regular in Buildings 01, 03, 04 and 10 was due to the presence of intense sinking and stone breaks in automobile courses. For the variable Garden conditions and garbage deposits, it was found that in Tambau neighborhood, condominiums had gardens wooded, with continuous treatment, because of that, good and great maintenance performance state (Tables 1 and 3). Also in Garden conditions and garbage deposits was found that no studied condominium conducts selective collection of generated waste.

In a general assessment of maintenance performance state of the variables, among the 16 (sixteen), 08 (eight) had fewer degraded parts, less than 30%, and 08 (eight) had various parts degraded, about 50% (Table 3). Studying the general average of maintenance performance state of the variables (6.82) presented in Table 3, if we take as basis the classification set out in Table 1, it can be classified as regular.

## 6. Conclusions

This study aimed complete the survey on maintenance that has being adopted in residential condominiums in Joao Pessoa City, specifically in Jaguaribe and Tambau neighborhoods.

According to field collected data and, based on the theoretical reference searched, it is possible to reach the following conclusions:

It was observed that the frequency of assistance for the completion of maintenance is quite minimized, occurring mainly in the neighborhood with less economic power. In order to maintain the minimum conditions for maintenance performance of the building, conservation and repair are the most commonly used forms on the type of maintenance adopted in all condominiums studied, which results in greater applicability of corrective strategies to restore the performance of its components. It was not identified direct relationship between the age and maintenance performance state of the variables studied, which go against to some international authors (ALNER e FELLOWS, 1990; LITTLEWOOD e MUNRO, 1996; GALSTER e HESSER, 1982), although this result is representative only to the sample surveyed.

Regarding the relationship between neighborhood and maintenance performance state in studied condominiums, the completion of maintenance is linked mainly to the economic power of the neighborhood. The practice of periodic maintenance is carried out only in Tambau neighborhood, where the site is considered high pattern of living. This conclusion is supported by results presented in international studies (SHEAR, 1983; MERCER e PHILLIPS, 1981; BOEHM e IHLANFELDT, 1986)

To avoid the appearance of maintenance problems, it is necessary that administrations of condominiums act on realization of preventive maintenance, providing improved performance of components of the building.

## References

- Associação Brasileira de Normas Técnicas (1998). NBR-5626: Instalações prediais de água fria.
- Almeida, C. S.; Vidal, M. C. R. (2001). Gestão da manutenção predial. Rio de Janeiro: Edição do autor. **229p**.
- Alner, G. R.; Fellows, R. F. (1990). Maintenance of local authority school buildings in UK: a case study. In: *International Symposium on Property Maintenance Management and Modernization* □ CIBW70, Singapore. Proceedings...Singapore: [s.n.]. **90-99p**.
- Boehm, T. P.; Ihlanfeldt, K. R. (1986). The improvement expenditures of urban homeowners: an empirical analysis. *AREUEA Journal*, v.14, n.1, **48-60p**.
- Cremonini, R. A. (1989). A avaliação de edificações em uso a partir de levantamentos de campo – subsídios para a programação da manutenção de edifícios e novos projetos. In: *Simpósio Nacional de Tecnologia da Construção Civil*, São Paulo. Anais...São Paulo: USP. **137-147p**.
- Dal Molin, D. C. C. (1988). Fissuras em estruturas de concreto armado – levantamento de casos no Estado do Rio Grande do Sul. In: *Simpósio de Desempenho de Materiais e Componentes de Construção Civil*, 1., 1988, Florianópolis. Anais...Florianópolis: UFSC. **144-156p**.
- Galster, G. C.; Hesser, G. W. (1982). The social neighborhood: an unspecified factor in homeowner maintenance? *Urban Affairs Quarterly*, v.18, n.2, **235-254p**.
- Helene, P. R. L. (1988). Corrosão de armaduras para concreto armado. In: *Simpósio de Desempenho de Materiais e Componentes de Construção Civil*, 1., Florianópolis. Anais...Florianópolis: UFSC. **171-184p**.
- Ioshimoto, E. (1988). Incidência de manifestações patológicas em edificações habitacionais. In: *EPUSP*, 1988, São Paulo. Anais...São Paulo: USP. **363-377p**.

John, V. M. (1989). Princípios de um sistema de manutenção. In: *Seminário Sobre Manutenção de Edifícios: escolas, postos de saúde, prefeitura e prédios públicos em geral*, Porto Alegre. Anais...Porto Alegre: UFRGS. **126-138p.**

Lichtenstein, N. B. (1986). Patologia das construções. São Paulo. Boletim Técnico, USP.

Littlewood, A.; Munro, M. (1996). Explaining disrepair: examining owner occupiers' repair and maintenance behaviour. *Housing Studies*, v.11, n.4, **503-525p.**

Lopes, B. A. R. (1998). Sistema de manutenção predial para grandes estoques de edifícios: estudo para inclusão do componente estrutura. Dissertação (Mestrado em Engenharia Civil). Universidade de Brasília, Brasília. **308p.**

Lopes, J. L. R. (1993). Sistemas de manutenção predial: revisão teórica e estudo de caso adotado no Banco do Brasil. Dissertação (Mestrado em Engenharia Civil). Universidade Federal do Rio Grande do Sul, Porto Alegre. **128p.**

Meira, A. R. (2002). Estudo das variáveis associadas ao estado de manutenção e a satisfação dos moradores de condomínios residenciais. Tese (Doutorado em Engenharia de Produção). Universidade Federal de Santa Catarina, Florianópolis. **285p.**

Mercer, J.; Phillips, D. (1981). Attitudes of homeowners and the decision to rehabilitate property. *Urban Geography*, v.2, n.3, **216-236p.**

Pinto, A. K. (1999). Manutenção: função estratégica. Rio de Janeiro: Qualitymark. **287p.**

Seeley, I. H. (1987). Building maintenance. London: Macmillan Press LTD. **452p.**

Shear, W. B. (1983). Urban housing rehabilitation and move decisions. *Southern Economic Journal*, v.49, n.4, **1030-1052p.**



## Maintenance in Educational Facilities. Three Public Schools in São Paulo, Brazil

Ana Judite G. Limongi França<sup>1</sup>, Sheila Walbe Orsntein<sup>2</sup>

<sup>1</sup> Architect and Master's Student at Faculty of Architecture and Urbanism, University of São Paulo (FAUUSP)

<sup>2</sup> Architect, Full Professor, Faculty of Architecture and Urbanism, University of São Paulo (FAUUSP); Researcher, National Scientific and Technological Development Board (CNPq)

*Corresponding email: alimongi@usp.br*

### Abstract

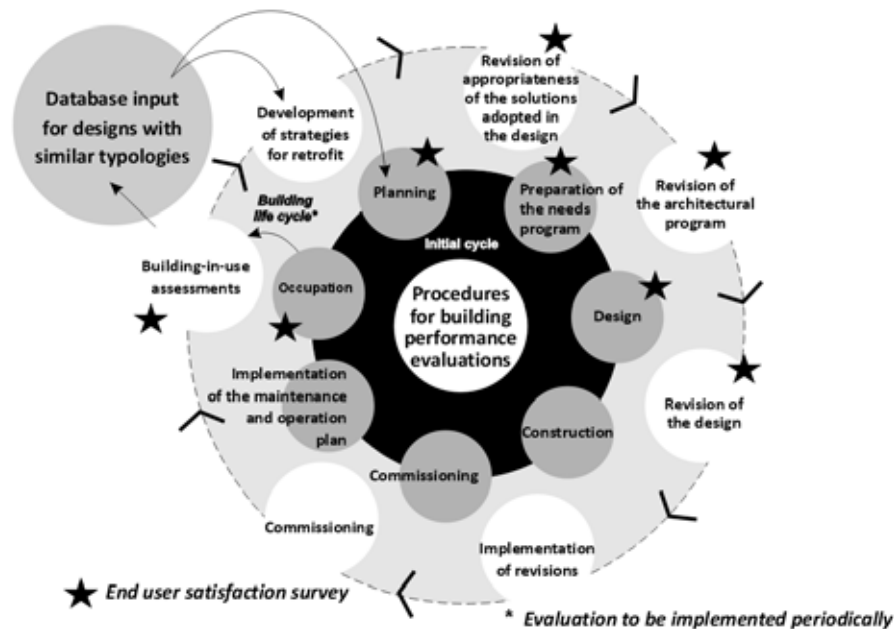
This paper presents partial results of an ongoing graduate research at FAUUSP which intends to evaluate the performance of public school buildings managed by the government of the State of São Paulo, located in the metropolitan region of São Paulo, built after 2003 and in use for more than one year. In order to do so, Post-Occupancy Evaluation (POE) methods and techniques have been adopted to evaluate the performance of the buildings intended for São Paulo's public schools and the impacts of operation and maintenance procedures according to the perception of their users. It is expected that such buildings meet appropriate conditions for teaching and learning. However, their environmental quality depends not only on proper design and construction but also on an effective maintenance program. The results have enabled the identification of the procedures adopted for the maintenance and operation of these schools, as well as the possible recurring critical aspects and opportunities for the reduction of maintenance costs. The importance of the implementation of the POE for the preparation of a feedback database that can be used in future designs of buildings of similar typology is also identified.

**Keywords:** public educational facilities, operation, maintenance, post-occupancy evaluation, building performance.

## 1. Introduction

Rarely designers maintain a long-term relationship with the designed building, standing apart of the issues involving the operation and maintenance that are related with the design specifications (MELHADO; MESQUITA, 2006), although the adoption of a systematic method and constant updating regarding the building in use could help to improve its use conditions.

The issues listed in Figure 1 comprise an ideal situation for continued evaluation of the building and aim at enabling the diagnosis of school building, considering its positive and negative aspects as well as indicating possible risk situations.



*Figure 1: Procedures for building performance evaluations.*

*Based on: Preiser & Schramm, 2005, p. 17 and Ornstein et al., 2009, p.3. Adapted by A.J.G. Limongi França.*

The diagnosis made from this continued evaluation aims at providing support for the preparation of a plan for the requalification of the buildings evaluated, considering strategies for their maintenance and operation as well. According to the Associação Brasileira de Normas Técnicas – ABNT [Brazilian Association for Technical Standards], to establish a whole building performance, in accordance with the design, it is necessary to consider the appropriate

procedures for its maintenance and operation (ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS, 2008). Without proper management, the built environment becomes subject to the loss of functionality of its building systems.

In the case of public school buildings, run by the State Government of São Paulo, built in this century (XXI), attention to this issue is critical. Built in large scale, such buildings share the same architectural design approach, architectural programming and construction technology, specified by means of catalogues whose application is mandatory for the preparation of new designs, in which performance criteria, technical standards, good practices are set forth, aiming at increasing the durability of building systems in order to reduce the need for maintenance (FUNDAÇÃO PARA O DESENVOLVIMENTO DA EDUCAÇÃO, 2010).

Considering the guidelines developed by the Fundação para o Desenvolvimento da Educação - FDE [Foundation for Educational Development] to conduct maintenance on building systems (FUNDAÇÃO PARA O DESENVOLVIMENTO DA EDUCAÇÃO, 2008), this research aims to evaluate the conditions of these educational facilities in use, through the application of POE methodology, and research eventual relationship between critical issues and design conception or maintenance procedures, to allow its correction in similar buildings.

## 1. Methods and techniques

Based on the methodology consolidated for the application of the POE (ORNSTEIN, ONO, 2010) and considering the importance of collecting information in a systematic way on the performance of the school buildings under consideration, schools “A” (Picture 1), “B” (Picture 2), and “C” (Picture 3), whose building systems meet the recent guidelines set by the FDE (Table 1), have been selected to be case studies.

The three case studies were chosen considering similar building construction systems and architectural program. All of them are located in low income households areas in the metropolitan region of São Paulo, with few or none public equipments and have been in use for more than twelve months.

Table 1: Fact Sheet on Schools A, B, and C.

	School A	School B	School C
Land Area:	2266.21 m <sup>2</sup>	5861.39 m <sup>2</sup>	4064.12m <sup>2</sup>
Total built area (without overhang, including roofed pathways):	3548.62 m <sup>2</sup>	1142.72m <sup>2</sup>	3913.03m <sup>2</sup>
Number of floors	4	2	3
	<b>Building System:</b>		
Pillars and Beams:	Structure in Precast Concrete	Steel	Structure in Precast Concrete
Slabs:	Lattice Panel	Lattice Panel	Lattice Panel
Enclosures:	Hollow Brick	Hollow Brick	Hollow Brick
Solar Shading:	Hollow Clay Facing Brick	Perforated Metal Sheet	Hollow Clay Facing Brick
Frames:	Painted Iron	Painted Iron	Painted Iron
Tiles - Flooring:	Ceramic coating	Ceramic coating	Ceramic coating
Finish - Walls:	Matte latex paint. On wet areas, white ceramic tile	Matte latex paint. On wet areas, white ceramic tile	Matte latex paint. On wet areas, white ceramic tile
Roofing:	Painted Metal Shingles	Painted Metal Shingles	Painted Metal Shingles
	<b>Number of Students Enrolled:</b>		
Elementary School (1st to 4th Grade) *	511	405	0
Junior High School (5th to 8th Grade) *	411	353	1535
High School (Education for Youngsters and Adults – EJA) *	251	558	380
Students Enrolled in the 8th Grade	84	77	255
Shifts*	Morning, afternoon and evening	Morning, afternoon and evening	Morning, afternoon and evening
* Data regarding the 1st semester 2009.			



**Picture 1: School “A”** (Photo credit: A. J. G. Limongi França).



**Picture 2: School “B”** (Photo credit: A. J. G. Limongi França).



**Picture 3: School “C”** (Photo credit: A. J. G. Limongi França).

The methods and techniques adopted for the POE applied to schools “A”, “B”, and “C” enabled the systematic gathering of information and the preparation of analyses, considering the following tools: walkthroughs; check-lists; surveys; measurements of comfort; simulations of environmental comfort (prepared according to technical standards and good practices); interviews; focus groups activities; application of questionnaires and drawing of maps of the circulation routes (Table 2).

Table 2: Tools considered for the analysis and mains aspects surveyed.

Tools	Participants	Main aspects surveyed
walkthroughs	specialits, guided by users (principal, staff)	construction compliance with the design and standards requirements, practices for the maintenance and operation
check-lists	specialists	
surveys	specialists	
maps of the circulation routes measurements and simulations of environmental comfort	specialists	construction compliance with the designs and standards requirements
interviews	teachers, staff, principal	critical aspects of building use, practices for the maintenance and operation.
focus groups activities	teachers, staff	critical aspects of building use, practices for the maintenance and operation.
questionnaires	students	how the building works for its intended use

For the purpose of comparing the results obtained with indicators of school performance (SARESP - Sistema de Avaliação de Rendimento Escolar do Estado de São Paulo [State of São Paulo's Evaluation System of School Performance] and IDEB – Índice de Desenvolvimento da Educação Básica [Development Index of Basic Education]) (MENEZES FILHO et al., 2009), which consider students enrolled in the last year of junior high school (8th grade), questionnaires were applied to all students belonging to this group.

## 2. Findings

The results of the POE applied to schools "A", "B", and "C" showed situations in disaccord with the current technical standards. By implementing walkthroughs, checklists, interviews and focus groups, it was possible to identify their origins related to aspects involving the operation and maintenance of the buildings.

As for the assignment of responsibilities in the three cases studied, it was identified that the principal plays the role of the facility manager and absence of a resident janitor, responsible for carrying out small repairs or for watching the school when occupancy is low. This situation brings the principal to the facility decision-making process, which often involves building systems alterations, in despite of his or her technical capability.

Thereby, the solutions adopted by the management of school "A" to minimize the problem of trespassing on the building includes passive initiatives to discourage access by vandals and is an example the interference of the facility manager in the main circulation of the building, in despite of the relevant standards. Other changes found includes: installation of railings and iron gates inconsistent with the architectural design and replacement of vandalized lighting fixtures by components that do not exhibit the characteristics listed in the specifications. Another aspect addressed through interventions in the built environment is the control of students, allegedly due to the lack of staff for their supervision. Again, the solution adopted involves the locking of gates and restricting access to circulation and socializing areas. In addition to damaging socialization in the school environment, this approach may expose users to the risks inherent in the obstruction of access and escape routes (schools "A", "B" and "C").

All the case studies had damages to doors, hinges and locks, recorded during walkthroughs. Maintenance procedures on hardware (FUNDAÇÃO PARA O DESENVOLVIMENTO DA EDUCAÇÃO, 2008) provide for the replacement of screws and worn parts. However, improvisations aiming at strengthening these components were identified in the three case studies, which can be an indication of inadequate specification, being relevant to consider changes in future projects. Pictures 4 and 5 show anti-intruder improvised devices used by school "A", which include heavy-duty iron door, locks and hinges and the installation of metal plates on the windows located near the entrance. These devices also hinder access to the interior of the classroom in an emergency situation.



**Picture 4: Adaptation in disagreement with the design: door made of iron sheet and heavy-duty lock (School "A") (Photo credit: A. J. G. Limongi França).**



**Picture 5: Adaptation not pursuant to the design: installation of plate on the frame so as to prevent break-ins (School "A") (Photo credit: A. J. G. Limongi França).**

The application of the tools also showed the importance given in the three buildings to personal security and control over invasions and vandalism actions. This opinion is shared by clerks (focus groups), principals and coordinators (interviews and walkthroughs), as well as by the cleaning staff (focus groups), teachers (focus groups) and students themselves (questionnaires). Since this issue was considered as a priority in the decision making process of maintenance actions, its relevance was observed in several aspects, such as: accessibility, environmental comfort, ergonomics and fire safety.

Given the vertical character of buildings A, B, and C, the existence of an elevator was included in every one of the three designs in order to provide the disabled with proper accessibility conditions. Notwithstanding, in despite of the FDE standards regarding elevators maintenance (FUNDAÇÃO PARA O DESENVOLVIMENTO DA EDUCAÇÃO, 2009) only the school "C" elevator presented proper using conditions during the surveys (1st semester of 2009).

Electrical facilities presented critical conditions in schools "A", "B", and "C". It was detected that the changes to the use of environments and the shortage of outlets for computer use have led to adaptations. Moreover, outlets that had no operating conditions due to lack of components such as wires, screws and covers were found. This situation jeopardizes the use of environments and facilities and the precarious maintenance conditions create shock and fire hazards. The measures taken in school "A" to prevent theft of wiring involved the welding of latches and the installation of padlocks on electrical boxes, which can hamper access to these facilities in case of an emergency.

From the analysis of the Table 3 it is noticed that most of the critical aspects that involve the buildings in operation are common to all three case studies. Therefore, the adoption of a systematic process of review and refinement of design specifications and maintenance procedures could bring great benefits to building the network with similar building typology.

Table 3. Main critical aspects identified regarding the operation and maintenance procedures

Component	Aspects identified	school A	school B	school C
Hydrants	Equipment damage, jeopardizing its use.	X	X	X
Fire alarm	Equipment damage, jeopardizing its use.	X	X	X
Extinguishers	Missing, in conflict with the design or storage of these items in locked room.	X	X	X
Frames	Painted iron low resistance to corrosion.	X	X	X
Doors	Hollow-core wood presents little resistance to humidity, using conditions and vandalism.	X	X	X
Glasses	Ordinary glass is easily shattered, leaving behind cutting surfaces that may offer risks to the users.	X	X	
Hardware	Galvanized or chromium-plated alloy are not resistant enough for frequent use. Installation of improvised reinforcements.	X	X	X
Outlets and switches	Missing components (covers, screws, wiring and modules), presence of foreign materials (paper, adhesive tape).	X	X	X
Switchbox	Anti-vandalism reinforcements (welded bars, padlocks) hindering its opening.	X		
Fluorescent luminaries	Replacement of luminaries and lamps in disagreement with the design. The replacement of damaged luminaries with others not in accordance with the design specifications and the replacement of 32W lamps (specified in the design) with others of lower unit price, but with 40W.	X	X	X
Metal and ceramic wares	Missing/damaged components.	X	X	
Piping	Leakings and infiltrations. Plumbing and sanitary fixtures and fittings present the negative consequences of vandalism and the lack of maintenance.	X	X	
Drains and linear grates	Problems with the declivity of the piping, causing the return of the runoff.	X	X	X
Tiles	Regarding the cleaning of floors and frames, despite a recommendation to use a damp cloth (FUNDAÇÃO PARA O DESENVOLVIMENTO DA EDUCAÇÃO, 2008) the procedures adopted involve washing them with potable water, even in environments where exposure to water was not foreseen in the design and, therefore, where slabs are not sealed. Thus in these cases the premature degradation of paints, coatings and water infiltrations in the lower floors can be seen.	X	X	X
Elevators	Equipment damage jeopardizing its use, in despite of the guidelines for the maintenance and conservation of elevators, pertinent technical standards, tryout procedures, inspections and the evaluations needed to ensure safety conditions involving cables, brakes, alarms and locking devices are available in specific publication issued (FUNDAÇÃO PARA O DESENVOLVIMENTO DA EDUCAÇÃO, 2009).	X	X	

Analyses of the results have enabled the identification of the following major critical issues involving the misuse of environments:

- Lack of preventive maintenance. This would comprise the building systems and facilities (structure, sealing elements, coatings, painting, concrete sealing; hydraulic and sanitary facilities, electrical and lighting facilities, information technology (IT) facilities (FRANÇA; ORNSTEIN, 2009); fire safety; elevators; roofing; furniture; visual communication; landscaping and external areas); in order to adopt measures to enable the full use of the facilities throughout their expected lifetime;

- Insufficient corrective maintenance of building systems and equipment (also including cases of vandalism);

Thus, users may be exposed to hazards such as missing or loose floor tiles on stairways and schoolyards (Schools “A”, “B”, and “C”) and poorly fastened railings and grab bars in hallways and restrooms (School “A” and “B”). Furthermore, these conditions may cause the improper use of environments, not in accordance with the design.

### 3. Recommendations and final considerations

The Brazilian Standard NBR 5674 (ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS, 1999) defines the maintenance of a building as a set of actions performed in order to preserve it, including its corresponding facilities and equipment, from damage, deterioration and other risks, so as to ensure its conditions of use and functionality, considering the performance foreseen in the design. In addition, Article 39 of the Código de Defesa do Consumidor – CDC [Consumer Defense Code] (BRAZIL, 2004) states that every product or service must comply with the technical standards ratified by the corresponding official organ or another institution accredited by the Conselho Nacional de Metrologia, Normalização e Qualidade Industrial – CONMETRO [National Council for Metrology, Standardization and Industrial Quality]. Thus it is understood that not only the school building must be designed and constructed according to existing technical standards but any subsequent actions carried out to change it must also be in accordance with these same standards.

The building operation stage shall provide adequate conditions for the intended use. This phase will set the boundaries for its useful life, due to proper maintenance services. Thus, it must be guaranteed the ability to perceive and adapt to the user’s needs, as they change all long the occupation period (JOHN; SILVA; AGOPYAN, 2001).

The maintenance program of a building must include preventive actions which consider activities and schedules that must be defined by the recommendations of manufacturers, suppliers and designers. Physical interventions to equipments or systems and inspection activities may be included, in order to support the long term maintenance decision-making process (PRADO, 2003). Therefore, the building service life may be affected by the design, the quality of the materials, the execution, the use patterns and the maintenance level, once even the well designed and constructed buildings may not be able to reach the predicted life cycle if they are not well maintained (CHRISTIAN; NEWTON; GAMBLIN, 1999).

Moreover, changes in design details can affect the component resistance from degradation factors can impact its service life, once building components durability depends on the design and the maintenance conditions, and is not an intrinsic quality of a material (JOHN; SJÖSTRÖM; AGOPYAN, 2002).

To use school buildings in accordance with their design and construction, the manager must rely on a survey of the premises that will enable him or her to understand the operation of the



school building and to identify needs and priorities, in order to provide the effective and safe maintenance and use, over the building life cycle (ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS, 2008). By doing so, it is possible to prevent the building from having to cope with shortcomings that adversely affect the use of environments intended for teaching and learning and to avoid high costs deriving from the deferral of scheduled maintenance procedures.

The maintenance and operation procedures should describe the criteria and performance levels set for each environment in addition to listing the critical processes that may entail risks to users such as the handling of potentially polluting products, defining appropriate periods for their implementation, such as the hours of low occupancy of the building (THE COLLABORATIVE FOR HIGH PERFORMANCE SCHOOLS, 2004). Although some of the maintenance work on the school buildings evaluated does not require a high level of technical expertise (such as cleaning tasks and the tending of gardens), it is necessary to program every piece of work and make sure it is properly carried out according to the predefined frequency (for example: daily, weekly, monthly or yearly). To do so, it is necessary to assign responsibilities for the performance of tasks involving inspection, checking and safety.

Thus, it is recommended to present to the facility manager an operation and maintenance manual before the occupation phase, made in accordance to the Brazilian Standard 14.037 (ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS, 1998), regarding at list the following aspects: updated graphic information, specificities provided for in the design, building systems, definitions of the limits of the building, aiming at its safe use; with emphasis on structural systems and facilities; approach of the risks inherent in the building in use; considering normal operational conditions, description of devices that allow modifications; expansions and upgrades of components and facilities and recommended routine actions for the verification and correction of conditions involving the malfunction of components according to the frequency expected for their implementation.

Furthermore, when analyzing the results of the POE, it is convenient to notice that, despite advances in the management and control of the construction quality of the school buildings evaluated, standardization may also lead to the recurrence of critical aspects, showing the importance of developing a database of good practices. By factoring in previous experiences, it is possible to improve design guidelines, implementation and operation, in order to improve, for example, the criteria for the specification of components and establishing maintenance, replacement, purchasing or supply policies. Thereby it is important to incorporate into the stages of design and use of the building an ongoing procedure for the evaluation of its quality and efficiency so as to enable its full use.

## References

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS - ABNT. NBR 15.575 (2008) *Desempenho de edifícios habitacionais de até 5 pavimentos – Parte 1: Requisitos gerais*. Rio de Janeiro, ABNT.

\_\_\_\_\_. NBR 5413 (1992) *Illuminância de interiores*. Rio de Janeiro, ABNT.

\_\_\_\_\_. NBR 14.037 (1998) *Manual de operação, uso e manutenção das edificações - conteúdo e recomendações para elaboração e apresentação*. Rio de Janeiro, ABNT.

\_\_\_\_\_. NBR 5674 (1999) *Manutenção de edifícios: Procedimentos*. Rio de Janeiro, ABNT.

BRAZIL (2004) *Código de Proteção e Defesa do Consumidor*. Lei nº 8.078 de 11 de setembro de 1990. 15ª ed. São Paulo, Saraiva.

BORGES, Carlos A. de Moraes; SABBATINI, Fernando H. (2008) O conceito de desempenho de edificações e a sua importância para o setor da construção civil no Brasil. *Boletim Técnico da Escola Politécnica da USP, Departamento de Engenharia de Construção Civil*. São Paulo, EPUSP.

CHRISTIAN, J.; NEWTON, L.; GAMBLIN, T. (1999) Developing tools for a management system to improve the quality of a facility. *CIB W99 International Conference on Construction Project Management Systems: The Challenge of Integration*, Escola Politécnica da Universidade de São Paulo, Departamento de Engenharia da Construção Civil, São Paulo 25-28, p. 181-191. March 2003. Available online: [www.cibworld.nl](http://www.cibworld.nl) [accessed on 12/07/2010].

FRANÇA, Ana Judite G. Limongi; ORNSTEIN, Sheila W. (2009) Impactos da Tecnologia da Informação (TI) em Ambientes Escolares: O caso de três escolas públicas situadas na região metropolitana de São Paulo. In: *IX Workshop Brasileiro de Gestão do Processo de Projeto na Construção de Edifícios, Anais do Simpósio Brasileiro de Qualidade do Projeto no Ambiente Construído - SBQP*, 2009. São Carlos.

FUNDAÇÃO PARA O DESENVOLVIMENTO DA EDUCAÇÃO (FDE) *Catálogos técnicos sobre ambientes e distribuição; mobiliário; componentes; serviços; normas de apresentação de projetos; arquitetura e paisagismo; instalações prediais, estrutura e outros*. Available online: [www.fde.sp.gov.br/PORTAL\\_FDE](http://www.fde.sp.gov.br/PORTAL_FDE) [accessed on 02/04/2010].

\_\_\_\_\_. (2009) *Manual de uso e conservação de elevadores em escolas*. São Paulo, FDE. Available online: [www.fde.sp.gov.br](http://www.fde.sp.gov.br) [accessed on 02/04/2010].

\_\_\_\_\_. (2008) *Roteiro para Conservação de Edifícios Escolares da Rede Pública de Ensino do Estado de São Paulo*. São Paulo, FDE.

JOHN, Vanderley Moacyr; SJÖSTRÖM, Christer; AGOPYAN, Vahan (2002) Durability In The Built Environment And Sustainability In Developing Countries. In: *9th Int. Conf. on Durability of Building Materials and Components (9th DBMC)*, 2002, Brisbane. Conf. Proceedings of 9th Int. Conf. on Durability of Building Materials and Components (9th DBMC). Australia: CSIRO, 2002. p. 11-1-11-7.

JOHN, Vanderley Moacyr; SILVA, Vanessa Gomes; AGOPYAN, Vahan (2001) Agenda 21: uma proposta de discussão para o construbusiness brasileiro. ANTAC – *Encontro Nacional e I*

*Encontro Latino Americano sobre Edificações e Comunidades Sustentáveis*. CD ROM. Canela, Brasil.

MELHADO, Silvio Burrattino; MESQUITA, Maria Julia de Moraes (2006) Project management: towards an emphasis in conception-operation interface. In: *CIB W107 Construction in Developing Economies International Symposium*, 2006. Proceedings of The CIB W107 Construction in Developing Economies International Symposium Construction in Developing Economies: New Issues and Challenges. Santiago: PUC - Chile.

MENEZES FILHO, Naercio et al. Comparando as Escolas Paulistas com Melhor e Pior Desempenho no SARESP e na Prova Brasil. *São Paulo em Perspectiva*, São Paulo, v. 23, n. 1, p. 115-134, jan./jun. 2009. Available online: [www.seade.gov.br/produtos/spp/v23n01/v23n01\\_09.pdf](http://www.seade.gov.br/produtos/spp/v23n01/v23n01_09.pdf) [accessed on 10/07/2010].

ORNSTEIN, Sheila Walbe et al. (2009) Improving the quality of school facilities through building performance assessment: Educational reform and school building quality in Sao Paulo, Brazil. *Journal of Educational Administration*, v. 47, pp. 50-367.

ORNSTEIN, Sheila Walbe; ONO, Rosaria (2010) Post-Occupancy Evaluation and Design Quality in Brazil. Concepts, Approaches and Example of Application. *Architectural Engineering and Design Management*, V. 6. Pp. 48-67.

PRADO, Racine Tadeu Araújo (2003) *Contribuição ao estudo do papel da engenharia nas interações entre o homem, o edifício e o ambiente*. 197 p. Thesis. Escola Politécnica, Universidade de São Paulo, São Paulo.

PREISER, Wolfgang F. E. & SCHRAMM, Ulrich (2005) A conceptual framework for building performance evaluation. In: W. F. E. Preiser & J. C. Vischer [Eds.], *Assessing Building Performance*. Cap. 2, p. 15-26. Oxford, Elsevier Butterworth-Heinemann.

THE COLLABORATIVE FOR HIGH PERFORMANCE SCHOOLS – CHPS (2004) *CHPS Best Practices Manual. Volume IV. Operation & Maintenance*. California, CHPS Inc.



## Maintenance Costs of Condominiums in João Pessoa - Brazil

**Alexsandra Rocha Meira**

Federal Institute of Education, Science and Technology of Paraíba - Brazil  
alexrmeira@uol.com.br

**Djanice Silva de Santana**

Federal Institute of Education, Science and Technology of Paraíba - Brazil  
djanice23@hotmail.com

**Durwal Albuquerque da Silveira**

Federal Institute of Education, Science and Technology of Paraíba - Brazil  
durwal\_@hotmail.com

### Abstract

Life cycle costing includes the costs of acquisition and the subsequent costs of operation, maintenance and disposal. This paper focuses attention on the cost of keeping the building in good repair and working condition (maintenance costs). It describes the results of a research developed in three condominiums in João Pessoa city. It was investigated all the maintenance costs for the buildings over a period of twenty months. It demonstrates that some items such as lifts are responsible for much of the maintenance. It also shows that maintenance costs represent some 18% of the total running costs of the condominiums analyzed. As unfortunately the maintenance costs of buildings are frequently difficult to assess the results of this paper are important in special for similar buildings.

**Keywords:** Maintenance cost, running cost, condominium.

## 1. Introduction

The operating costs of an asset can be defined as the costs associated with operating the building itself. They include the cost of cleaning, rates, energy and security (AL-HAJJ, 1999). In cases of condominiums it includes also administrative costs.

The maintenance costs are defined as all costs of keeping the building in good repair and working condition. This includes painting, repairs and renewals.

Very little consideration has been given to maintenance, operation and support. This practice has been expensive because the cost of maintenance, operation and support constitute a major portion of the asset life cycle cost (LCC) (EL-HARAM & HORNER, 2002).

Either the operating costs or the maintenance costs vary according a great number of aspects. There are various statistics related to several countries regarding the operation and maintenance of facilities.

In Canada, more than half the residential construction expenditure is on renovation and restoration works. Maintenance and renovation works in the United Kingdom were estimated to be about 46% of the total construction output in 1986, whereas for Singapore, with about 50% of its building stock below 10 years of age, such works accounted only for about 21% of the total construction output (KIANG, 1991).

In Sweden and Germany these costs are estimated to be 3% of the value of annual construction production (HAMMARLUND & JOSEPHSON, 1991, apud KOSKELA, 2000). For Norway, the corresponding figure is 5% (INGVALDSEN, 1994, apud KOSKELA, 2000).

In an analysis of occupancy costs for a range of commercial organizations, located in Hong Kong, Davis (2000) found that rent forms the major component of occupancy cost in Hong Kong and maintenance and running costs are the third most expensive item.

Marteinsson & Jónsson (1999) show that costs of maintenance are quite variable according to the age. The average annual maintenance cost for housing, calculated over 60 years, is 2% of the building cost for a new house. Other authors present similar results of maintenance costs in terms of building age (ASTERISK REALTY, 2009; ANDERSEN, 1995).

McEwan (2000) presented a research on Government buildings across the state of Queensland, taking into consideration several key factors including geographical location, size and complexity of asset design, to determine cost variances and possible funding models. One of the observation of the analysis was that there was a general decrease in maintenance cost as the gross floor area of facilities increased.

Other researches evaluate the maintenance cost for each item of the construction. Analyzing maintenance and operation costs in blocks of flats in Argentina during three years, Amarilla

(1992) showed that the main costs correspond to sanitary system, lifts, façade and roof waterproofing.

Based in a study realized in 20 university buildings over a period of 18 years, Al-Hajj (1999) and Al-Hajj & Horner (1998) concluded that 30% to 40% of the items of a building contribute to 80% to 90% of the maintenance costs.

In terms of maintenance costs related to condominiums there are still little research, in special in Brazil (MEIRA, 2002). In this work, a total ten buildings were chosen to be investigated. The author found that cleaning and maintenance contribute to 5% to 14% of the annual costs in the condominiums.

In the research described in this paper, the maintenance cost of twenty months of three condominiums were compiled and analyzed. The hypothesis applied in this research is that few items of maintenance concentrate the most of maintenance cost. The objective of the research is to analyze maintenance costs of condominiums in the city of João Pessoa- Brazil, determining the high-cost components. Moreover, it will investigate the effect of age on maintenance costs.

## 2. Methodology

This study was developed in João Pessoa city, located in the Paraíba state in the northeast part of Brazil.

The criteria to select the sample were:

- Building multi-storey, residential, with similar standard level of finishes.
- Located in the same area of the city (near the beach).
- The data collected, in terms of costs, should begin for all the buildings in the same period (month and year).
- Different ages of the buildings.

Thus, the first two criteria show that the effects on maintenance costs of location, size and finishes were not investigated.

The sample originally aimed to capture a great number of buildings (approximately twenty). However, in the most of cases the building managers did not permitted the access to condominiums costs. Then, after the period reserved for data collection, only three buildings (residential condominiums) were analyzed. This number of buildings undertook the analysis of the effect of age on maintenance costs, as will be seen in the results.

The maintenance cost data was collected during twenty months. The data collection began for all condominiums in the same month and year. During this period (January 2008 until August 2009) it was felt that the inflationary effects would be minimal and could therefore be ignored.

The authors were entirely responsible for collecting, checking and in some cases rechecking the data. They were available for consultation only in each condominium.

The costs of the twenty months for the three buildings were divided by the total area of all buildings to produce uniform costs. Thus, all the data are presented in dollars per built area.

Statistical data were obtained. They were analyzed and represented through graphs and tables.

It is important to point that the results of this study are valid for the building analyzed. However, similar results can be obtained for condominiums with similar characteristics.

### 3. Condominiums description

Three residential condominiums located in João Pessoa city were analyzed. They were identified by the letters A, B and C in order to preserve them. All of them were built near the beach. Table 1 shows distributions of age, neighborhood, built area, height, number of apartments and existence of lift.

*Table 1: Characteristics of each condominium*

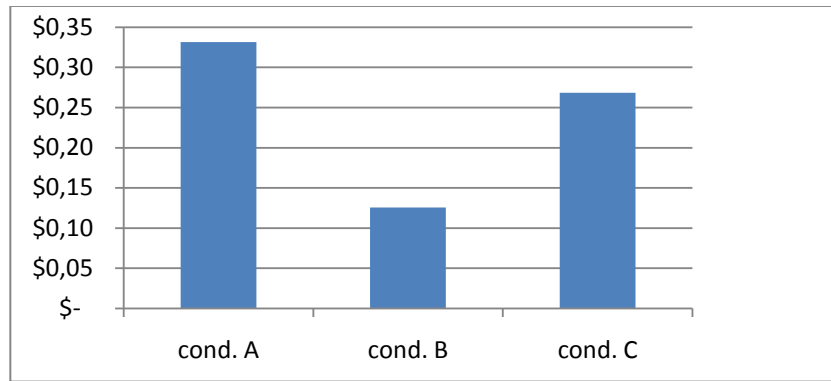
Condominium	Age (years)	Neighborhood	Built area (m <sup>2</sup> )	Height (number of paviments)	Number of apartments	Lift
A	5	Tambau	16.424,29	25	100	Yes
B	20	Bessa	3.144,00	03	24	No
C	25	Tambau	1.592,00	04	16	Yes

All buildings are under 30 years of age and the condominium identified by A is the newest and the largest of all them.

### 4. Costs of condominiums

A summary of average monthly maintenance cost (in \$ per m<sup>2</sup>) for the entire 20-month period of the study is given in Figure 1. Condominium A obtained the highest average cost of maintenance (0.33\$/m<sup>2</sup>).



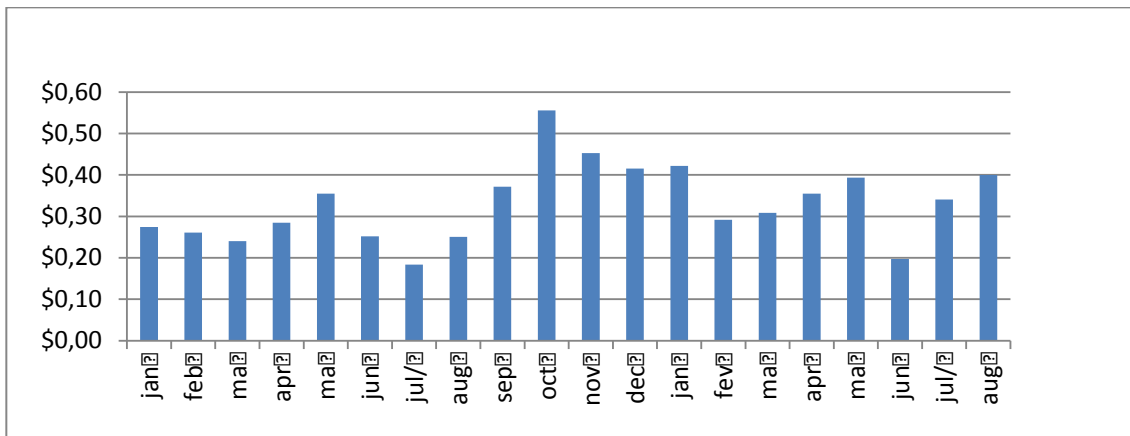


*Figure 1: Average maintenance cost for the 20-month period (\$/m<sup>2</sup>)*

Comparing condominiums, the data collected showed noticeable variations of average costs of maintenance. The same variability can be observed for the maintenance costs of each condominium throughout the twenty months. Then, to better understand this variability it is important to analyze each building.

**Condominium A**

Figure 2 shows distributions of monthly average costs of maintenance during the period studied.



*Figure 2: Monthly average cost of maintenance*

It can be observed that most of the cost is tightly grouped below 0.40\$/m<sup>2</sup>. Some months with outstandingly higher costs were due the repair in the expansion joints in this building. This item is responsible for almost 30% of the maintenance cost of the Condominium. In October 2008 it was observed the higher maintenance cost of maintenance. Besides spending on the repair in the expansion joints it was also the repair in the waterproofing. This occurred soon after the rainy season in the region, which justifies higher maintenance costs with these particular items.

Distributions for each of the maintenance cost items are given in Figures 3 and 4.

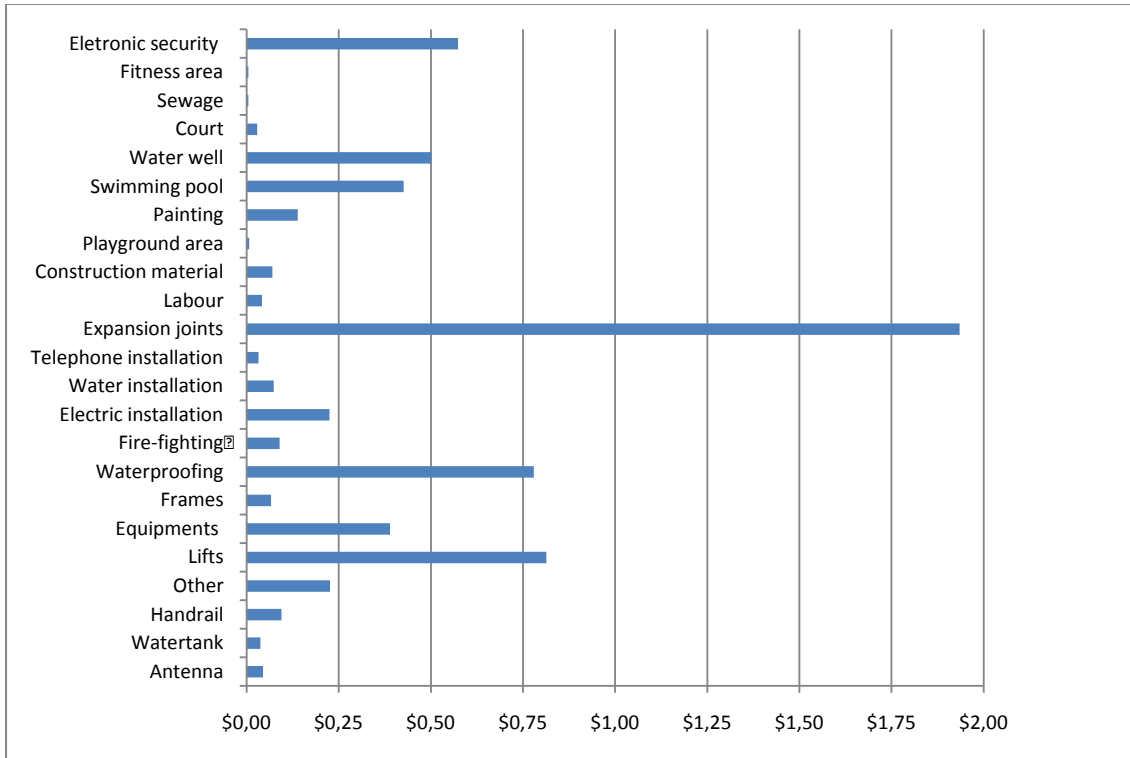


Figure 3: Total expenses per item (\$/m<sup>2</sup>)

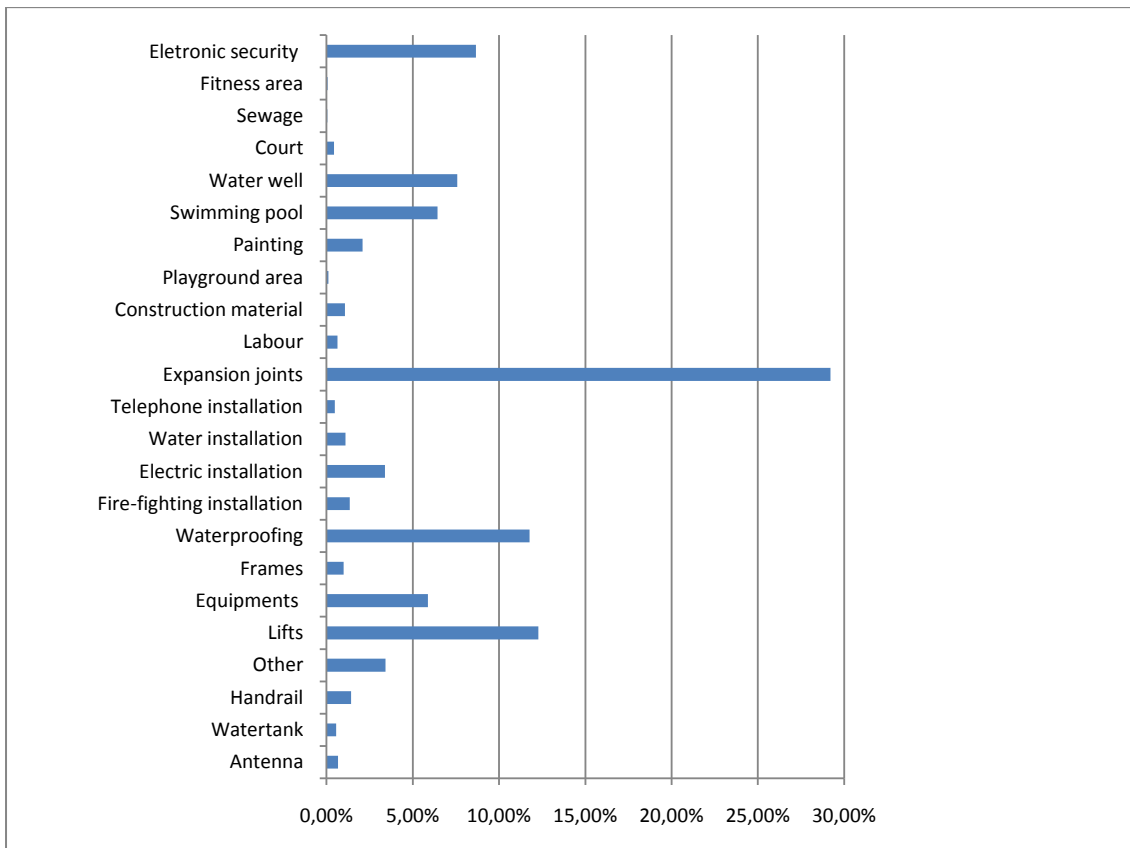


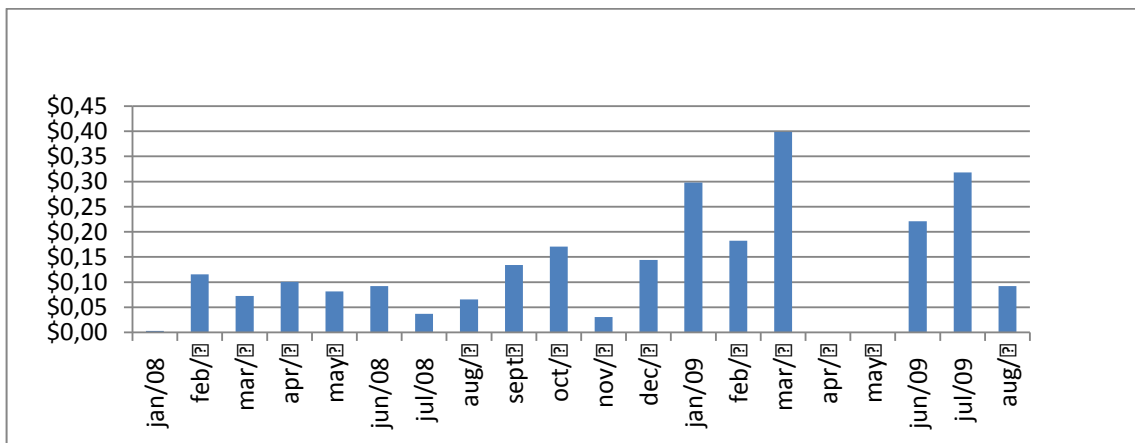
Figure 4: Distribution of items of maintenance costs (%)

It was observed that expansion joints maintenance does not occur continuously in this condominium. Moreover, the other two buildings had not this type of maintenance item. Then, to better compare the data, this item was removed and the new average maintenance cost of Condominium A decreased of 0.33\$/m<sup>2</sup> to 0.21\$/m<sup>2</sup>. This new value is between the average maintenance cost of the two other buildings (Figure 1).

Considering the withdrawal of that item, lifts and waterproofing /grout were the most representative items in terms o maintenance costs. Each one represented around 17% of maintenance cost for this condominium.

**Condominium B**

In this case the average cost of maintenance was 0.13\$/m<sup>2</sup>. The distribution of monthly average costs of maintenance during the period is showed in Figure 5.

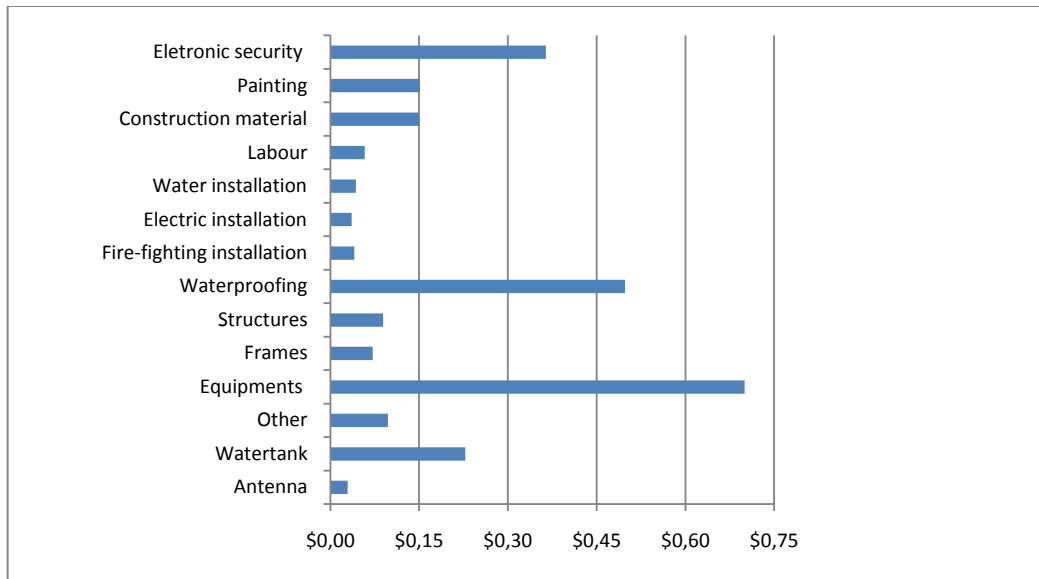


*Figure 5: Monthly average cost of maintenance*

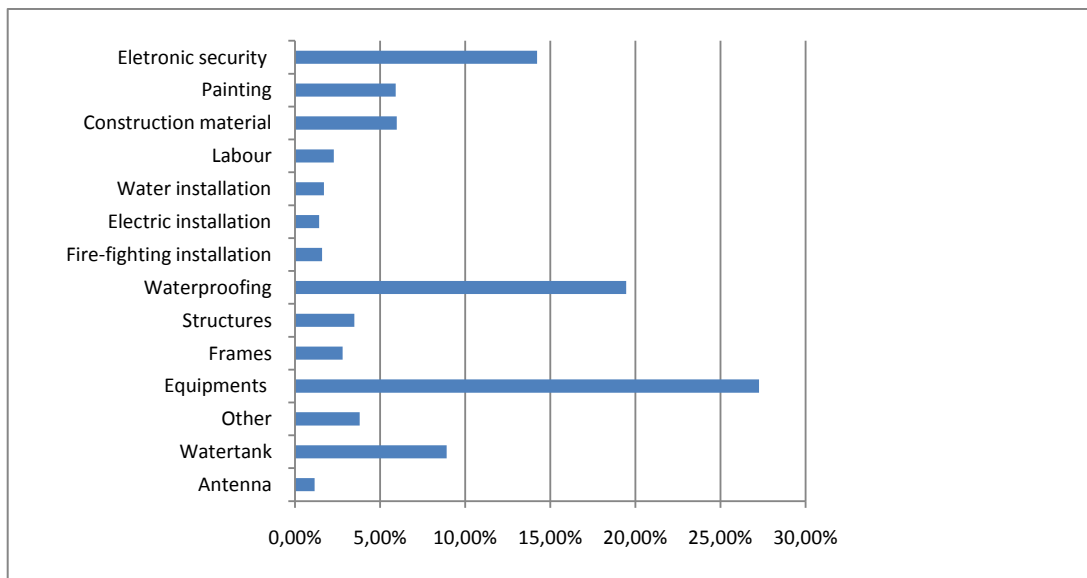
It can be observed that maintenance costs present a very large variability during the twenty months studied. In some one it wasn't identified maintenance expenses. In April and May 2009, for example, there has been no maintenance cost. The use of corrective maintenance strategy justifies this result, because in this period no abnormality was identified in common areas. Moreover, in March 2010 it was identified the highest cost (0.40\$/m<sup>2</sup>). The maintenance in the electronic security system was responsible for much of that in this month. January and July 2009 were also high cost because of the maintenance in equipments in common area

In this condominium it wasn't identified increase in maintenance costs after the rainy season, as observed in condominium A.

Distributions for each of the maintenance cost items are given in Figures 6 and 7.



**Figure 6: Total expenses per item (\$/m<sup>2</sup>)**

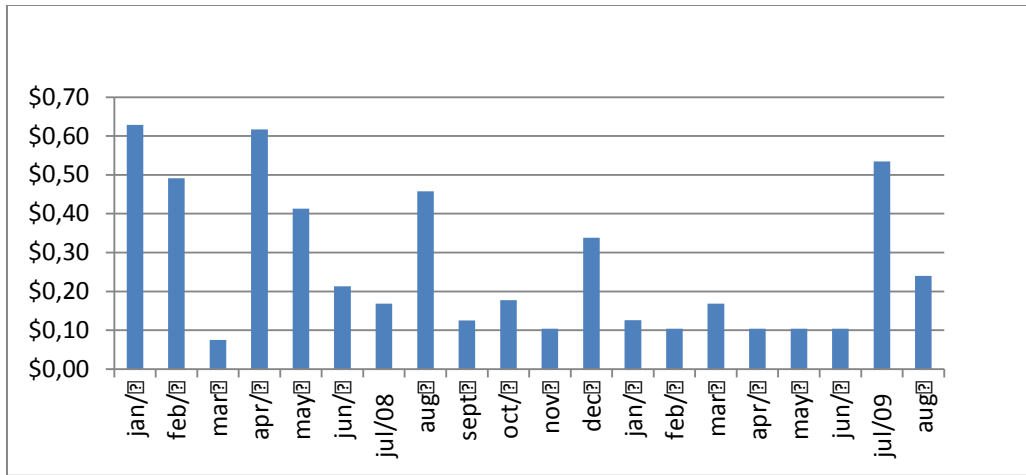


**Figure 7: Distribution of items of maintenance costs (%)**

Equipment, waterproofing and electronic security were the most representative item of this condominium. These three items accounted for almost 60% of maintenance costs and only equipment was responsible for around 26% of the costs. The cost of waterproofing was around 19%. This value is closed to that found in Condominium A.

**Condominium C**

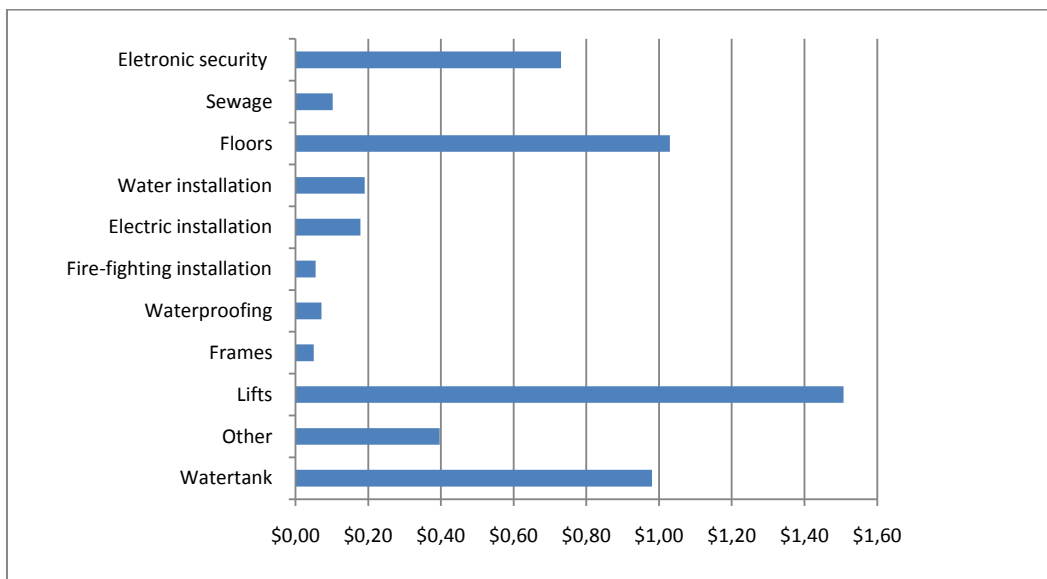
The average maintenance cost for this building was 0.26\$/m<sup>2</sup>. The monthly distribution of costs is given in Figure 8.



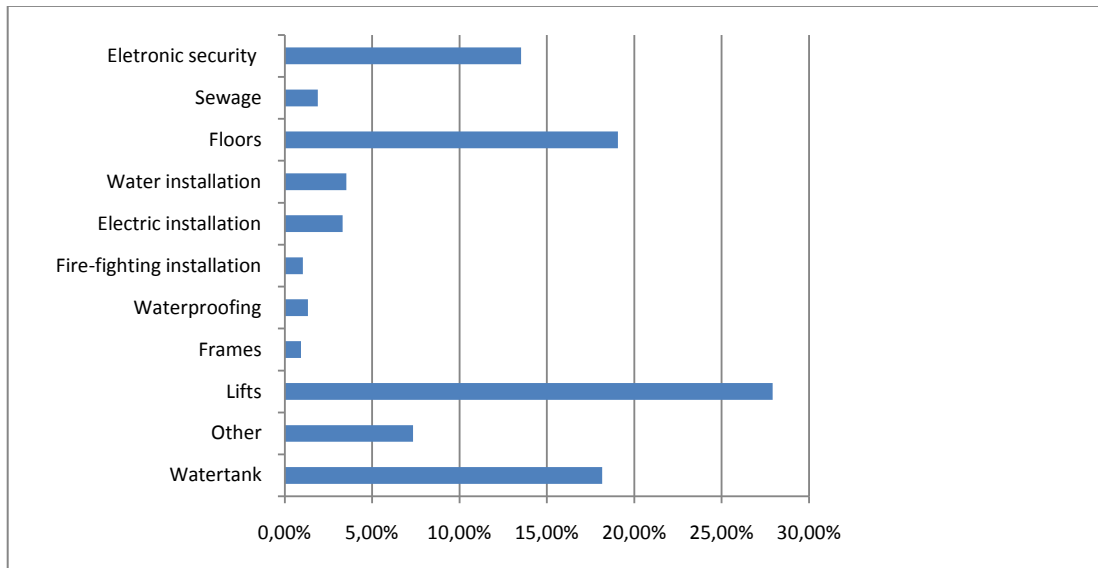
**Figure 8: Monthly average cost of maintenance**

During the twenty months, maintenance cost varied from 0.07 – 0.63\$/m<sup>2</sup>, although for 60% of the months the cost was in the range from 0.07 – 0.21\$/m<sup>2</sup>. January and April 2008 had high maintenance costs because of the extra services in the lifts and in the floors. Rainy season affect a little some maintenance costs, specifically in August 2008, where it was realized maintenance in the waterproofing of the condominium. Already in July 2009 there was an atypical spending on maintenance in the watertank which contributed to the increase in the cost this month.

Distributions for each of the maintenance cost items are given in Figures 9 and 10.



**Figure 9: Total expenses per item (\$/m<sup>2</sup>)**



**Figure 10: Distribution of items of maintenance costs (%)**

For the twenty months analysed, it can be observed that expenditures were concentrated in few items (only 11) and the most expensive items in terms of maintenance were lifts, floors, pumps and watertank. These three items account for 65.2% of the total maintenance cost. Other items had very little effect on the total maintenance cost.

An analysis of the most representative items of the other condominium shows that, for Condominium A, lifts is an item with a large percentage of cost at around 17%. For Condominium C the percentage of cost at almost 28%. It is noteworthy that in Condominium B there aren't lifts.

### Comparative analysis

It is important to know how much of total running cost (operating cost and maintenance cost) is allocated for maintenance cost. This investigation can be seen in Figure 11.

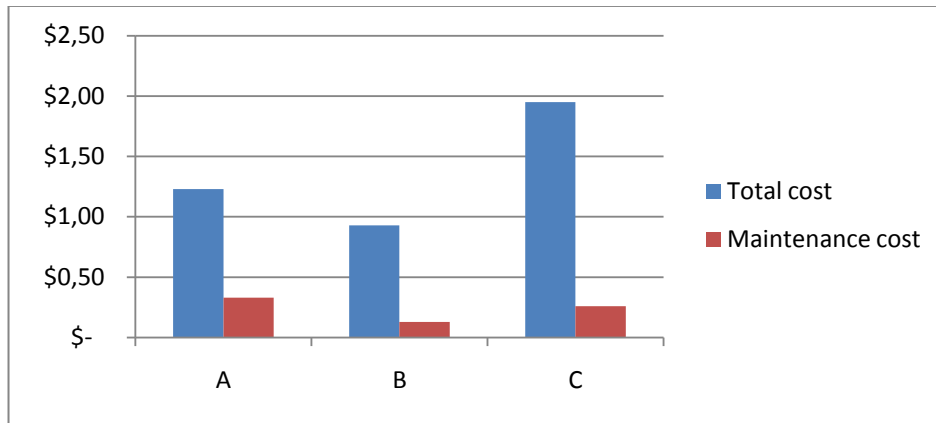


Figure 11: Average monthly running cost and average monthly maintenance cost

It is possible to see that Condominium C is the one with the highest total running cost (1.95\$/m<sup>2</sup>). From this value it is allocated 0.26\$/m<sup>2</sup> for maintenance. It represents less than 15% of the total running cost. Condominium B has the lowest current cost (0.93\$/m<sup>2</sup>) and the lowest maintenance cost (0.13\$/m<sup>2</sup>). Maintenance represents almost 14% of the running cost. Condominium A has the largest number of items of maintenance (21 items) and the highest average monthly maintenance (0.33\$/m<sup>2</sup>). Running cost is responsible for 1.23\$/m<sup>2</sup>. Maintenance represents 26.8% of total running cost.

The average monthly running cost for the three condominiums is 1.37\$/m<sup>2</sup> and the average monthly maintenance cost is 0.24\$/m<sup>2</sup>. The percentage of running cost is closed to 18%.

Figure 12 shows how the maintenance cost of the condominiums varies according to the age of them.

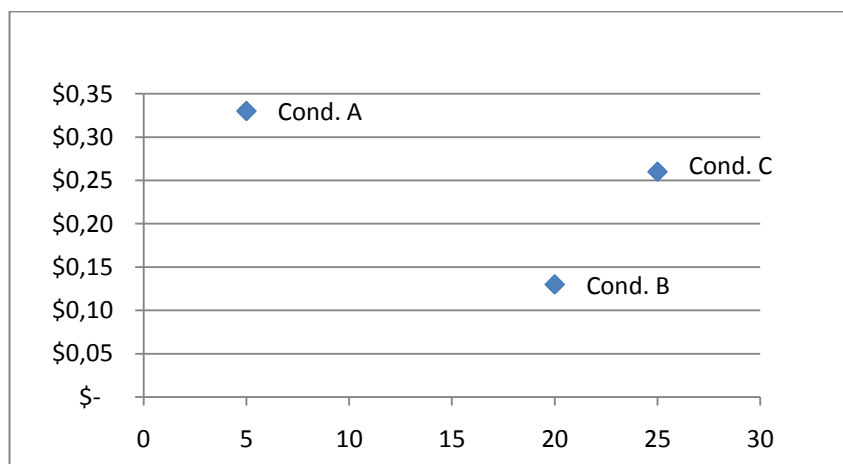


Figure 12: Average monthly maintenance cost by age of the building

The results demonstrate that there isn't a strong relationship between maintenance cost and age of the building, as several authors reported (MARTEINSSON and JÓNSSON, 1999; ANDERSEN, 1995).

## 5. Conclusions

Some aspects were concluded during this work:

- Few items concentrate most of the maintenance cost of the condominiums. This result in a very irregular distribution of costs.
- Lifts and waterproofing are the items responsible for higher costs in condominiums.
- It wasn't identified relationship between maintenance cost and age of the condominium, in contradiction with some authors. Although the number of condominiums studied was small, what makes the results representative only for the sample, the research could be more thorough in these cases, increasing the number of months analyzed. Twenty months is insufficient to study the effect of age on maintenance costs. Thus, for future works, it is suggested a longer period of investigated months.
- The rainy season in the region usually occurs during the months from May to July. It was observed some increases in the cost of some maintenance items in the months subsequent to such periods, as a consequence of the rainy season.

Finally, it is important to say that if maintenance costs are taken into account from design and construction stages, better buildings will be achieved, with moderate costs of maintenance during the life cycle. Moreover, if the studies related to maintenance were used by the buildings, it would be possible improve its services and reduce maintenance costs. However, it is interesting to note that only 5% of the organisations use the data collected from the maintenance function for any analysis (BRADSHAW, 2000).

## References

- Al-Hajj, A. (1999) "Modeling running and maintenance costs for life cycle costing applications in buildings". *Proceedings of the eighth International Conference on Durability of Building Materials & Components*, 1999, Vancouver: 1699-1706.
- Al-Hajj, A.; Horner, M. W. (1998) "Modeling the running costs of buildings". *Construction Management and Economics* 16: 459-470.
- Amarilla, B. C. (1992) "Maintenance costs of blocks of flats in developing countries". *Housing Science and its Applications* 16: 107-114.
- Andersen, H. S. (1995) "Explanation of decay and renewal in the housing market: what can Europe learn from American research?" *Netherlands Journal of Housing and the Built Environment* 10: 65-85.
- Asterisk Realty (2009) "Average Maintenance cost of office building in Tokyo" (available online <http://www.asteriskrealty.jp/articles/news/average-meintenance-cost-office-tokyo.html> [accessed on 16/07/2010])



- Bradshaw, L. (2000) *Improving your maintenance planning*, Victoria, Australia.
- Davies, H. (2000) “Occupancy costs in Hong Kong” *Proceedings of the Brisbane 2000 CIB W70 International Symposium on Facilities Management and Maintenance*, 15-17 November 2000, Queensland University of Technology, Brisbane.
- El-Haram, M. A.; Horner, M. W. (2002) “Practical application of RCM to local authority housing: a pilot study. *Journal of Quality in Maintenance Engineering* 8: 135-143.
- Kiang, Q. L. (1991) “Building maintenance and modernization – research and practice trends”. *Management, quality and economics in building*. A. Bezelga and P. Brandon, eds., E & FN SPON, London, England: 1167-1177.
- Koskela, L. (2000) “An exploration towards a production theory and its application to construction”. *Thesis (Doctorate in Technology)*. Technical Research Center of Finland, Espoo. p.296.
- Marteinsson, B.; Jónsson, B. (1999) “Overall survey buildings – performance and maintenance”. *Proceedings of the eighth International Conference on Durability of Building Materials & Components*, 1999, Vancouver: 1634-1644.
- McEwan, A. (2000) “Maintenance cost analysis of government buildings in Queensland”. *Proceedings of the Brisbane 2000 CIB W70 International Symposium on Facilities Management and Maintenance*, 15-17 November 2000, Queensland University of Technology, Brisbane.
- Meira, A. (2002) “Estudo das variáveis associadas ao estado de manutenção e a satisfação dos moradores de condomínios residenciais”. *Thesis (Doctorate in Production Engineering)*. Federal University of Santa Catarina, Florianópolis, p.285.



# INTERNATIONAL COUNCIL FOR RESEARCH AND INNOVATION IN BUILDING AND CONSTRUCTION

CIB's mission is to serve its members through encouraging and facilitating international cooperation and information exchange in building and construction research and innovation. CIB is engaged in the scientific, technical, economic and social domains related to building and construction, supporting improvements in the building process and the performance of the built environment.

## **CIB Membership offers:**

- international networking between academia, R&D organisations and industry
- participation in local and international CIB conferences, symposia and seminars
- CIB special publications and conference proceedings
- R&D collaboration

**Membership:** CIB currently numbers over 400 members originating in some 70 countries, with very different backgrounds: major public or semi-public organisations, research institutes, universities and technical schools, documentation centres, firms, contractors, etc. CIB members include most of the major national laboratories and leading universities around the world in building and construction.

**Working Commissions and Task Groups:** CIB Members participate in over 50 Working Commissions and Task Groups, undertaking collaborative R&D activities organised around:

- construction materials and technologies
- indoor environment
- design of buildings and of the built environment
- organisation, management and economics
- legal and procurement practices

**Networking:** The CIB provides a platform for academia, R&D organisations and industry to network together, as well as a network to decision makers, government institution and other building and construction institutions and organisations. The CIB network is respected for its thought-leadership, information and knowledge.

CIB has formal and informal relationships with, amongst others: the United Nations Environmental Programme (UNEP); the European Commission; the European Network of Building Research Institutes (ENBRI); the International Initiative for Sustainable Built Environment (iiSBE), the International Organization for Standardization (ISO); the International Labour Organization (ILO), International Energy Agency (IEA); International Associations of Civil Engineering, including ECCS, fib, IABSE, IASS and RILEM.

**Conferences, Symposia and Seminars:** CIB conferences and co-sponsored conferences cover a wide range of areas of interest to its Members, and attract more than 5000 participants worldwide per year.

## **Leading conference series include:**

- International Symposium on Water Supply and Drainage for Buildings (W062)
- Organisation and Management of Construction (W065)
- Durability of Building Materials and Components (W080, RILEM & ISO)
- Quality and Safety on Construction Sites (W099)
- Construction in Developing Countries (W107)
- Sustainable Buildings regional and global triennial conference series (CIB, iiSBE & UNEP)
- Revaluing Construction
- International Construction Client's Forum

## **CIB Commissions (June 2010)**

- TG58 Clients and Construction Innovation
- TG59 People in Construction
- TG62 Built Environment Complexity
- TG63 Disasters and the Built Environment
- TG64 Leadership in Construction
- TG65 Small Firms in Construction
- TG66 Energy and the Built Environment
- TG67 Statutory Adjudication in Construction
- TG68 Construction Mediation
- TG69 Green Buildings and the Law
- TG71 Research and Innovation Transfer
- TG72 Public Private Partnership
- TG73 R&D Programs in Construction
- TG74 New Production and Business Models in Construction
- TG75 Engineering Studies on Traditional Constructions
- TG76 Recognising Innovation in Construction
- TG77 Health and the Built Environment
- TG78 Informality and Emergence in Construction
- TG79 Building Regulations and Control in the Face of Climate Change
- TG80 Legal and Regulatory Aspects of BIM
- TG81 Global Construction Data
- W014 Fire
- W018 Timber Structures
- W023 Wall Structures
- W040 Heat and Moisture Transfer in Buildings
- W051 Acoustics
- W055 Building Economics
- W056 Sandwich Panels
- W062 Water Supply and Drainage
- W065 Organisation and Management of Construction
- W069 Housing Sociology
- W070 Facilities Management and Maintenance
- W077 Indoor Climate
- W078 Information Technology for Construction
- W080 Prediction of Service Life of Building Materials and Components
- W083 Roofing Materials and Systems
- W084 Building Comfortable Environments for All
- W086 Building Pathology
- W089 Building Research and Education
- W092 Procurement Systems
- W096 Architectural Management
- W098 Intelligent & Responsive Buildings
- W099 Safety and Health on Construction Sites
- W101 Spatial Planning and Infrastructure Development
- W102 Information and Knowledge Management in Building
- W104 Open Building Implementation
- W107 Construction in Developing Countries
- W108 Climate Change and the Built Environment
- W110 Informal Settlements and Affordable Housing
- W111 Usability of Workplaces
- W112 Culture in Construction
- W113 Law and Dispute Resolution
- W114 Earthquake Engineering and Buildings
- W115 Construction Materials Stewardship
- W116 Smart and Sustainable Built Environments
- W117 Performance Measurement in Construction





# INTERNATIONAL COUNCIL FOR RESEARCH AND INNOVATION IN BUILDING AND CONSTRUCTION

**Publications:** The CIB produces a wide range of special publications, conference proceedings, etc., most of which are available to CIB Members via the CIB home pages. The CIB network also provides access to the publications of its more than 400 Members.



### Recent CIB publications include:

- Guide and Bibliography to Service Life and Durability Research for Buildings and Components (CIB 295)
- Performance Based Methods for Service Life Prediction (CIB 294)
- Performance Criteria of Buildings for Health and Comfort (CIB 292)
- Performance Based Building 1st International State-of-the-Art Report (CIB 291)
- Proceedings of the CIB-CTBUH Conference on Tall Buildings: Strategies for Performance in the Aftermath of the World Trade Centre (CIB 290)
- Condition Assessment of Roofs (CIB 289)
- Proceedings from the 3rd International Postgraduate Research Conference in the Built and Human Environment
- Proceedings of the 5th International Conference on Performance-Based Codes and Fire Safety Design Methods
- Proceedings of the 29th International Symposium on Water Supply and Drainage for Buildings
- Agenda 21 for Sustainable Development in Developing Countries

**R&D Collaboration:** The CIB provides an active platform for international collaborative R&D between academia, R&D organisations and industry.

### Publications arising from recent collaborative R&D activities include:

- Agenda 21 for Sustainable Construction
- Agenda 21 for Sustainable Construction in Developing Countries
- The Construction Sector System Approach: An International Framework (CIB 293)
- Red Man, Green Man: A Review of the Use of Performance Indicators for Urban Sustainability (CIB 286a)
- Benchmarking of Labour-Intensive Construction Activities: Lean Construction and Fundamental Principles of Working Management (CIB 276)
- Guide and Bibliography to Service Life and Durability Research for Buildings and Components (CIB 295)
- Performance-Based Building Regulatory Systems (CIB 299)
- Design for Deconstruction and Materials Reuse (CIB 272)
- Value Through Design (CIB 280)

**Themes:** The main thrust of CIB activities takes place through a network of around 50 Working Commissions and Task Groups, organised around four CIB Priority Themes:

- Sustainable Construction
- Clients and Users
- Revaluing Construction
- Integrated Design and Delivery Solutions

### CIB Annual Membership Fee 2010 – 2013

Membership will be automatically renewed each calendar year in January, unless cancelled in writing 3 months before the year end

Fee Category		2010	2011	2012	2013
FM1	Fee level	11837	12015	12195	12378
FM2	Fee level	7892	8010	8131	8252
FM3	Fee level	2715	2756	2797	2839
AM1	Fee level	1364	1384	1405	1426
AM2	Fee level	1133	1246	1371	1426
IM	Fee level	271	275	279	283

All amounts in EURO

The lowest Fee Category an organisation can be in depends on the organisation's profile:

- FM1** Full Member Fee Category 1 | Multi disciplinary building research institutes of national standing having a broad field of research
- FM2** Full Member Fee Category 2 | Medium size research Institutes; Public agencies with major research interest; Companies with major research interest
- FM3** Full Member Fee Category 3 | Information centres of national standing; Organisations normally in Category 4 or 5 which prefer to be a Full Member
- AM1** Associate Member Fee Category 4 | Sectoral research & documentation institutes; Institutes for standardisation; Companies, consultants, contractors etc.; Professional associations
- AM2** Associate Member Fee Category 5 | Departments, faculties, schools or colleges of universities or technical Institutes of higher education (Universities as a whole can not be Member)
- IM** Individual Member Fee Category 6 | Individuals having an interest in the activities of CIB (not representing an organisation)

### Fee Reduction:

A reduction is offered to all fee levels in the magnitude of 50% for Members in countries with a GNIPc less than USD 1000 and a reduction to all fee levels in the magnitude of 25% for Members in countries with a GNIPc between USD 1000 – 7000, as defined by the Worldbank. (see <http://siteresources.worldbank.org/DATASTATISTICS/Resources/GNIPC.pdf>)

### Reward for Prompt Payment:

All above indicated fee amounts will be increased by 10%. Members will subsequently be rewarded a 10% reduction in case of actual payment received within 3 months after the invoice date.

### For more information contact



CIB General Secretariat:  
e-mail: [secretariat@cibworld.nl](mailto:secretariat@cibworld.nl)

PO Box 1837, 3000 BV Rotterdam,  
The Netherlands  
Phone +31-10-4110240;  
Fax +31-10-4334372  
[Http://www.cibworld.nl](http://www.cibworld.nl)

