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An Overview of Green Retrofitting Implementation in Non Residential Existing Buildings

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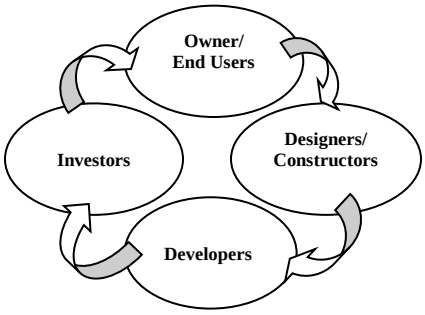

The Circle of Blame

Abstract

Sustainability has been the latest value added service in the facility management field. However, the practice of sustainability in the facility management field is not well recognized and understood by the facility management team. As a result, building sector account to be the largest source of greenhouse gas emissions around the world. In fact, there is a strong business case for green building, yet green buildings represent the next phase of buildings. Since, the majority of the existing stock of buildings is not sustainably built and as it is not practically viable to demolish all the existing buildings, hence, one alternate solution is green retrofitting. However, the responses for green retrofitting are at very low rate. This paper reports the need to green retrofitting, reasons behind the limited number of green retrofitting implementation, and finally, a critical review of the existing body of knowledge on green retrofitting has been conducted. It is found that there has been no research conducted till to date on identifying the success factors for successful green retrofitting implementation.

Keywords: Sustainability; facility management; existing building; green retrofitting; success factors

Abstrak

Kemampanan merupakan perkhidmatan terkini dalam bidang pengurusan fasiliti yang akan meningkatkan nilai perkhidmatan. Walau bagaimanapun, kemampanan dalam bidang pengurusan fasiliti tidak diamalkan dengan berleluasa oleh golongan pengurusan fasiliti. Hal ini merupakan punca utama sektor bangunan muncul sebagai sumber terbesar pelepasan gas rumah hijau. Walaupun, pembinaan bangunan hijau semakin berkembang, tetapi apa yang tidak dapat dinafikan adalah bangunan hijau baru mewakili fasa baru bangunan. Malah, kebanyakan bangunan sedia ada tidak mampan dan tidak wajar untuk merobohkan kesemua bangunan ini untuk digantikan dengan bangunan hijau, maka satu cara alternatif adalah pengubahsuaian hijau. Akan tetapi, pengubahsuian hijau tidak mendapat sambutan yang hangat. Kajian ini melaporkan sebab keperluan pengubahsuaian hijau, sebab sambutan yang terhad dalam perlaksanaan pengubahsuaian hijau dan akhir sekali, kajian kritikal literatur dijalankan dalam bidang pengubahsuain mampan. Adalah didapati, tiada sebarang kajian yang dijalankan sehingga kini dalam mengenalpasti faktor kejayaan untuk pelaksanaan pengubahsuaian hijau.

Kata kunci: Kemampanan; pengurusan fasiliti; bangunan sedia ada; pengubahsuaian mampan; faktor kejayaan

1.0 INTRODUCTION

Facilities management (FM) is a term that covers a wide range of activities comprised in the effective management of built assets. Alexander acknowledged facilities management as a process by which an organization delivers and sustains support services in quality environment to meet strategic needs.[1] The International Facility Management Association (IFMA) defines facilities management as a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, processes and technology.[2] Therefore, facility management is an umbrella term under which, a wide range of property and user related functions may be brought together for the benefit of the organization and its employees as a whole.[3] It involves the complete management of all services that support the fundamental business of the organization.[3] For instance, facilities management services cover real estate management, financial management, change management, human resources management, health and safety, contract management, in addition to, building and engineering services maintenance, domestic services and utility supplies.[4] The latest value added service in the facility management field is sustainability.[5]

Facility managers often becomes the promoter of sustainable and green building practices.[6] According to World Commission on Environment and Development or the Brundtland Commission, sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable or "green" building is a division under the umbrella of sustainable development and are in accordance with the three aspects of sustainable development; economic social and environmental benefits. Green building is defined as "an outcome of a design which focuses on increasing the efficiency of resource use energy, water and materials while reducing building impacts on the human health and the environment during the building's lifecycle, through better sitting, design, construction, operation, maintenance and removal.[7] Additionally, according to Kozlowski, sustainable building is one that "uses a careful integrated design strategy that minimized energy use, maximizes daylight, has a high degree of indoor air quality and thermal comfort, conserves water, reuses materials and uses materials with recycled content, minimizes site disruptions and generally provides a high degree of occupant comfort".[8] Hence, there is no doubt that implementing sustainability and green building approaches to facilities will benefit an organization through greater financial returns, increased standing in the community, improved productivity and reduced detrimental effects on the environment.[6]

Despite, Pong added that majority of the facilities team do not practice sustainability services in the facilities management and are still wondering what are sustainability.[5] As a result, building sector by far has been one of the largest sources of greenhouse gas emissions around the world. An estimates by the American Institute of Architects (AIA), suggests that nearly 50% of all greenhouse gas emissions are generated by buildings and their construction in term of the energy used in the production of materials, transportation of materials from production factories to construction site as well as energy used in running and operating buildings. Additionally, according the USGBC, existing buildings are accountable for 72% of electricity consumption, 40% of raw material usage, 39% of energy use, 35% carbon dioxide emissions, 30% waste output and 14% potable water consumption.[9] To summarize, buildings are estimated to account for approximately half of all annual energy and greenhouse gas emissions.[10] These numbers are enough to demonstrate that there is indeed a huge negative impact of buildings on the environment. Thus, one prospective solution is to make certain that the design, construction and maintenance of the built environment is sustainably developed.[10-11] Indeed, there is a strong business case for sustainable or "green" buildings.[12] It is worth noting that green building has been used as a term interchangeably with sustainable building and high performance building.[13] However, for the purpose of this study the term green building is preferred as it is widely used in the Malaysian government sector, for example, Ministry of Energy, Green Technology and Water, Green Building Index Malaysia.

Whilst there is growing recognition that green buildings outperform conventional buildings in term of a variety of environmental, social and economic indicators,[14] green buildings represent the next phase of buildings. The reality is that, the vast stock of existing buildings which make up the bulk of the market are not sustainably built. The growing support for green building practices and the current development of new green building construction starts are not enough to reverse this cycle. Consequently, according to Miller and Buys, if the challenge of climate change is to be successfully addressed, therefore, these vast stock of existing buildings needs to be retrofitted.[14] Furthermore, according to Pedini and Ashuri, the ratio of existing buildings to new green construction is overwhelming; retrofitting of existing buildings for sustainability could be the logical solution to reduce the environmental effects sooner.[15] Therefore, the enormous challenge in green building is not to construct a minority of highly new green buildings, so much as to raise the sustainability of the entire stock of buildings in active use through retrofitting.

Douglas defined retrofit as "any work to a building over and above maintenance to change its capacity, function or performance, in other words, any intervention to adjust, reuse or upgrade a building to suit new conditions or requirements".[16] Retrofit events can be referred to as alterations and extensions, upgrade, change of use and renovations and multi-tenanted buildings can experience multiple events in the one building.[17] United State Green Building Council (USGBC) defined green retrofit as "any type of upgrade at an existing building that is wholly or partially occupied to improve energy and environmental performance, reduce water use, improve comfort and quality of space in terms of natural lighting, air quality and noise, all done in a way that it is financially beneficial to the owner".[9] Additionally, green building refurbishment not only decrease energy consumption but also improves whole condition of the building; its exploitation, noise insulation, exterior, and comfort; prolongs buildings lifecycle, increase value of the buildings, reduces negative impact to environment and guarantees healthy living and working condition.[18] Therefore, green retrofits will results in lower greenhouse gas emissions, less resource use and consumption and healthier workplaces for building users.[17] There is a surfeit of terms used to cover retrofit such as adaptation, refurbishment, upgrade, conversion, renovation and exist in a "state of happy confusion".[19] Furthermore, it is also worth noting that green retrofit has been used as a term interchangeable with sustainable retrofit and sustainable building refurbishment. However, for the purpose of this study, the term green retrofit is preferred as it is more commonly used among researchers, though some researchers use the terms interchangeably.

Green retrofit projects in vast stock of conventional buildings offers significant opportunities for reducing global energy consumption and greenhouse gas emissions. This is because, although socio-economic growth generates a constant demand for new buildings, the number of buildings constructed annually in developed countries only corresponds to 1.5-2 percent of the existing building stock.[20] At this rate of construction output, it would take anything from 50 to 100 years to replace the current stock of existing buildings.[20] Therefore, the majority of these existing building stocks will remain with us for decades.[21-23] On the other hand, existing buildings correspond to an energy investment that has already been expended in the procurement, manufacture and transportation of materials and in the construction process itself. Thus, to demolish an existing building and to build a new "green" building in its place is counter-productive to the idea of energy conservation. By some estimation, it would take more than 65 years to regain the energy savings of demolishing an existing building and replacing it with a new "green" building.[24]

Therefore, the negative impacts of existing buildings are twofold; on the one hand, if they are replaced, the demolition waste would fill and pollute landfills, on the other hand, if these buildings are allowed to stand without retrofitting, their negative impact on the environment would continue.[15] In this situation, implementing green retrofit projects in existing buildings using any viable standard would bring the benefit of green building to existing structure and help mitigate the negative environmental impact caused by them. Green retrofit projects are considered as one of the major approaches to practically achieving reduced energy consumption and greenhouse gas emissions in the built environment at fairly low cost and high uptake rates.[25] Since,

when all building types are measured, the major single source of greenhouse gas emissions in buildings came from commercial buildings, and therefore the focus for making significant reductions of emissions lies within this group.[26] In fact, according to Menassa and Baer, stakeholders are concerned with raising the sustainability of their existing buildings from social, environmental, economic and technical perspectives.[27]

Despite of all these facts, the question is how much progress are actually done in regards to "green retrofits"? Unfortunately, even with the growing concerns of stakeholders over environmental, social and economic aspects, green retrofit project is not winning its place at the forefront as hoped for.[15] Existing buildings are continued to be retrofitted at a very low rate.[28] For instance, according to Olgyay & Seruto, existing commercial building stock is currently being retrofitted at a rate of approximately 2.2% per year only.[28]

■2.0 PROBLEMS IN IMPLEMENTING GREEN RETROFIT PROJECTS

Green retrofit projects are still not widely practiced, although there is significant demand for green buildings.[27] The limited response of the commercial property markets to sustainability is well recorded.[29-31] For instance, in Malaysia, the situation is even worse, Table 1.1 below illustrates the GBI certified projects by category in Malaysia and Table 1.2 illustrates the GBI certified projects by rating categories. It is clear from the table that only 16 non residential existing buildings have applied for the GBI status till 15 January 2014. Yet, 15 buildings are qualified for registration and only 7 buildings have obtained certification. Furthermore, out of 7 buildings, 5 buildings received provisional certification after design assessment where else; only 2 buildings received final certification after the completion and verification assessment. For the purpose of this research, the term non-residential existing building will be used in referring to existing commercial buildings hereinafter in order to be in line with the term in Green Building Index Malaysia.

Table 1.1 GBI certified projects in Malaysia

Update on Green Building Index	TOTAL as of 15 JANUARY 2014	NRNC	RNC	INC	NREB	IEB	T
Applied	532	277	210	14	16	3	12
Registered	494	250	202	13	15	2	12
Total Certified	199	98	87	2	7	1	4
	(100%)	(48%)	(44%)	(1%)	(4%)	(1%)	(2%)
Received with Provisional Certification after DA	182	91	81	-	5	-	4
Received Final Certification after CVA	17	7	5	2	2	1	-

Table 1.2 GBI certified projects by rating categories

RATING	TOTAL as of 15 JANUARY 2014	NRNC	RNC	INC	NREB	IEB	T
PLATINUM	7	3	2	-	1	-	1
86 to 100 points	(4%)						
GOLD	54	35	19	-	-	-	-
74 to 85 points	(27%)						
SILVER	26	13	10	-	1	-	2
66 to 75 points	(13%)						
Certified	112	47	56	2	5	1	1
50 to 65 points	(56%)						
Total Certified	199	98	87	2	7	1	4

Source: Green Building Index Malaysia

LEGEND:

NRNC–Non Residential New Construction
NREB – Non Residential Existing Building
INC–Industrial New Construction
CVA – Completion & Verification Assessment
RNC–Residential New Construction
IEB – Industrial Existing Building
T – Township
DA – Design Assessment

According to Menassa and Baer, a decision on whether a building should undergo green retrofit needs to be agreed by the building stakeholders.[27] Foley defines stakeholders as "… those entities and/or issues, which a business identifies from the universe of all who are interested in and/or affected by the activities or existence of that business, and are capable of causing the enterprise to fail, or could cause unacceptable levels of damage, if their needs are not met".[32] Building stakeholders are encouraged to enable operations towards sustainability of non residential existing buildings in order to reduce poor impacts on the environment as well as occupant health over the entire building life cycle. Therefore, in particular major initiatives from building stakeholders are necessary for implementing green retrofit projects. However, according to Wilkinson, research proven that particular building stakeholders are less likely to retrofit and authorities need to consider ways to initiate stakeholders towards green retrofit.[17] Indeed, according to Cadman, the major barrier that obstructs the development of sustainability in existing buildings is the circle of blame.[33] Figure 1.1 displays the vicious circle in which the main

stakeholders of sustainable real estate development have been trapped for many years. All parties said that they were willing to contribute to green building, but they need cooperation of the other stakeholders. Indeed, green retrofit requires the cooperation and participation of a wide range of stakeholders.[14] Therefore, lack of participation and cooperation among stakeholders has been the reason behind the poor record of green retrofit projects implementation. Furthermore, Boecker *et al*., emphasized that engaging all stakeholders early on the design process is key to challenging deeply held assumptions and achieving better solutions that are environmentally, functionally, esthetically and economically viable.[34]

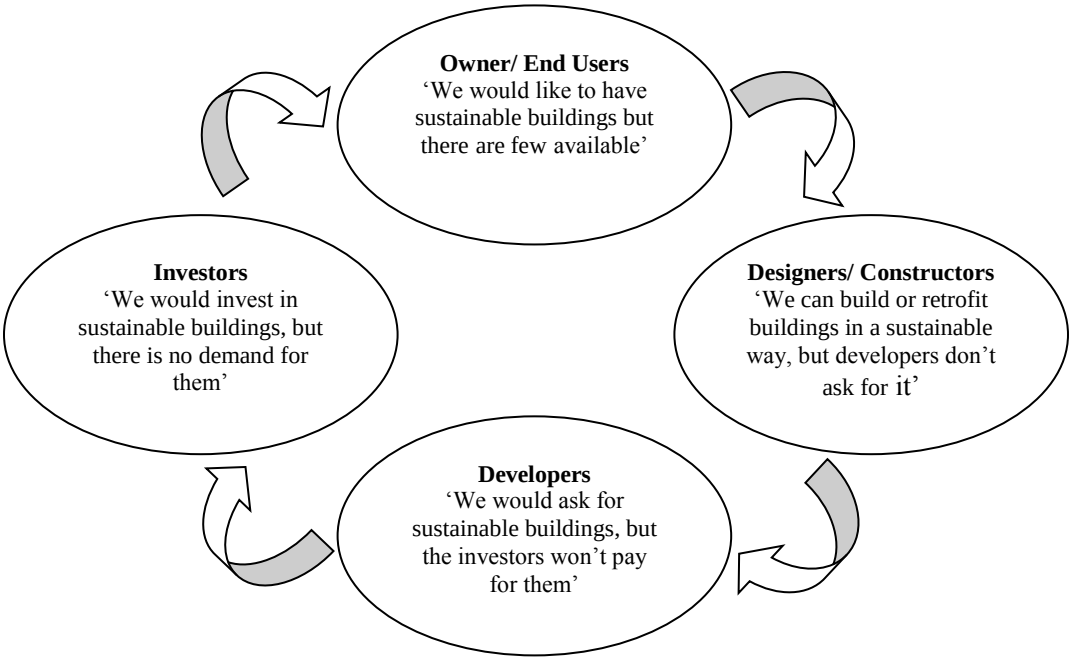

Figure 1.1 The circle of blame[33]

Further review of literature revealed the lack of participation and cooperation among stakeholders of existing buildings is due to the challenges, obstacles, barriers or problems faced by stakeholders that affect the successful implementation of green retrofit projects.[25] The challenges, obstacles, barriers or problems faced by stakeholders may include perceived high upfront costs and uncertain return[15,35-49]; lack of green building professionals[15,35,39-47,49]; lack of financial incentives[15,36,39,41,42,45-48]; knowledge gap in green development quantification[15,37,38,42,43,48-51]; green retrofit awareness[15,36,39,41,43,48]; lack of communication between stakeholders[15,36-38,44,50]; lack of internal leadership[15,36,38]; green material and technology[15,40,48]. These challenges, barriers, obstacles or problems stated above are the influential forces which impede successful implementation of green retrofit projects. In a nutshell, they are the factors contribute to the failure of a project.

According to Toor and Ogunlana, to achieve success on project, it is imperative to start by determining the failure factors.[52] Indeed, a variety of failure factors determined affecting the success of a green retrofit project, such as policies and regulations, client resources and expectations, retrofit technologies, building specific information, human factor and other uncertainty factors.[25] These varieties of failure factors, propels the study of this research onto the critical success factors. According to De wit a project is considered successful if there was a high level of satisfaction concerning the project outcome among key stakeholders from the parent organization, the project team and end users.[53] However, there is no an industry accepted or standardized definition of project success because the fact is the individual project teams find themselves in unique situations, implying that their definition of success will differ from that of another project team. In fact, according to Lapinski *et al*., implementation of green retrofit projects involves a significant amount of planning and communication with numerous stakeholders to obtain a commitment to shared goals and achieve a beneficial solution for all involved.[54] According to Boecker *et al*., diversity of values, opinions, expectations and perspectives among stakeholders is expected but need to be properly managed to turn it from a liability that can significantly impede project success into an asset.[34] Therefore, to successfully implement green retrofit projects, the understanding and determination of stakeholder success factors is a crucial consideration for facility manager/project manager or more commonly known as the change agent. The term change agent will be used throughout this research to represent the facility manager or the project manager. Similarly, once the change agent team is well aware of the success factors, they can easily identify and prioritize critical issues associated with implementing the project plan.[55] In fact, understanding the structural relationship between different success factors is vital in developing strategies for effective implementation. The importance of the success factors cannot be ignored as they guide practitioners to focus on key area during implementation.[56] Thus, the basis of this research is the investigation on the CSFs of green retrofit projects implementation.

■3.0 CURRENT STATE OF RESEARCH ON CSFS OF GREEN RETROFIT PROJECTS IMPLEMENTATION

CSF was first developed by Rockart.[57] CSFs are the limited number of areas in which results, if they are satisfactory will

ensure successful competitive performance for the organization.[57] CSFs are also known as the few key areas where 'things must go right' for the business to flourish, areas of activity that should receive constant and careful attention from management, and also areas in which good performance is necessary to ensure attainment of goals.[57]

Review on the literature on green retrofits revealed no research has been conducted till now on the critical success factors (CSFs) for green retrofit projects implementation (Refer Table 1.3). As a result, till to date there is no strong constructs of CSFs for green retrofit. In fact, in order to address the current issue of this study, specific review on CSFs has been conducted which highlight the current limitation.

3.1 Lack of Comprehensive List of CSFs for Green Retrofit Projects Implementation

Critical review of previous researches on green retrofits has been tabulated in Table 1.3 below. Generally, most of the researchers on green retrofitting focused on green retrofit methods and framework. Indeed, few studies have explored the technical, economic and environmental implications of existing building green retrofits.[58-65] Additionally, a review on recent literature shows very few studies have conducted on what motivates public and private building owners to pursue green and green building design initiatives.[27] Yudelson identified multiple reasons why building owners and operators are interested in energy efficient and sustainably retrofitted buildings.[47] Where else, Fuerst and McAllister outlined the rational to pursue green building design.[66]

Table 1.3 A critical review of researches related to green retrofits projects implementation

Issues	Literature	Frequency
Methods and Framework	Lam[80]; Hayter *et al*.,[81]; Asadi *et al*.,[71]; Ferrante *et al*.,[76]; Wolf[77]; Xing *et al*.,[78]; Mickaityte *et al*.,[18]; Boron & Murray[79]; Scichili & James[74]; Alanne[75]; Dascalaki & Balaras[67]; Ma *et al*.,[25]; Gohardani & Bjork[73]; Bullen[20]; Aroul & Hansz[82]; Kaklauskas *et al*.,[68]; Dong *et al*.,[72]; Phdungsilp & Martinac[70]; Dan[69]; Chidiac *et al*.,[58]; Wilkinson[17].	22
Technical, Economic and Environmental Implications	Chidiac *et al*.,[58]; Entrop *et al*.,[59]; Gaterell and McEvoy[60]; Gluch and Baumann[61]; Juan *et al*.,[62]; Nemry *et al*.,[63]; Papadopoulos *et al*.,[64]; Poel *et al*.,[65].	8
Challenges	Pedini & Ashuri[15]; Brown & Southworth[51]; Mcdonald *et al*.,[37]; International Labour Organization[43]; Benson *et al*.,[42].	5
Benefits/ Motivates	Kok *et al*.,[83]; Reed and Wilkinson[26], Yudelson[47]; Fuerst and McAllister [66]; Miller & Buys[14]	5
Sustainability Assessment	Juan *et al*.,[62]; Ellison and Sayce[84].	2
Role of Stakeholder	Menassa and Baer[27]	1

3.2 Lack of CSFs in the Facilities Management Field

Various studies have been conducted since 1960, to explore the factors that are really important to be considered for achieving the success on projects. In fact, numerous studies related to CSFs have been conducted in various sectors until to date such as information technology (IT), industrial systems, construction, process engineering, business development and operations management.[52] However, no research has been conducted to investigate the CSFs in the facilities management sector. Table 1.4 below shows studies on CSFs over the years in various sectors.

Table 1.4 Previous studies on CSFs across various sectors

	Sector	Literature
CSFs	Project Management	Pinto and Slevin[85]
	Educational Management	Volery and Lord[86]
	Information Management System	Magal, Carr and Watson[87]
	Product Management	Cooper and Kleinschmidt[88]
	Enterprise Resource Planning	Nah and Delgado[89]
	Construction Project	Chua, Kog and Loh[90]
	Business Management	Yusuf[91]
	Software Projects	Reel[92]
	Financial Services	Cooper and Edgett[93]
	Information Technology	Gottschalk and Solli-Saether[94]
	Industrial	Rothwell[95]
	Banking	Chen[96]
	Marketing	Baker and Cameron[97]
	Tourism	Thomas and Long[98]
	Facilities Management	???

4.0 CONCLUSION

Based on the above studies on the problems in implementing green retrofit projects and critical review of literature on CSFs for green retrofit projects implementation and facilities management, it is clear a substantial gap in research exists in the area of CSFs of green retrofit projects implementation. Since, every project has a specific set of success factors which may not be transferable to another project,[44] this research aims to fill in the substantial gap in the current research area. Therefore, this paper proposes to develop a critical success factors (CSFs) model for green retrofit projects implementation. The identification of CSFs model for green retrofit projects implementation is an important starting point as this will enable limited resources such as time, manpower and money to be allocated appropriately. Therefore this paper seeks to present a new agenda in developing the knowledge base, focusing on the CSFs for implementing green retrofit projects in non residential existing buildings.

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References

[1] Alexander, K. 2003. A Strategy for Facilities Management. *Facilities.* 21(11/12): 269–274.
[2] International Facilities Management Association, 1994. Research Report No. 13–Benchmark II, Texas.
[3] Amaratunga, D., Baldry, D., Sarshar, M. 2000. Assessment of Facilities Management Performance–What Next? *Facilities*. 18(1/2): 66–75.
[4] Kamaruzzaman, S. N., Zawawi, E. M. A. 2009. Practice Paper Development of Facilities Management in Malaysia. *Journal of Facilities Management.* 8(1): 75–81.
[5] Pong, Y. Y. 2010. The Implementation and Practice of Facilities Management in Malaysia. MsC Thesis. Heriot-Watt University, Department of Engineering and Survey.
[6] Hodges, C. P. 2005. A Facility Manager's Approach to Sustainability. *Journal of Facilities Management.* 3(4): 312–324.
[7] Frej, A., Browning, W. D. 2005. Green Office Buildings: A Practical Guide to Development. Urban Land Institute.
[8] Kozlowski, D. 2003. Green Gains:Where Sustainable Design Stands Now. *Building Operating Management.* 50(7): 26–32.
[9] USGBC. 2003. The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force, USGBC, San Francisco, CA. Available at: www.usgbc.org.
[10] Brown, M., Southworth, F., Stovall, T. 2005. Towards A Climate Friendly Built Environment. Pew Center on Global Climate Change, Airlington, VA.
[11] Commission for Architecture and The Built Environment. 2007. Sustainable Design, Climate change and the Built Environment.
[12] Davies, P., Osmani, M. 2011. Low Carbon Housing Refurbishment Challenges and Incentives: Architects' Perspectives. *Building and Environment.* 46(8): 1691-1698.
[13] Zuo, J. and Zhao, Z. Y. 2014. Green Building Research-Curent Status and Future Agenda: A Review. *Renewable and Sustainable Energy Reviews.* 30: 271–281.
[14] Miller, E. and L. Buys. 2008. Retrofitting Commercial Office Buildings for Sustainability: Tenants' Perspectives. *Journal of Property Investment and Finance*. 26(6): 552–561.
[15] Pedini, A. D. and B. Ashuri. 2010. An Overview of the Benefits and Risk Factors of Going Green in Existing Buildings. *Internation Journal of Facility Management.* 1(1).
[16] Douglas, J. 2006. *Building Adaptation.* Butterworth Heinemann, Stoneham, MA.
[17] Wilkinson, S. 2012. Analysing Sustainable Retrofit Potential in Premium Office Buildings. *Structural Survey*. 30(5): 398–410.
[18] Mickaitytë, A., E. K. Zavadskas, A. Kaklauskas and L. Tupënaitë. 2008. The Concept Model of Sustainable Buildings Refurbishment. *International Journal of Strategic Property Management.* 12: 53–68.
[19] Mansfield, J. R. 2002. What's in a Name? Complexities in the Definition of 'Refurbishment". *Property Management.* 20(1): 23–30.
[20] Bullen, P. A. 2007. Adaptive Reuse and Sustainability of Commercial Buildings. *Facilities.* 25(1/2): 20–31.
[21] Sustainable Construction Task Group. 2000 Reputation, Risk and Reward: The Business Case for Sustainability in the UK Property Sector, BRE, Watford.
[22] Kohler, N., Hassler, U. 2002. The Building Stock as a Research Project. *Building Research and Information.* 30(4): 226–236.
[23] Curwell, S., Cooper, I. 1998. The Implications of Urban Sustainability. *Building Research and Information*. 26(1): 17–28.
[24] Township's Boards of Historical and Architecture Review. 2008. Historic Preservation and Sustainability. CHRS Inc., of North Wales, Pennsylvania.
[25] Ma, Z., P. Cooper, D. Daly, L. Ledo. 2012. Existing Building Retrofits: Methodology And State Of The Art. *Energy and Buildings*. 55: 889–902.
[26] Reed, R. G., Wilkinson, S. J. 2005. The Increasing Importance of Sustainability for Building Ownership. *Journal of Corporate Real Estate.* 7(4): 339–350.
[27] Menassa CC, Baer B. 2014. A Framework to Assess the Role of Stakeholders in Sustainable Building Retrofit Decisions. *Sustainable Cities and Society*. 10: 207–221.
[28] Olgyay, V, Seruto, C. 2010. Whole Building Retrofits: A Gateway to Climate Stabilization. *ASHRAE Transactions (Part 2).* 116: 244–251.
[29] Pivo, G., McNamara, P. 2005. Responsible Property Investing. *International Real Estate Review*. 8(1): 26–42.
[30] Cox, J., Cadman, D. 2000. Commercial Property Markets in a Sustainable Economy, School of Public Policy and Jackson Environment Institute, UCL, London.
[31] Brownhill, D., Yates, A. Environmental Benchmarking for Property Portfolio Managers, BRE Centre for Sustainable Construction, Watford.
[32] Foley, J. M. 2005. Analogues: Modern Oral Epics. 196–212.
[33] Cadman, D. 2000. The Vicious Circle of Blame. What About Demand? Do Investors Want 'Sustainable Buildings'. The RICS Research Foundation.
[34] Boecker J, Horst S, Keiter AL, Sheffer M, Toeys B, Reed BG. 2009. *The Integrative Design Guide to Building Green–Redifining the Practice of Sustainability*. Hoboken, New Jersey: Wiley & Sons, inc.
[35] Urge-Vorsatz, D., Harvey, L. D. D., Mirasgedis, S., Levine, M. D. 2007. Mitigating CO_2 Emissions from the Energy Use in the World's Building. *Building Research and Information*. 35(4): 379–398.
[36] Richardson, G. R. A. and J. K. Lynes. 2007. Institutional Motivations and Barriers to the Construction of Green Buildings on Campus: A Case Study of the University of Waterloo, Ontario. *International Journal of Sustainability in Higher Education*. 8(3): 339–354.
[37] McDonald, C., S. Ivery, and C. M. Gagne. 2008. ACEEE Summer Study on Energy Efficiency in Buildings.
[38] Choi, C. 2009. Removing Market Barriers to Green Development: Principles and Action Projects to Promote Widespread Adoption of Green Development Practices. *Journal of Sustainable Real Estate.* 1(1).
[39] Galuppo, L. A. and C. Tu. 2010. Capital Markets and Sustainable Real Estate What Are the Perceived Risks and Barriers? *Journal of Sustainable Real Estate.* 2(1).
[40] Azizi, N. S. M., E. Fassman, and S. Wilkinson. 2010. Risks Associated in Implementation of Green Buildings. Beyond Today's Infrstructure.
[41] Reza, E. M., M. A. Marhani, R. Yaman, A. A. Hassan, N. H. N. Rashid and H. Adnan. 2011. Obstacles in Implementing Green Building Projects in Malaysia. *Australian Journal of Basic and Applied Sciences*. 5(12): 1806–1812.
[42] Benson, A., E. Vargas, J. Bunts, J. Ong, K. Hammond, L. Reeves, M. Chaplin, and P. Duan. 2011. Retrofitting Commercial Real Estate: Current Trends and Challenges in Increasing Building Energy Efficiency. UCLA Institute of the Environment and Sustainability.
[43] Skills and Occupational Needs in Green Building. 2011. International Labour Office.
[44] Liu, J. Y., S. P. Low and X. He. 2012. Green Practices in the Chinese Building Industry: Drivers and Impediments. *Journal of Technology Management in China*. 7(1): 50–63.
[45] Urban Land Institute. 2009. Retrofitting Office Buildings to be Green and Energy Efficient: Optimizing Building Performance, Tenant Satisfaction, and Financial Return. Washington, DC.

[46] Bond, S. 2010. Best of the Best in Green Design: Drivers and Barriers to Sustainable Development in Australia. PRRES Conference Sydney.
[47] Yudelson, J. 2010. *Greening Existing Buildings*. New York: McGraw Hill–A Green Source Book.
[48] Bond, S. and G. Perrett. 2012. The Key Drivers and Barriers to the Sustainable Development of Commercial Property in New Zealand. *Journal of Sustainable Real Estate*. 4(1).
[49] Tam V. W. Y., J. L. Hao and S. X. Zeng. 2012. What Affects Implementation of Green Buildings? An Empirical Study in Hong Kong. *International Journal of Strategic Property Management.* 16(2): 115–125.
[50] Kastenhofer K. and C. Rammel. 2005. Obstacles to and Potentials of the Societal Implementation of Sustainable Development: a Comparative Analysis of Two Case Studies. *Sustainability: Science, Practice, & Policy*. 1(2).
[51] Brown, M. and F. Southworth. 2006. Mitigating Climate Change Through Green Buildings and Smart Growth. Georgia Institute of Technology.
[52] Toor, S. R. and Ogunlana, S. O. 2009. Construction Professionals' Perception of Critical Success Factors for Large Scale Construction Projects. *Construction Innovation*. 9(2): 149–167.
[53] De, Wit A. 1986. Measuring Project Success: An Illusion. Proc., 18th Annual Seminar/Symposium, Project Management Institute, Montreal, Canada. 13–21.
[54] Lapinski, A. R., Horman, M. J, Riley, D. R. 2007. Lean Processes for Sustainable Project Delivery. *Journal of Construction Engineering and Management*. 132(10): 1083–1091.
[55] Boynton, A. C., Zmud, R. W. 1984. An Assessment of Critical Success Factors. *Sloan Management Review*. 25: 17.
[56] Abdullah, Z. S., Quaddus, M. 2012. A Critical Success Factors Model for IS Implementation: Development and Validation of a Structural Model using PLS. In Computing and Convergence Technology (ICCCT), 7th International Conference on IEEE. 144–152.
[57] Rockart, J. F. 1979. Chief Executives Define their own Data Needs. *Harvard Business Reviews*. 57(2): 81–93.
[58] Chidiac, S. E., Catania, E. J. C., Morofsky, E., Foo, S. 2011. Effectiveness of Single and Multiple Energy Retrofit Measures on the Energy Consumption of Office Buildings. *Energy*. 36: 5037–5052.
[59] Entrop, A. G., Brouwers, H. J. H., Reinders, A. H. M. E. 2010. Evaluation of Energy Performance Indicators and Financial Aspects of Energy Saving techniques in Residential Real Estate. *Energy and Buildings*. 42(5): 618–629.
[60] Gaterell, M. R., McEvoy, M. E. 2005. The Impact of Energy Externalities on the Cost Effectiveness of Energy Efficiency Measures Applied to Dwellings. *Energy and Buildings.* 37(10): 1017–1027.
[61] Gluch, P., Baumann, H. 2004. The Life Cycle Costing (LCC) Approach: A Conceptual Discussion of its Usefulness for Environmental Decision Making. *Building and Environment*. 39(5): 571–580.
[62] Juan, Y. K., Gao, P., Wang, J. 2010. A Hybrid Decision Support System for Sustainable Office Building Renovation and Energy Performance Improvement. *Energy and Buildings*. 42: 290–297.
[63] Nemry, F., Uihlein, A., Colodel, C. M., Wetzel, C., Braune, A., Wittstock, B. *et al*. 2010. Options to Reduce the Environmental Impacts of Residential Buildings in the European Union–Potential and Costs. *Energy and Buildings*. 42(7): 976–984.
[64] Papadopoulos, A. M., Theodosiou, T. h. G., Karatzas, K. D. 2002. Feasibility of Energy Saving Renovation Measures in Urban Buildings: The Impact of Energy Prices and Acceptable Payback Time Criterion. *Energy and Buildings*. 34(5): 455–466.
[65] Poel, B., Van Cruchten, G., Balaras, C. A. 2007. Energy Performance Assessment of Existing Dwellings. *Energy and Buildings.* 39(4): 393–403.
[66] Fuerst, F. and P. McAllister. 2009. An Investigation of the Effect of Eco-Labeling on Office Occupancy Rates. *Journal of Sustainable Real Estate*. 1(1).
[67] Dascalaki, E. and C. A. Balaras. 2004. XENIOS: A methodology for Assessing Refurbishment Scenarios and the Potential of Application of RES and RUE in Hotels. *Energy and Buildings*. 36: 1091–1105.
[68] Kaklauskas, A., E. K. Zavadskas, S. Raslanas. 2005. Multivariant Design and Multiple Criteria Analysis of Building Refurbishments. *Energy and Buildings*. 37: 361–372.
[69] Dan, M. D. B. 2004. Multi-criteria Decision Model for Retrofitting Existing Buildings. *Natural Hazards and Earth System Sciences*. 4: 485–499.
[70] Phdungsilp, A. and I. Martinac. 2004. A Multi-Criteria Decision-Making Method for the Retrofitting of Designated Buildings in Thailand. *Conference on Passive and Low Energy Architecture.*
[71] Asadi, E., M. G. D. Silva, C. H. Antunes and L. Dias. 2010. Multi-Objective Optimization Model For Building Retrofit Strategies. *Energy and Buildings*. 44: 81–87.
[72] Dong, B., C. A. Kennedy, K. Pressnail. 2002. To Retrofit Or Rebuild, That Is The Question: Using Life-Cycle Energy Performance For Comparing Construction Options. *Annual Conference of the Canadian Society for Civil Engineering.*
[73] Gohardani, N. and F. Bjork. 2012. Sustainable Refurbishment In Building Technology. *Smart and Sustainable Built Environment.* 1(3): 241–252.
[74] Scichilli, R. and James, S. M. 2010. An Introductory Overview of Green/ Sustainable Retrofitting of Existing Buildings in the U.S. The Cheapest Energy is Saved Energy.
[75] Alanne, K. 2004. Selection of Renovation Actions Using Multi Criteria "Knapsack" Model. *Automation in Construction*. 13: 377–391.
[76] Ferrante, A., Mochi, G., Gulli, R. and Cattani, E. 2011. Retrofitting and Adaptability in Urban Areas. *Procedia Engineering*. 21: 795–804.
[77] Wolf, A. T. 2011. Sustainable Renovation of Building–A Model Applicable to China. *International Journal of Energy Science.* 1(1): 58–61.
[78] Xing, Y., Hewitt, N. and Griffiths, P. 2011. Zero Carbon Buildings Refurbishment: A Hierarchical Pathway. *Renewable and Sustainable Energy Reviews.* 15: 3229–3236.
[79] Boron, S. and Murray, K.. 2004. Bridging the Un-sustainability Gap: A Framework for Sustainable Development. *Sustainable Development.* 12: 65–73.
[80] Lam, K. C. 2008. Design for Maintenance from the Viewpoint of Sustainable Hospital Buildings. *The Australian Hospital Engineer.* 30(1).
[81] Hayter, S. J., Torcellini, P. A. and Judkoff, R. 2000. Designing for Sustainability. National Renewable Energy Laboratory. American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Conference 2000.
[82] Aroul, R. R. and Hansz, J. A. 2011. The Role of Dual Pane Window and Improvement Age in Explaining Residential Property Values. *Journal of Sustainable Real Estat*e. 3(1).
[83] Kok, N., Miller, N. G. and Morris, P. 2012. The Economics of Green Retrofits. *Journal of Sustainable Real Estate.* 4(1).
[84] Ellison, L. and Sayce, S. 2007. Assessing Sustainability in the Existing Commercial Property Stock. *Property Management.* 25(3): 287–304.
[85] Pinto, J. K. and Slevin, D. P. 1987. Critical Factors in Successful Project Implementation. Engineering Management. *IEEE Transactions.* 1: 22–27.
[86] Volery, T and Lord, D. 2000. Critical Success Factors in Online Education. *International Journal of Educational Management.* 14(5): 216–223.
[87] Magal, S. R., Carr, H. H. and Watson, H. J. 1988. Critical Success Factors for Information Center Managers. *MIS Quarterly*. 413–425.
[88] Edget, S. J. and Kleinschmidt, E. J. 2003. Bests Practices in Product Innovation: What Distinguishes Top Performers. Stage-Gate.
[89] Nah, F. H. and Delgado, S. 2006. Critical Success Factors for Enterprise Resource Planning Implementation and Upgrade. *Journal of Computer Information System*. 46(5): 99.
[90] 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.
[91] Yusuf A. 1995. Critical Success Factors for Small Business: Perceptions of South Pacific Entrepreneurs. *Journal of Small Business Management.* 33: 2–68.
[92] Reel, J. S. 1999. Critical Success Factors in Software Projects. *Software IEEE*. 16(3): 18–23.
[93] Cooper, R. G. and Edgett, S. J. 1996. Critical Success Factors for New Financial Services. *Marketing Management.* 5: 26–37.
[94] Gottschalk, P. and Saether, H. S. 2005. Critical Success Factors from IT Outsourcing Theories: An Empirical Study. *Industrial Management And Data Systems*. 105(6): 685–702.
[95] Rothwell, R. 1992. Successful Industrial Innovations: Critical Factors for the 1990s. *R&D Management.* 22(3): 221–240.
[96] Chen, T. Y. 1999. Critical Success Factors for Various Strategies in the Banking Industry. *International Journal of Bank Marketing*. 17(2): 83–92.
[97] Baker, M. J. and Cameron, E. 2008. Critical Success Factors in Destination Marketing. *Tourism and Hospitality Research*. 8(2): 79–97.
[98] Thomas, R. and Long, J. 1999. Improving Competitiveness. Critical Success Factors for Tourism Development. *Local Economy*. 14(4): 313–328.