THE PERCEIVED BARRIERS TO THE CONSTRUCTION OF GREEN BUILDINGS IN NELSON MANDELA BAY, SOUTH AFRICA

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Abstract
The awareness of the need for the construction of Green Buildings (GB's) in South Africa has increased dramatically in recent years. There are numerous perceived benefits that are to be reaped from the construction of GB's that may provide long-term advantages for the owners of such buildings, however, obstacles to the construction of these projects continue to exist. This study therefore aims to identify what particular aspects are deemed to impact on the viability of constructing these projects when compared with traditional buildings and whether these perceptions are valid for all building types. Alongside a detailed literature review, a structured questionnaire was distributed amongst medium to large general contractor members of the East Cape Master Builders Association and members of the Eastern Cape Institute of Architects residing in Nelson Mandela Bay. The results of the research indicate that there is demand for GB's but that the perceived increased upfront costs, aligned to high material costs, minimum standard requirements and specialist knowledge required of the construction team, are the main obstacles that hinder the full adoption and construction of GB projects. The findings highlight that this is primarily due to insufficient knowledge and awareness existing amongst working professionals in the built environment of the region in terms of the requirements needed for the construction of GB's.

Keywords: Cost, Green Buildings, Specialist knowledge

1 Introduction

According to Harrison and Seiler (2011: 551) the past decade has seen recognition of the need for the awareness and implementation of sustainable initiatives within the construction industry through Green Building (GB) projects. GB's are a relatively new concept with regards to the Republic of South Africa (RSA) and numerous challenges still confront their construction. The establishment of the GBCSA in 2007 and the progressive development of the Green Star SA rating tool have provided the industry with an initial framework for financing, developing and investing in sustainable buildings (Windapo, 2014). Other countries such as the United Kingdom (UK), the United States of America (USA) and Australia are far more experienced and familiar with the construction processes and viability studies of green projects (McGraw-Hill Construction, 2013). However, the results from this research also show that South Africa, although starting from a low base of only 16% in 2012 is likely to see a 36% increase by 2015 to 52%, the greatest increase of those countries surveyed, a significant indication of the trend towards GB's now occurring. In addition, the research also identifies that South Africa has the highest level of green activity in the residential marketplace, with over a third (36%) of firms reporting planned green activity for low-rise residential projects (one to three floors) by 2015. This statistic collides with the reported main challenges for GB's of higher initial capital costs and lack of political support/incentives. Pearce (2008) states that a significant barrier to sustainable construction is the perceived likelihood of a first cost premium linked to such projects. Jackson (2009) finds that almost three quarters of developers believe green construction developments add more than 5% to construction costs, whilst more than 40% of those respondents believe that costs actually exceed 10% when compared with conventional projects.

Globally, the construction environment generates many more pollutants when compared to other forms of industries and has an adverse effect on the natural environment, resulting in pollution of the earth (Ding, 2008; Durand *et al.*, 1996). It is therefore essential for the modern built environment industry to become aware of the need for the implementation of sustainable developments to reduce the amount of environmental impacts that the construction industry leaves on the natural environment. According to Verbruggen *et al.* (2010), contemporary society considers sustainable development as the best possible way to address these complex and interrelated problems, not only for the sake of current and future generations, but mainly for the future integrity of the planet and its natural environment. This is supported by McGraw-Hill (2013) showing that 44% of South African respondents believe the main reason for future GB's is that it is the right thing to do and Kibert (2013). This therefore suggests that there is great opportunity within the South African construction industry to grow sustainably by creating sustainably constructed buildings!

The greatest obstacle to implementation remains viability relating to the business case, which often results in the client omitting green building features (Milford, 2009). Due to the fact that construction professionals in South Africa are not entirely comfortable and practically acquainted with regards to the construction of GB's (Le Jeune et al., 2013), this study is therefore highly important with regards to the analytical process followed when assessing the perceived reasoning for a GB. A vast number of professionals in the construction environment have as a perception that GB's cost more to construct when compared to conventional type buildings (GBCSA, 2012; McGraw-Hill Construction, 2013). The aim of the research was therefore to determine what aspects of GB's were perceived to be more expensive whilst the objective of the research was to identify whether: the acquisition of green/sustainable materials causes GB's to be more costly to construct; contractors impose higher profit mark-ups when undertaking green projects; the design phase is more expensive when compared to traditional type buildings, and; the acquisition of expertise relative to green projects is expensive.

2 Literature Review

2.1 What is a Green Building?

A GB incorporates design, construction and operational practices that significantly reduce or eliminate its negative impact on the environment and its occupants whilst providing an opportunity to use resources efficiently while creating healthier environments for people to live and work in (Indian GBC, 2007 & GBCSA, 2008). Chang *et al.* (2011) state that a GB is a structure that is designed, renovated, built, operated, or reused in an ecological and resource-efficient manner to incorporate energy efficiency, water conservation, waste minimisation, pollution prevention, resource-efficient materials, and indoor environmental quality in all phases of the building's life. There exist standardised benchmarks that are set globally in order to establish exactly which buildings do indeed meet the requirements to be able to be labelled as a GB with several rating systems in use, namely LEED (USA), BREEAM (UK) and Green Star (Australia). The GBCSA uses the Green Star South Africa rating system which is based on the Australian rating system but customised for the South African context (GBCSA, 2008).

With regards to GB projects, a holistic and integrated design process is utilised at the very beginning of the project process due to the fact that a GB comprises of many unique design features that are not necessarily found in conventional buildings (Kibert, 2008).

2.2 The need for Green Buildings

According to Dorsey and Hedge (2013) the global population is increasingly becoming more urbanised and as of the 23rd May 2007, over 51% of the world's population now live in urban environments (Hanlon, 2007). As buildings worldwide produce a vast scale of GHG emissions due to the fact that buildings constitute more than one third of total energy usage, the implementation of green practices and green projects have the largest potential for mitigating such adverse emissions into the natural environment (UNEP, 2009; Ade and Rehm, 2013). According to Jain et al. (2013) buildings do not stop impacting the environment once they are built – they have serious adverse effects on the natural environment throughout the life of the structure. Bhatia (2009) states that by implementing green practices, it is the best possible way to make the earth healthy for future generations; therefore all project stakeholders and civilians globally, are responsible to promote and adopt the concept of building green. Kneifel (2010) states that the implementation of energy efficiency measures within buildings can reduce their carbon footprint by 16% on average, therefore improving the GB LCC effectiveness.

The USGBC identifies that the optimal performance of a GB will be achieved when it is both energy efficient and effectively promotes the occupants' comfort within the building environment (Dorsey and Hedge, 2013). According to research in the Northern Hemisphere (Bayer-Oglesby et.al, 2007), the average citizen spends more than 85% of their time indoors, therefore it is in their best interests that the built environment be created to provide for well-equipped ergonomically fit indoor environments to allow for high occupancy satisfaction rates and improved worker production outputs. Hedge *et al.* (2011) identify that amongst many traditional or conventional (non-green) office buildings there has been inadequate ergonomics design with regards to office workstations which results in the regular occurrence of work-related musculoskeletal disorders, a significant financial cost to any organisation. According to Arsenault et al. (2013) 'green buildings' prove to possess superior indoor environmental performance when compared with similar conventional type buildings' with a variety of physical features resulting in improved occupancy outcomes. Results from occupancy satisfaction surveys show that GB's score a much higher occupancy satisfaction rate when compared to conventional type buildings (Dorsey and Hedge, 2013).

According to McCown and Qualk (2009: 20) a theory referred to as the "triple bottom line", has become inherent in decision making when it comes to the construction of high-performance buildings. The theory posits that there is substantial occupancy satisfaction and the construction of the building enhances environmental conservation, with the building owner experiencing financial prosperity. The benefits can be measured and reproduced independently across a variety of project types and building locations. An example of this is energy efficient installation savings within the GB and the ability for the building owner to charge higher rental rates. Other quantitative benefits include water savings and carbon tax benefits, whilst qualitative benefits include fewer vacancies and better overall occupant health.

2.3 Obstacles identified with regards to the adoption of GB's

The primary obstacle facing the adoption of GB's is the perception that it costs more to construct such projects (Langdon and Morris, 2007; Hwang and Tan, 2012), whilst McCown and Qualk (2009) state that green design within a building is considered to be a feature that is added to the original cost of the design. Fletcher (2009) states that despite the benefits of long-term returns, it does indeed cost more to build green, however, evidence from LEED-certified GB's suggest a maximum of 1 to 2 percent more expense is incurred. In some circumstances, this barrier inhibits sustainability construction from a business perspective as well as completely excluding consideration of such projects.

According to Pearce (2008) despite the overwhelming commitment to developing sustainable structures and buildings in the modern era, many organisations are experiencing difficulty with regards to implementing the concept of GB's due to the way in which funding is allocated. Ade and Rehm (2013) argue that the GB soft costs are higher than conventional type projects due to incremental costs incurred that are associated with the process of actually achieving a GB star rating. According to Baetz *et al.* (2010) these incremental costs include both application costs as well as additional consulting required with regards to the various rating tools.

Henn *et al*. (2008) states that there is always a risk that human bias towards traditional or conventional type building projects can hinder the adoption of green or sustainable projects. According to Tulacz (2008) although some contractors have already delivered and executed several LEED projects, most contractors remain sceptical with regards to the wholesale adoption of the GB agenda because it is perceived to pose additional requirements and risks. Duckles (2009) states that the process and the relative documentation is still evolving and burdensome for professionals in comparison with conventional projects whilst the USGBC Research Committee (2011) has identified strategic issues facing the GB community. According to Edwards *et al*. (2012) the shift to adopt GB projects has resulted in new industry boundaries and has presented contractors with unique challenges that could hinder or eliminate the achievement of green project goals. In both this research and that conducted in India (Jain *et al.*, 2013) similar obstacles were identified including the lack of professionals with the required knowledge and expertise to implement new or unfamiliar technologies and products; Sceptical sub-contractors who may instigate myths about sustainable construction and the administration costs associated with supporting compliance; The conflicts between existing building codes and GB strategies or standard requirements, and; The scarcity of the specified high-efficiency products or green materials that are included in the contract documents, crucial with regards to compliance with GB standards.

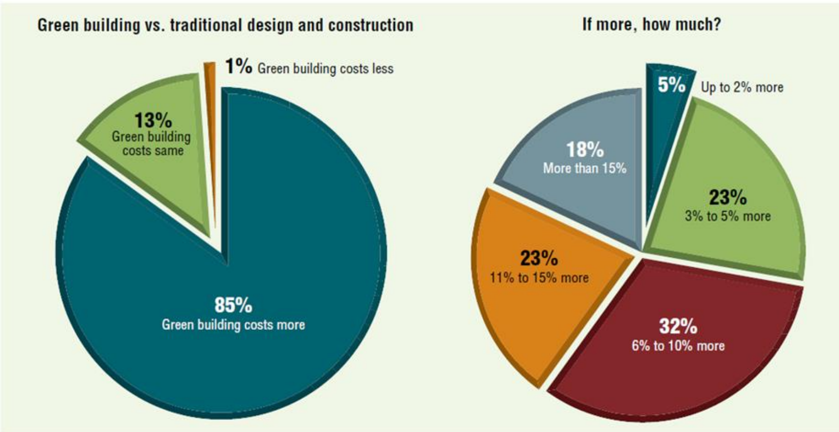

Figure 1. Market perceptions of GB construction costs (McCown and Qualk, 2009)

Malin (2000) states that environmentally friendly materials do in fact cost more due to limited production linked to these specialised materials and they need to be specially ordered – either through local supply yards or directly from the manufacturer. Extra costs are also incurred when additional technology is invested into responsible manufacturing. The most common misconception is comparing the cost of the green project with the original project budget / anticipated cost of the project. The outcome of this process results in contractors comparing the difference between what the final project was estimated to cost and how much it actually cost to complete. Cole and Sterner (2000) state that although LCC accounting is superior to initial capital costs alone, it remains a limited approach to account for the broader environmental and social costs associated with GB's operating benefits such as lower energy and water consumption. Yudelson (2008), suggests it is a challenge to convince the developer to undertake a green project when there is unequal distribution of the benefits to the builder and tenants. According to Hwang and Tan (2012), developers have to often pay high upfront cost premiums for GB developments with inadequate information available with regards to green products or materials, while the tenants accrue the benefits from the improved performance in the indoor environment quality and cost savings, mainly related to water and electricity.

3 Research Methodology

The research was undertaken by conducting an empirical study using a quantitative approach in conjunction with a literature survey. The primary data for this study was obtained through a structured questionnaire sent randomly to 35 medium to large GC members of the ECMBA and 55 members of the ECIA drawn from a list of active members provided by each organisation. 17 members of the ECMBA responded and 13 members of the ECIA responded, providing a response rate of 48.57% and 23.64% respectively. Two Likert scale questions were used, the first ranges from 0-5, 0 being does not and 5 being major extent, whilst the second ranges from 1-5, 1 being minor extent, not at all, or strongly disagree and 5 being major extent, very, or strongly agree. Descriptive statistics in the form of frequencies, and a measure of central tendency, a mean score (MS), were computed from the data gathered using Excel. The responses are tabulated in terms of percentage responses in the range of 1 (minor) to 5 (major), and a MS with a minimum value of 1.00 and a maximum value of 5.00. MSs > 3.00 indicate that respondents can be deemed to perceive the extent of certain aspects affecting the need for the implementation of GB's are of a major extent as opposed to a minor extent, as in the case of MSs ≤ 3.00. These descriptive statistics were organised, analysed, and presented in tables.

4 Findings and Discussion

Table 1; Table 2, and Table 3 indicate the extent to which certain aspects may affect the need for the implementation of GBs.

Table 1. The factors affecting the need for the implementation of green buildings

Aspect / Factor	Response (%) Unsure	Minor……Major 1	2	3	4	5	Mean Score (MS)	Rank
The global increase in carbon emissions and greenhouse gases	0.00	0.00	10.00	30.00	50.00	10.00	4.44	1
The high maintenance costs linked to the life-span of traditional buildings	3.33	10.00	20.00	26.67	30.00	10.00	3.78	2
The increase of waste production on traditional construction sites	0.00	10.00	30.00	30.00	26.67	3.33	3.76	3
The adverse effect that the current traditional building industry has on the natural environment	0.00	13.33	33.33	20.00	30.00	3.33	3.69	4
The ever increasing levels of water pollution generated by the global construction industry	16.67	10.00	13.33	33.33	20.00	6.67	3.32	5
The current ineffective methods of traditional construction	0.00	23.33	43.33	13.33	16.67	3.33	3.24	6
The ever increasing levels of air pollution generated by the global construction industry	3.33	16.67	6.67	33.33	30.00	10.00	3.10	7
The current usage of VOC (Volatile Organic Compound) materials in traditional buildings	20.00	6.67	10.00	30.00	23.33	6.67	3.04	8
The ever increasing levels of noise pollution generated by the global construction industry	3.33	23.33	23.33	23.33	20.00	6.67	2.62	9

Eight out of the nine (88.89%) aspects listed in Table 1 have MSs > 3.00, which indicates that the grouped respondents of the GCs and architects can be deemed to perceive the aspects affecting the need for the construction of GB's as of major extent as opposed to minor extent. The grouped respondents perceived that the need for the implementation of GB's is mainly due to the fact that the current traditional building environment is emitting ever increasing levels of GHGs and carbon emissions with regards to the natural environment. This factor is ranked first with a MS of 4.44. None of the individuals responded 'Does not' to the factors which may imply that the respondents believe that all the factors listed do have a role to play with the implementation of GB's. When the responses for Architect's and GC's are separated in order to do a comparative analysis of the results an interesting dynamic occurs (see Tables 2 and 3).

Table 2. The factors affecting the need for the implementation of green buildings (Architects)

Aspect / Factor	Response (%) Unsure	Minor……Major 1	2	3	4	5	Mean Score (MS)	Rank
Passive design within a green building provides better occupancy usage	0.00	7.69	7.69	0.00	38.46	46.15	4.08	1
Clients' preferences are changing towards the favour of green buildings	0.00	7.69	7.69	30.77	30.77	23.08	3.54	2
The inadequate ergonomics design with regards to office workplaces	7.69	15.38	7.69	15.38	30.77	23.08	3.42	3

Table 3. The factors affecting the need for the implementation of green buildings (GC's)

Aspect / Factor	Response (%) Unsure	Minor 1	2	3	4	Major 5	Mean Score (MS)	Rank
Passive design within a green building provides better occupancy usage	5.88	5.88	11.76	23.53	35.29	17.65	3.50	1
Clients' preferences are changing towards the favour of green buildings	11.76	0.00	17.65	29.41	29.41	11.76	3.40	2
The inadequate ergonomics design with regards to office workplaces	11.76	5.88	23.53	29.41	23.53	5.88	3.00	3

All of the factors listed in Table 2 have MSs in the range of between > 3.42 ≤ 4.08, which indicates that the architect respondents perceive these factors to have some extent to near major extent / near major effect in terms of the factors affecting the need for the implementation of GB's. In contrast, 66.67% of the GC factors listed have MSs > 3.42, which indicates that they perceive only one of these factors to have the same affect. With regards to the architects' responses, they believe the no.1 ranked factor affecting the need for the construction of GBs is due to the fact that passive design within a GB provides for better occupancy usage. As a design based question, architects were more likely to respond in a more favourable manner towards this so it is notable that the GC's scored these aspects in the same order.

All but one (an unsure contractor) perceived GBs to cost 'More' to construct when compared with traditional buildings. This shows a very definite trend in opinion in terms of the perceptions of built environment professionals towards GBs. Respondents were also asked to choose an amount by how much more they believed GBs would cost (see Figure 2). The MSs of the responses proves to be quite a substantial amount, for both the architects and GCs. The architects' average percentage is 28.23%. The GCs' average percentage is 28.67%, a remarkably similar average, showing that built environment professionals believe it costs nearly a third more to construct a GB than a traditional building.

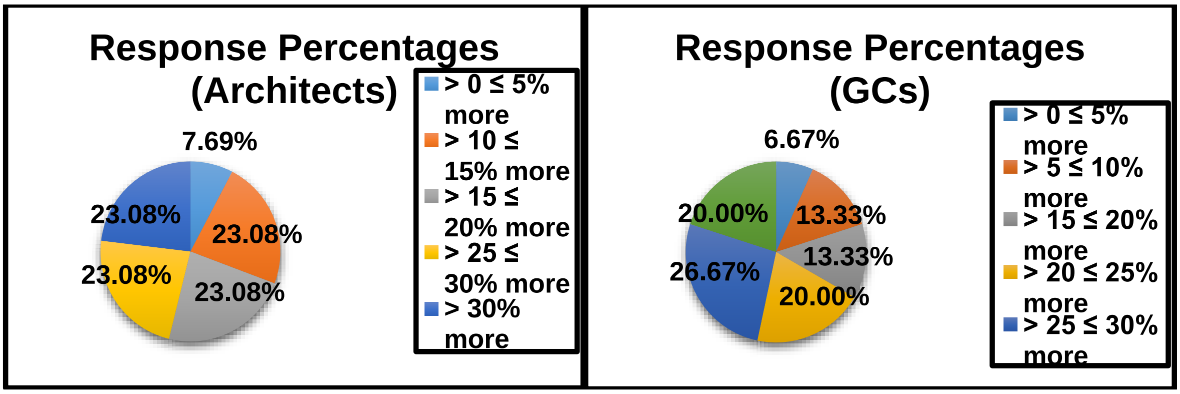

Figure 2. How much more GB's cost to construct when compared with traditional buildings

Having identified that both groups of respondents perceive there to be a cost implication when constructing Green buildings, understanding what factors are perceived to affect the construction from a cost perspective becomes paramount to not only better controlling those costs but also in terms of mitigating for those costs (see Table 4).

Table 4. The factors affecting the construction costs of green buildings

Aspect / Factor	Response (%)						Mean Score (MS)	Rank
	Unsure	Minor…………………………….Major						
		1	2	3	4	5		
The expertise utilised	0.00	0.00	0.00	16.67	46.67	36.67	4.20	1
The building type	10.00	0.00	3.33	13.33	40.00	33.33	4.15	2
Materials used	0.00	0.00	10.00	20.00	33.33	36.67	3.97	3
The design process	0.00	0.00	13.33	13.33	50.00	23.33	3.83	4
The accreditation phases	10.00	3.33	13.33	23.33	20.00	30.00	3.67	5
Construction methods	0.00	0.00	13.33	26.67	43.33	16.67	3.63	6
Recycling of waste materials	3.33	10.00	6.67	23.33	30.00	26.67	3.59	7
The project location	6.67	3.33	16.67	36.67	16.67	20.00	3.36	8
The method of procuring materials	3.33	3.33	23.33	30.00	20.00	20.00	3.31	9
The site conditions	3.33	10.00	16.67	50.00	13.33	6.67	2.90	10

Respondents perceive 90% of the factors listed to have an important effect with regards to the construction costs of GB's with 7 having MSs in the range of > 3.40 ≤ 4.20, which indicates that the respondents perceive the factors listed to have an important to more than important / more than important affect. The no.1 ranked factor perceived to affect the construction costs of GBs are the expertise utilised for the construction of the green projects.

Respondents were also requested to expand on the extent to which they believe certain benefits may exist with regards to the occupancy usage of GBs. The 1st to 6th ranked benefits listed have MS's that are in the range of between > 3.34 ≤ 4.17, which indicates that the grouped respondents may perceive that the existence of these benefits with regards to the occupancy usage of GBs has some extent to near major extent / near major extent impact. In general these responses followed a similar pattern to that of the literature with "Improved indoor thermal conditions" ranked 1st whilst "Better speech privacy" was the only benefit that scored below 3.

Table 5. The extent to which respondents agreed with the following statements

Aspect / Factor	Response (%)						Mean Score (MS)	Rank
	Unsure	Minor…………………………….Major						
		1	2	3	4	5		
The specialised materials utilised for the construction of green buildings imposes additional expenses with regards to the construction process	0.00	0.00	0.00	6.67	53.33	40.00	4.33	1
Green building developments are the best method of construction in which to improve the future integrity of the planet and its natural environment	6.67	0.00	0.00	10.00	43.33	40.00	4.32	2
There needs to be an improved awareness for the construction of green buildings	0.00	3.33	3.33	13.33	36.67	43.33	4.13	3
Green roofs pose high upfront costs	23.33	0.00	0.00	16.67	33.33	26.67	4.13	4
The accreditation phases required to obtain green star ratings imposes additional expenses to the project	16.67	0.00	6.67	6.67	40.00	30.00	4.12	5
The construction methods related to green buildings impose additional expenses	3.33	0.00	0.00	26.67	36.67	33.33	4.07	6

The life cycle cost benefits related to green buildings out-weigh the high upfront costs linked to such projects	**26.67**	**0.00**	**3.33**	**13.33**	**33.33**	**23.33**	**4.05**	**7**
The design process linked to green buildings imposes additional expenses to the project	**3.33**	**0.00**	**10.00**	**10.00**	**43.33**	**33.33**	**4.03**	**8**

Finally, respondents gave their opinion on a number of factors highlighted by the literature review as having an impact on the construction of green buildings. All of the statements listed have MSs > 3.00 which indicates that the respondents agree with all of the statements listed to some extent to near major extent / near major extent. According to the 1st ranked statement listed which has a MS of 4.33, the respondents perceive that the specialised materials utilised for the construction of GB's imposes additional expenses with regards to the construction process.The 2nd ranked statement listed in the question provides a MS of 4.32, confirms however that respondents perceive that GB developments are the best method of construction in which to improve the future integrity of the planet and its natural environment.

5 Conclusion and Further Research

The researchers have concluded that there is a certain amount of demand relative to the construction of GB's, however, due to the perception by the respondents of high upfront costs linked to the construction of such projects, the adoption of such projects is hindered. In addition, the respondents perceive there to be benefits reaped from the reduced LCC of GB's that out-weigh the high upfront costs of such projects, which challenges the notion that this should be a barrier to greater uptake of GB's in the region. However, respondents noted that GB materials are perceived to cost significantly more when compared to materials used for the construction of traditional buildings and that on the back of these higher material costs, general contractors tend to impose higher profit mark-ups when undertaking GB projects. Furthermore, individuals surveyed perceive the design phase relative to GB projects to be more expensive when compared to traditional buildings. Adding to this, respondents strongly agree with the fact that the expertise utilised for the construction of GBs imposes higher expenses. It was further noted by respondents that there needs to be an improved awareness and education required with regards to the working professionals within the built environment in order to increase their knowledge of what aspects constitute the construction of GBs.

As a result of this research, it is the opinion of the researcher that in consideration of those undertaking tertiary education as built environment professionals, there is a need to have specific education and training to acquire GB knowledge before they enter professional practice. Furthermore, in order to increase the adoption rate of GB's in RSA, it is recommended that the government should subsidise portions of the construction costs of GB projects in order for GB's to assist in meeting South Africa's commitments on climate change. The exact nature of these subsidies, possibly in the form of tax rebates or similar incentivisation schemes, should be investigated in future studies. Additionally, it is recommended that further studies should be undertaken to focus on the physical cost of materials used in the GB construction process, comparisons of the cost of expertise or the standard requirements that need to be met to achieve a GB rating in order to calculate the impact of these aspects on the total build cost.

6 References

Ade, R. and Rehm, M. (2013). Construction costs comparison between 'green' and conventional office buildings. *Building Research & Information*, 41(2), pp. 199.

Arsenault, C., Birt, B., Burns, G., Galasiu, A., Gover, B., Macdonald, I., Mancini, S., Newsham, G., Thompson, A. and Veitch, J. (2013). Do 'green' buildings have better

indoor environments? New Evidence. *Building Research & Information,* 41(4), pp. 415-434.
Baetz, B., Chidiac, S., Cupido, A. and Pujari, A. (2010). Evaluating institutional green building policies: a mixed-methods approach. *Journal of Green Building,* 5(1), pp. 115-131.
Bayer-Oglesby, L., Edwards, R., Gauderman, W., Ilacqua, V., Jantunen, M. and Schweitzer, C. (2007). Indoor time microenvironment-activity patterns in seven regions of Europe. *Journal of Exposure Science and Environmental Epidemiology,* 17(2), pp. 170-181.
Bhatia, N. 2009. Sustainable infrastructure and eco-efficiency. *The Times of India*, pp. 14.
Chang, N., Rivera, B. and Wanielista, M. (2011). Optimal design for water conservation and energy savings using green roofs in a green building under mixed uncertainties. *Journal of Cleaner Production,* 19(11), pp. 1180-1188.
Cole, R. and Sterner, E. 2000. Reconciling theory and practice of life-cycle costing. *Building Research & Information,* 28(5/6), pp. 368-375.
Ding, G. (2008). Sustainable construction – the role of environmental assessment tools. *Journal of Environmental Management,* 86(3), pp. 451-464.
Dorsey, J. and Hedge, A. (2013). Green buildings need good ergonomics. *Ergonomics,* 56(3), pp. 492.
Duckles, B. (2009). *The green building industry in California: from ideals to buildings*. Unpublished PhD thesis. Tucson: The University of Arizona.
Durand, E., Gobin, C., Pedregal, P., Peuportier, B., Polster, B. and Sommereux, I. (1996). Evaluation of the environmental quality of buildings towards a more environmentally conscious design. *Solar Energy,* 57(3), pp. 219-230.
Edwards, D., Holt, G., Ofori-Boadu, A. and Owusu-Manu, D.-G. (2012). Exploration of management practices for LEED projects: Lessons from successful green building contractors. *Management of LEED projects,* 30(2), pp. 145-162.
Fletcher, L. (2009). Green Construction Costs and Benefits: Is National Regulation Warranted? *Natural Resources and Environment,* 24(1), pp. 20.
Hanlon, M. (2007). World population becomes more urban than rural. [Online]. Available: http://www.gizmag.com/go/7334/ [Accessed 27 September, 2014].
Harrison, D. and Seiler, M. (2011). The political economy of green office buildings. *Journal of Property Investment & Finance,* 29(4/5), pp. 551-554.
Hedge, A., Puleio, J. and Wang, V. (2011). Evaluating the impact of an office ergonomics program. *In: Proceedings of the human factors and ergonomics society 55th annual meeting*, 19-23 September 2011, Las Vegas, Nevada, Santa Monica, California, Human Factors and Ergonomics Society, pp. 594-598.
Henn, R. and Hoffman, A. (2008). Overcoming the Social and Psychological Barriers to Green Building. *Organization & Environment,* 21(4), pp. 394.
Hwang, B. and Tan, J. (2012). Green Building Project Management: Obstacles and Solutions for Sustainable Development. *Sustainable Development,* 20(1), pp. 339-342.
Indian Green Building Council (2007). Green building defined. [Online]. Available: http://www.igbc.in/site/igbc/index.jsp [Accessed 15 September, 2014].
Jackson, J. (2009). How risky are sustainable real estate projects? An evaluation of LEED and Energy Star development options. *Journal of Sustainable Real Estate,* 1(1), pp. 91.
Jain, M., Mital, M. and Syal, M. (2013). Obstacles and Catalysts Associated with Implementation of LEED-EB in India. *Environment and Urbanization ASIA,* 4(2), pp. 349-363.
Kibert, C. (2008). *Sustainable construction: Green building design and delivery*. 2nd edition. New Jersey: John Wiley & Sons.

Kibert, C. (2013). *Sustainable construction: Green building design and delivery.* 3rd edition. New Jersey: John Wiley & Sons.
Kneifel, J. (2010). Life-cycle carbon and cost analysis of energy efficiency measures in new commercial buildings. *Energy and Buildings*, 42(3), pp. 333-340.
Langdon, D. and Morris, P. (2007). What Does Green Really Cost? *The Green Issue Feature, PREA Quarterly*, pp. 55-58.
Le Jeune, K., Nurick, S. and Roux, J. (2013). The business case for building green: Using life cycle cost analysis to motivate for energy saving design. In *Green Vision 20/20*. The South African Council for the Quantity Surveying Profession, pp. 105–116.
Malin, N. (2000). The cost of green materials. *Building Research & Information*, 28(5/6), pp. 408-411.
McCown, P. and Qualk, J. (2009). *The Cost Effectiveness of Building 'Green'*. Belfast: Penton Publishing.
McGraw-Hill Construction (2013). *World Green Building Trends*, Available at: http://www.worldgbc.org/files/8613/6295/6420/World_Green_Building_Trends_SmartMarket_Report_2013.pdf.
Pearce, A. (2008). Sustainable capital projects: leapfrogging the first cost barrier. *Civil Engineering and Environmental Systems*, 25(4), pp. 291 – 300.
Green Building Council of South Africa (2008). *Technical Manual Green Star SA Office Design & Office as Built 2008*, Cape Town, RSA: GBCSA.
Tulacz, G. (2008). The top green contractors. *Engineering News Record*, 261(9), pp. 116 – 118.
United States Green Building Council Research Committee (2011). A national green building research agenda. [Online]. Available: www.usgbc.org/ShowFile.aspx?DocumentID=3402 [Accessed 01 September, 2014].
Verbruggen, A., Waas, T. and Wright, T. (2010). University research for sustainable development: definition and characteristics explored. *Journal of Cleaner Production*, 18(7), pp. 629-636.
Windapo, A. (2014). Examination of Green Building Drivers in the South African Construction Industry: Economics versus Ecology. *Sustainability*. 6088–6106. DOI: 10.3390/su6096088.
Yudelson, J. (2008). *The Green Building Revolution*. Washington, DC: Island.