CONVENTIONAL AND SUSTAINABLE BUILDINGS: A COMPARATIVE BENEFIT AND COST ANALYSIS

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ABSTRACT

The study examines conventional and sustainable buildings and whether there are significant differences between these two building types based on benefit and cost. The rationale for the examination is the general belief among stakeholders that although there is an increasing need to provide sustainable and affordable buildings for both housing and commercial purposes, buildings procured using sustainable construction initiatives are significantly more expensive than those constructed through conventional construction approach. The study adopted a quantitative research approach using semi-structured questionnaires involving a combination of both open and close-ended questions, in eliciting objective and subjective benefit and cost information on sustainable and conventional buildings from purposively selected construction industry stakeholders in South Africa. The study results indicate that there were perceived cost advantages in both conventional and sustainable buildings and that the cost difference between both sustainable and conventional buildings is less significant than perceived by construction stakeholders. This challenged previous ideas about a significant cost difference between both building types. The study thus concludes that since the cost difference between the two buildings is insignificant, the government should encourage sustainable building development through incentives and legislation because of its ecological advantage. The results of the study are of significance because it provides a business case to support the active development of sustainable buildings due to the insignificant difference in cost between sustainable and conventional buildings and the environmental benefits of sustainable buildings. However, the results are limited by the smallness of the sample size which is because stakeholders who have experience in the construction of both sustainable and conventional buildings are few and are not therefore generally distributed in the target population. A more extensive study, which includes other cities such as Cape Town, Durban and Pretoria which will confirm the findings of this research, is recommended.

Keywords: Cost, Conventional Building, Construction Method, Sustainable Building

1. INTRODUCTION

Sustainable construction is a combination of sustainable building features including water efficiency, energy and atmosphere, material and resources, the indoor environment of a building, sustainable sites, innovation and the construction process. According to Du Plessis et al. (2002), sustainable construction practices mean that all the principles of green buildings are initiated from the extraction of raw materials to the deconstruction and disposal of waste material. Du Plessis et al. (2002) refer to conventional practices as an agenda that accentuates the problems of poverty and underdevelopment by using more environmental resources. In this paper, the terms ‘green building practices' is used interchangeably with ‘sustainable construction methods’.

McNamara (2010) identifies some reasons for the slow adoption of green building practices on construction projects as people or companies' mindsets regarding the implementation of these techniques; technology and economics of a country; lack of clarity from government or any higher authority regarding green building legislation requirements making it difficult to monitor and guide people in the industry; and the costs incurred by real estate developers, construction companies, tenants and owners both directly and indirectly. For example, this has meant that construction company employees and suppliers undergo training regarding green building techniques and practices so that they are compliant with environmental standards. Ali (2009) posits that even though an investor might gain through benefits such as low maintenance costs, the payback on the investment made in going green could take years. Furthermore, investors are often sceptical about green buildings practices due to the perceived higher cost and financial implications that are associated with them (UNEP, 2009).

According to Kruse (2004), there are calls for the construction industry to adopt green building practices and to refrain from conventional construction methods due to their negative impact on the environment including climate change. The continuous use of conventional building practices, which include heavy loads, use of cranes on site, and electrical hot work by firms in the industry, contribute to environmental degradation and major changes to the climate, such as global warming, leading to torrential rains and floods. Lack of working documents that mandate the use of green building techniques by construction stakeholders and the perception of high costs linked to green buildings has probably led to the continuous use of conventional building methods in South Africa. Though the majority of stakeholders in the construction industry are aware of green building projects, they are unaware of the actual cost of these green-building projects compared to conventional projects and are also unaware of what constitutes green building practices (Kaplow, 2010). This study, therefore, examines conventional and sustainable methods used on construction projects in South Africa, their benefits and whether there are significant differences between these practices (conventional and sustainable) based on cost. This is towards understanding the issues relating to the perceived low adoption of sustainable construction methods on projects.

2. OVERVIEW OF THE CHARACTERISTICS OF CONVENTIONAL AND SUSTAINABLE CONSTRUCTION

This section gives an overview of the characteristics of the conventional and sustainable construction, consisting of a review of construction stakeholders, stakeholders level of awareness of sustainable construction methods, cost of sustainable versus conventional construction, advantages and disadvantages of sustainable and conventional construction.

2.1 Construction Stakeholders

Government is a major stakeholder in all public projects, and their regulatory bodies get to formulate rules and guidelines for sustainable construction (Windapo & Goulding, 2015; DPW, 2007). Other stakeholders who have an impact on the planning and construction of a project are the design team members. The design team members influence the design of a project, materials to be used, disposal of materials, and the financial side of the project (McNamara, 2010). The other stakeholders who are active in advocating for environmental and green building construction are non-governmental organisations (NGOs) and community-based organisations (CBOs). These organisations usually play a 'watchdog role', which includes the monitoring and evaluation of environmental and climate issues (DuPlessis et al., 2002). These organisations include the United Nations Environment Programme (UNEP), Council for Scientific and Industrial Research (CSIR), International Environmental Technology Centre (IETC), Green Building Council of South Africa (GBCSA), Council for Research and Innovation in Building and Construction (CIB), Construction Industry Development Board of South Africa (cidb) and Agenda 21.

2.2 Stakeholder's Level of Awareness of Sustainable Construction Methods

Previous studies by Webb (2005) based on a survey conducted in the United States of America, Umar and Kamidi (2012) and Windapo and Goulding (2015) show that most stakeholders are not aware of sustainable construction methods and initiatives, and the role that they should play when it comes to these. Webb (2005) established that a significant number of experts in the field of green building, identify green building practices as an energy saving approach, and regard materials as an important focus as opposed to water efficiency and air quality. This point is also emphasised by Umar and Kamidi (2012), Copiello and Bonifaci (2015), Stephan and Stephan (2016), who determined that green building, is perceived mainly as energy efficiency. Jay et al. (2013) note that the problem of awareness is linked to a lack of understanding regarding sustainability. Ecological matters drive sustainability, but the expanded form of sustainability includes economic and social development as well (Littig and Griebler, 2005). Windapo (2014) found that economic considerations drive most green building initiatives and trying to balance economic and social matters with environmental matters can become a problem.

2.3 Cost of Sustainable versus Conventional Construction

There is a cost differential between building projects constructed using conventional construction methods and those in which sustainable methods are used. The perception amongst construction scholars is that the construction costs of green buildings (the final product of the sustainable construction process) are very high. For example, a study by Adamson (2004) found that the initial costs of a green building are slightly higher than, or match, those of conventional buildings. Kaplow (2010) also found in a study of 107 projects in New York City, out of which 63 undertook green building practices under the LEED rating certification (a green building rating used in the USA), that the cost per square foot of green building projects was $440, compared to $436 per square foot for conventional buildings, and the median costs of design fees for green-star rated buildings were $0.56 per square foot, compared to $0.30 for conventional projects. In a related study, Cruywagen (2013), established that the cost difference between green and conventional buildings is approximately 7.58% based on a case study of a four-star rated green building that was upgraded to five stars in Johannesburg, South Africa and that costs decrease as green building methods used are improved.

According to du Toit (2014), sceptics of sustainable construction methods argue that there are substantial cost premiums to be paid when constructing a green building. While, the advocates of green buildings such as Matthiessen and Morris (2004) argue that these extra costs can be quickly recovered through the faster lease-up, rental premiums and increased market valuation of the green building. Matthiessen and Morris also argue that, by making use of experienced green building consultants in the design and supervision of the project, the cost can be controlled, and extra costs usually incurred by green buildings can be curbed. Also, according to Natural Resource Defence Council (NRDC 2014) if the investor or developer intends to construct another building they could benefit from using the same design and supervision team.

Matthiessen and Morris (2004) posit that the cost difference between the two construction types is insignificant when compared to the benefits that investors and occupants accrue after the project is complete. They add that the level of the cost difference is dependent on the design of the building and whether it is sustainable or not. Suttel (2006) agrees and states that green buildings can be constructed at little or no extra cost as long as the initial design is thoroughly done. Suttel (2006) notes that there is no data for calculating the comparative costs of a conventional building versus those of a green building, and vice versa and posits that this has led to the general idea that green buildings are more expensive than conventional buildings and to the continuous implementation of conventional construction practices.

2.4 Advantages and Disadvantages of Sustainable Construction

Cruywagen (2013) identifies the advantages of green building practices as including the recycling of construction waste for later use, the use of locally available building materials, controlling pollution (noise, light and air), protection of natural habitats, limiting stormwater runoff, efficient and low maintenance of buildings, and use of low-emitting materials and less harmful equipment on projects. Suttel (2006) groups the potential benefits of green buildings according to the different aspects of life affected by them. He elaborates that these benefits are dependent on design and construction teams working together in the initial stages of the project. The three

classes he identifies are environmental benefits, economic benefits and social benefits.

The environmental benefits of green buildings are: (1) the enhancement and protection of biodiversity and the ecosystems. As noted by Du Plessis et al. (2002), green buildings are concerned about the ecosystem's well-being, and their design and construction incorporates the environment and tries to minimise damage or disturbance to it as much as possible; (2) the improvement of air and water quality. Green building projects seek to improve the quality of the air and water involved in the project and are one of the nine criteria for achieving green star rating (Green Building Council of South Africa (GBCSA), 2013); (3) the reduction of waste streams. Components are designed to fit together with less wastage, and therefore designers must ensure that their design has minimal wastage regarding layout that is the design should be efficient enough for most of a tile to be used (GBCSA, 2013); (4) the conservation and restoration of natural resources. At the design stage of a project, the designers specify the material to be used for a project based on the availability of that resource in the area.

The economic benefits of green buildings are: (1) reduced operating costs. This is a major pull factor for most investors or clients because for example, the operational cost of a high electrical bill, which would be caused by conventional air conditioning, can be minimised (Wessels, 2012); and (2) the profitable trade in green products and services. Currently there is a relatively short supply of green building products in the market, so they are relatively costly. This has led to less competition and more profits made on green building components and services. The social benefits of green buildings are: (1) the enhancement of occupant comfort and health. For example, green building project ‘The No. 1 Silo’ in Cape Town uses natural water from the sea to cool the building, which improves air quality as occupants breathe natural air as opposed to air-conditioned air (Wessels, 2012); and (2) improvement in aesthetic qualities. Most green buildings are designed with huge glass windows to allow natural light enter, which make these buildings appealing.

Du Plessis et al. (2002) identify the disadvantage of going green, as sacrifices by current generations for the benefit of future generations. Cruywagen (2013) concurs, calling this problem “*the present perception of future utility*”. This occurs when there is uncertainty in accounting for the world’s future, and a problem of dealing with unease from making decisions based on this uncertain future. Therefore, the disadvantage of green buildings is that investors are asked to trade current benefits offered by conventional buildings with the promise of future benefits, calling for a moral cost-benefit analysis where stakeholders are forced to consider future generations’ well-being. Other disadvantages are: Cost. The general perception that green buildings are more costly when compared to conventional buildings (Matthiessen & Morris, 2004); Air-cooling features. Supplementing the use of natural cooling components, with the use of mechanical appliances (Labour Law Centre Report, 2011); Labour laws. Labour laws have not yet been developed and green building projects still use conventional laws and this can be problematic; and the delay in obtaining green building permits because of its unconventional approach.

2.5 Advantages and Disadvantages of Conventional Construction

According to Osterberger et al. (2003) conventional construction is based on the assumption of “anticipated loading, common practices, use of traditional materials”,

and the construction of buildings of a typical size and shape, and due to the current demand for innovative materials, and the increased complexity and size of projects, conventional construction is no longer adequate. Davis et al. (2008), mention that conventional construction has advantages, such as accountability caused by competitive selection based on an abundant supply of contractors, suppliers, consultants and subcontractors in the construction market who are willing to bid and execute work; prior experience on how to execute construction tasks; the construction practices used have been tried and tested; and consultants have rates to work with from previous project estimates and this makes management of a conventional building project easier as available historical information can be used.

Disadvantages of conventional construction identified in literature are: (1) conventional construction is based on history, and it is therefore difficult to determine when the construction techniques are inadequate, and (2) the general practices of conventional building construction are transferred from project to project even though the techniques do not necessarily suit the project at hand. It is noted that this one-size-fits-all style of construction has led to other disadvantages, which include the carrying over of bad practices such as mismanagement and waste of resources (Osterberger et al., 2003; Tam et al., 2007).

3. RESEARCH METHODOLOGY

This research is based on a quantitative approach, and the data was collected quantitatively by sending out semi-structured questionnaires (with a combination of both open and close-ended questions) to the clients and design team members who worked for organisations that were involved in the delivery process of four green star rated buildings in the Johannesburg area of South Africa. It was not the intention of the research to do a multi-case study but to use the four green star rated buildings to reach respondents who have probably worked on both green and conventional building projects. The use of a quantitative approach was driven by the need to answer questions related to the costs and benefits of green and conventional buildings. The research analyses and summarises the costs and benefits of using sustainable/green construction practices against those of conventional construction. Therefore, the following hypothesis (H_A) was stated to guide the direction of the study:

H_A: The construction cost of sustainable/green buildings are significantly higher than that of conventional buildings.

This study therefore proceeded as follows: (1) a literature review of topics related to sustainable and conventional construction; (2) data collection using semi-structured questionnaires sent to project clients or representatives and other project stakeholders; (3) data analysis to establish whether there are any trends or common denominators between the two practices; and (4) review of the findings and interpretation of the data collected.

3.1 Research Design

A survey research design was used in eliciting data from a study population who have worked on both green and conventional building projects. This is because it was

not easy to identify respondents who have experience in both methods of construction and the view that a survey approach will facilitate this. The research conducted was based on an objective view of reality and a positivist paradigm. A quantitative approach was therefore used in the research to present the data in a numerical format, prove or disprove the hypothesis stated to guide the direction of the study and generalise the concepts appropriately in a conclusion. This method is supported by Boundless Journal (2014) which notes that for a researcher to draw a statistical generalization across an entire population a survey using a quantitative approach should be used.

3.2 Study Population

The population for this research were the consultants, contractors, government department, and green building advocating organisations, which were involved in the delivery of four green star rated building projects within the Johannesburg area of South Africa. The assumption was that the individuals targeted for the research were able to answer questions related to the costs of sustainable/green versus conventional construction. The choice of Johannesburg was based on the information that there were sixteen green building projects registered in the Gauteng Province compared to the other provinces in South Africa, and the City of Johannesburg alone had four green star rated projects as of January 2013 (GBCSA, 20013). The four green star rated building projects investigated are the Nedbank offices in Sandton, Vodafone Site Solution Innovation Centre, Forty on Oak in Melrose Arch, and Upper Grayston Office Park, were obtained from the GBCSA website.

3.3 Sampling Technique and ample Size

According to Leedy and Ormod (2010) sampling aims to describe a population based on information observed or provided by a selected few members of that population. The sample obtained for this research should, therefore, be a representative of construction stakeholders who can answer questions about green and conventional building projects. A purposive sampling technique was therefore used in selecting the study respondents. This research identified eight (8) types of construction stakeholders - professional quantity surveying firms, architectural firms, management consultants, contracting organizations, the GBCSA, and the Public Works Authority Department of Johannesburg, involved in the delivery process of the identified four green star rated building projects in the Johannesburg area. The intention was not to study or use these projects as case studies but as a means of identifying possible respondents, and collecting relevant data.

Table 1 shows the classification and number of respondents selected from each respective stakeholder group involved in the construction of the four green star rated buildings in the targeted area. A sample size of forty respondents was selected with the assumption that at least thirty responses representing the target population would be obtained, giving a more accurate conclusion (Xu, 1999). This sample size depends on aspects such as the population of construction stakeholders on each project and the confidence level.

It is acknowledged that selecting project stakeholders involved in the delivery process of four green star rated building projects in the Johannesburg area as the target population to represent a whole population is a form of bias. However, an effort was

made to eliminate further bias by selecting respondents from different companies, professions and organisations involved in the project delivery process.

Table 1. Distribution of respondents by organization and profession

Professional/Department	No. of respondents
Contractor/sub-contractors	12
Architects	4
Client	4
Engineers	4
Government	4
Green Building Advocates	4
PQS	4
Project Manager	4
Total	**40**

3.4 Method of Data Collection

Semi-structured questionnaires were used as primary data collection instruments. The semi-structured questionnaire contained both open and closed-ended questions and was distributed via electronic means to the targeted stakeholders and companies between October 2013 and February 2014. From the forty questionnaires sent to the respondents, twenty were returned complete, representing a 50% response rate. The reason for this response rate was that some consulting companies, like AECOM, Solid Green and Abland, had a presence in more than one green building project – the survey distribution list shows that Solid Green was the green building consultant at the Melrose Arch, Alice Lane and Lakeside Projects thereby narrowing the pool of respondents; probably the fact that the respondents had limited knowledge of green building methods (only six of the targeted respondents have experience in sustainable construction - see Table 2); and that the information about finances of a project is usually kept confidential.

3.5 Method of Data Analysis

The collected questionnaires were first checked for completeness and grouped according to responses. For this study, data were extracted from the completed questionnaires and presented in graphs and charts using Microsoft analytical tools and Statistical Package for the Social Sciences (SPSS) software. The data was then analysed using descriptive analysis techniques (Bar charts and percentages tables). Data from open-ended responses were analysed thematically by taking the narrative formats from questionnaires and representing the data statistically by grouping the responses according to the standard responses. The hypothesis developed to guide the direction of the study was tested using the t-test inferential statistical analysis technique.

4. DATA PRESENTATION AND ANALYSIS

The data collected in the study are presented under the following sub-sections:

4.1 Distribution of Respondents by Representative Organisations

Data collected revealed that a significant number of the respondents are affiliated to quantity surveying firms (22%) and construction companies (22%) followed by government departments (17%), client organisation (13%), green building organisations (9%), engineering firms (9%), project management firms (4%) and architectural firms (4%).

4.2 Experience in Sustainable and Conventional Construction Methods

The study sought to know whether the respondents have experience in sustainable construction methods. This question was posed as a multiple-choice question with a yes or no response. Table 2 shows that 30% (6) of respondents acknowledged having experience in sustainable construction methods while 70% (14) indicated that they do not have experience in that area.

Table 2. Experience in sustainable construction

Experience in Sustainable Construction		Total No. Respondents
Yes	No	
6	14	20

The study also sought to uncover whether respondents have conventional construction experience, which is the standard building practice adopted on projects in South Africa. Data collected in this regard shows that 90% (18) of the respondents have conventional construction experience while 10% (2) had none. The two respondents that indicated that they do not have conventional construction experience are both affiliated with green building organisations.

4.3 Sustainable Construction Methods used on Subject Projects

The study sought to find out from the six respondents involved in green building projects, which green building practices were implemented on their projects as stipulated by the GBCSA rating standards. This question allowed respondents to give multiple responses, dependant on the practices that they used on their projects. The data collected in this regard is presented in Table 3.

For a building to be classified as green, there are specific practices and steps that must be followed. These practices are stipulated in the contract of each project and usually determine the rating the building is given GBCSA (2013). Table 3 reveals that 67% of the respondents indicated that they did use local and renewable materials, 50% use waste and water control practices. Efficient and effective transportation and controlled dust and sulphur emissions recorded 33%, 33% and 17% respectively. Other respondents not involved in green building projects indicated answers based on conventional projects. It is important to note that all projects, including conventional projects, adopt green building legislation requirements and some of these overlaps with the GBCSA policies.

Table 3. Green building practices implemented in subject project

Green Building Practices	No. of Respondents	Mean Percentage Response Rate
Local and renewable material	4	67%
Waste and water control	3	50%
Efficient and effective transport and supply chain	2	33%
Control dust pollution	2	33%
Use of low sulphur emitting equipment	1	17%

4.4 Similarities and Differences between Sustainable and Conventional Construction Methods

The six respondents that acknowledged experience in sustainable and conventional construction methods were asked to indicate similarities and differences between the two methods, by answering an open-ended question. Data collected in this regard is presented in Table 4.

Table 4. Similarities and differences between sustainable and conventional construction methods

Similarities	Frequency
Same basic structure/similar workflow and documentation	5
Locally available materials.	2
Same construction techniques, practices and methodology.	2

Differences	Frequency
Greater consideration of green products/specifications/certification of material sources.	3
Green buildings are environmentally conscious (e.g. in terms of waste, carbon emissions etc.).	3
Green buildings are more energy efficient to run.	2
Time. Audit trail of the material source to be documented/Green building development takes longer/adherence to green star rating tool requirements can be onerous.	2
Green buildings are more expensive.	2
Construction methods used differ.	1
Life cycle assessments consider operation and maintenance costs - more than construction cost.	1

The most common similarity noted between the two construction practices was the similar workflow and documentation. One respondent viewed sustainable

construction practices as merely an addition or adjustment to conventional practices. A difference between the two practices, which was noted, was the cost differences between the two construction methods, with respondents noting the higher costs of sustainable construction when compared to conventional construction. Another difference highlighted is that sustainable/green construction practices tend to be more environmentally conscious regarding materials used and waste generated when compared to conventional construction practices. This supports the alternative hypothesis that the cost of green buildings is significantly higher than that of conventional buildings.

4.5 Benefits of Sustainable and Conventional Construction Methods

The benefits of sustainable and conventional construction methods were investigated in the study. Respondents were allowed to tick multiple answers and responses provided are presented in Tables 5 and Figure 1. While Table 5 reveals that all respondents viewed that their green building projects experienced reduced heating and cooling costs, followed by noise reduction, improved air quality and increased property value in ranking order, Figure 1 shows that the applicable benefits of using conventional building methods on projects are easy access to data and rates, availability of a readily available workforce, time-saving, locally available building materials, the ease of knowledge transfer and experience, and reduced construction costs in ranking order.

Table 5. The benefits of sustainable construction

Benefits of sustainable construction	Mean percentage response average
Reduced heat and cooling costs	100%
Noise reduction	63%
Improved air quality	38%
Increase in property value	13%

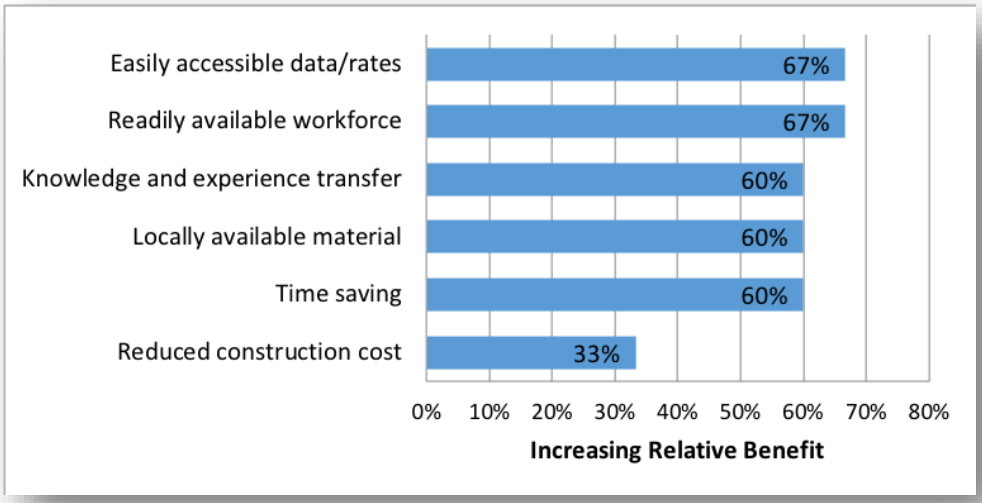

Figure 1.Benefits of conventional construction methods.

4.6 Hypothesis Testing

The study tested the alternate hypothesis that:

H_A: The construction cost of sustainable/green buildings are significantly higher than that of conventional buildings.

Respondents were requested to provide data on the construction cost of green and conventional buildings per m² for use in testing Hypothesis H_A. The cost data collected in this regard is presented in Table 6. Only the answers of the respondents who were involved in both green and conventional building projects were considered. Based on the data collected, it was established that the average construction cost per square meter of conventional buildings is R 7 066, while that of green buildings is R 8 576. The average percentage difference between the costs of the two building types is 8.55%. The calculated t-value of -2.631 is less than the tabulated value. Based on these findings, the null hypothesis, which states that the cost of green buildings is not significantly higher than that of conventional buildings, is accepted. Although the data were collected through non-random means, it is assumed that the sample data collected is normally distributed because all buildings that have been certified green in the Johannesburg area as at the time of the study were surveyed and data collected on these projects may not be significantly different to that which is available in South Africa.

Table 6. Construction Cost comparison between conventional and green buildings

	Construction Cost per m²		
Respondent	Conventional buildings	Green buildings	Percentage difference
1	R6 000	9.31%	9.31%
2	R10 000	R14 500	14%
3	R10 000	R12 000	10%
4	R6 800	R7 500	8%
5	R6 000	R6 500	5%
6	R3 600	R4 400	5%
Average	R7 066	R8 576	8.55%
T-Test Statistics			
	t	**Degree of Freedom**	**Sig. (2-tailed)**
	-2.361	5	0.065

Key: R = South African Rand; 1Rand = 0.083 US Dollars (05/02/18)

5. DISCUSSION OF FINDINGS

The study revealed that the benefits of sustainable construction are reduced heat and cooling costs, and noise reduction, while the benefits of conventional construction are the availability of information, as well as an experienced workforce, because of the common practices used across projects. It was also found that most green buildings

benefited from decreased energy and water consumption. The respondents noted that the higher cost of green buildings when compared to conventional buildings, the fact that there are only a few green building projects in South Africa, making it difficult to transfer experience, access green building information, and find experts to work on these projects is a disadvantage of green buildings.

The study also established that the average percentage cost difference between the cost of green buildings and that of conventional buildings is 8.55%, with the former higher than the latter. Also, all respondents that had worked on both green and conventional building projects acknowledged a cost difference between the two. However, the cost difference between these two building types is not statistically significant. This finding is aligned with findings of previous studies on cost differentials between the two building types by Matthiessen and Morris (2004) and Cruywagen (2013). While Matthiessen and Morris (2004) found the cost differential between the two types of buildings to be 8.6%, Cruywagen (2013) found this difference to be 7.8%. The findings of these earlier studies further validate the results of this research.

Clients and contractors who are affected by the cost differential prefer to use the conventional methods of construction on their projects. In the long run, if the costs are reduced and the practices that have been tried and tested and yield a positive result, the industry will embrace sustainable construction practices as they conserve the environment for future generations. Sacrificing the tangible benefits of conventional projects for the promised future benefits of the green building projects is probably difficult for clients, contractors and investors to imbibe.

6. CONCLUSION AND RECOMMENDATION

This paper examines conventional and sustainable/green buildings and whether there are significant differences between these two building types based on benefit and cost. The study established that the practices prevalent in all green star rated buildings are the use of local and renewable materials, waste and water control; the benefits of sustainable construction are decreased energy and waste consumption; and that green building cost more than conventional buildings by an average of 8.5%, however, the construction cost of green buildings are not significantly different from that of conventional/brown buildings. Based on these research findings, the study concludes that the construction cost difference between green building projects and conventional building projects though statistically insignificant, results in fewer stakeholders implementing sustainable construction initiatives on their projects although the practices and methodology of the two methods have many similarities and few differences; that the contractor and clients will seek out cheaper ways of project delivery unless the government introduce regulations that make the use of green building practices mandatory on construction projects; and that there is a business case for the use of green building practices with its attendant environmental benefits in the project delivery process.

It is therefore recommended that statutory legislation, which makes the use of green building practices such as waste management, should be enacted and made mandatory on construction projects to minimise the impact of construction activities on the environment. This should be incorporated into tender requirements and considered during tender adjudication, whereby contractors submit waste management plans used for this purpose. There need to be rewards such as tax breaks and incentives

to acknowledge construction stakeholders who employ green building techniques on their projects even though these projects are not intended to be green-star rated. By doing so, more stakeholders will be encouraged to implement sustainable construction initiatives on their projects. Furthermore, the use of recycled materials needs to be encouraged by the government to reduce the costs of sourcing of new raw materials and processing. Another recommendation is that all construction personnel on a project should undergo an induction that makes them environmentally aware. By involving site personnel, more stakeholders will become aware of sustainable construction methods, and with time, these will become standard practice in the construction industry.

The findings of this study are limited by the fact that the project quantity surveyors who were involved in the initial stage of the project were not the same individuals who handled the execution/construction stage, limiting the information to the project phase that the professional was involved in. Another limitation was that there were some professionals who were involved in more than one green building project; hence their answers were not defined by a specific project. The third limitation was that the information obtained from contractors and subcontractors was limited to construction professionals employed by the main contractor and not necessarily decision-making management staff. The results of the study are also limited by the smallness of the sample size which is because stakeholders who have experience in the use of both sustainable and conventional methods are few and are not therefore generally distributed in the target population. Future research that compares the costs of operating and maintaining a green building to the costs of operating and maintaining a conventional building and which includes other cities in South Africa such as Cape Town, Durban and Pretoria is recommended because a major advantage of green buildings is that of low maintenance and operational costs and an extensive study will confirm the findings of this research.

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