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Cost and Benefits Analysis of Sustainable Building Production in Western Cape Province, South Africa.

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ABSTRACT AND KEYWORDS

PURPOSE OF THIS PAPER
The increasing demand for shelter in the developing world is alarming. The provision of these facilities involves intense construction activities. Although construction activities in the past decades have been observed to impact the environment adversely, researchers opined that the adoption of sustainable buildings will significantly reduce the impacts of construction activities on the environment. Conversely, the high cost of total production has been a barrier to sustainable building adoption. Hence, this paper is set to ascertain the cost benefits of sustainable building production

DESIGN/METHODOLOGY/APPROACH
This paper evaluates the perceptions of construction stakeholders (contractors. consultants and clients) on the cost and benefits of sustainable buildings using a questionnaire survey. Quantitative data collected were analysed using descriptive statistical techniques.

FINDINGS
Findings from the analysis shows that the concepts and benefits of sustainable building production are familiar ideologies in the construction industry. In addition, the evaluation disclosed that achieving the benefits of sustainable buildings depends on the collaborative effort of the construction stakeholders and government towards construction materials cost reduction during construction.

RESEARCH LIMITATIONS/IMPLICATIONS
This paper provides empirical findings to the conference sub-theme on sustainable green building thus promoting sustainable construction education.

WHAT IS ORIGINAL/VALUE OF PAPER
This paper has recognised that the costs of materials for construction and procurement processes are core contributors to the high cost of producing sustainable buildings. The results can be useful to all construction stakeholders to enhance the adoption of sustainable buildings with the cost and benefits of production in perception. These combined efforts encourage stakeholders' participation in the production of sustainable building to reduce the environmental impacts of construction and improve social-economic statues of the population.

Keywords: Building production, Construction cost, Construction materials, Construction stakeholders, Sustainable building.

1.0: INTRODUCTION

Construction industries in developing countries have over the years intensify its pursuit to provide comfortable, affordable and sustainable structures. This is to satisfy the increasing demand for housing and infrastructure. Notably, the negative environmental impacts of these construction activities have increasingly become a concern in the construction industry towards sustainable development. In the quest to reduce these impacts, the concept of sustainable building production emerged in the late 1980's by the United Nation's World Commission on Environment and Development (WCED). In the past few decades, sustainability has been defined by various researches and writers in different ways. Although, literatures reveal that sustainable development was first defined by WCED (1987) in the "Brundtland report" as 'the ability to meet the present needs without compromising the ability of the future generations to meet their own needs'. Consequently, the essence of sustainability in every aspect of the human life (economic, social & environmental) cannot be over emphasized as every choice and actions made in the present affects the future.

Several researchers notably (Azis *et al.,* 2012; Lindahl *et al.,* 2014; Singhaputtangkul *et al.,* 2014; Gan *et al.,* 2015) have carried out studies in the area of sustainability and sustainable building production. Worthy of note, these studies and reviews indicates that sustainability has been a focus of study amongst researchers, with the most studies emphasising on how best to produce and deliver sustainable buildings (Khalfan *et al.,* 2011; Gan *et al.,* 2015; Yudelson, 2009). Relatively, these studies were focused on sustainable building production in the context of design, decision making and stakeholder's perspectives during construction. Comparatively,

few articles have investigated on the cost benefits of sustainable building (Kats, 2013), which poses as a major concern amongst contactors who perceive sustainable buildings as outrageously expensive. This research aims at addressing this gap by conducting a study on the cost benefit of producing sustainable buildings in the Western cape of South Africa.

In modern construction techniques, buildings that significantly consume less energy and water with reduced environmental impact than traditional conventional buildings have been termed as sustainable buildings (SP). Therefore, sustainable buildings according to Yudelson (2010) are buildings designed and constructed to reduce negative environmental impacts and improve the health of the habitat with the significant use of minimum water and energy. Consequently, Kubba (2012) describes sustainable buildings as structures designed, built, renovated, operated, or reused in an ecological and resource-efficient manner to meet the objectives of enhancing the health status of the occupants and efficient utilization of materials, water and other resources. Thus, this paper is set to ascertain the cost benefits of sustainable building production to encourage the adoption of the concept of sustainable construction in the industry.

2.0: OVERVIEW OF SUSTAINABLE BUILDING DEVELOPMENT

2.1: Sustainable construction

The term ‘sustainable construction’ is often interchanged with the term ‘sustainable. According to Kibert, and Kibert, (2008), the term ‘Sustainable construction’ embodies issues related to the ecological, economic and social aspects of a building. Conversely, Kibert (2012) further stressed that sustainable construction is the process of creating and operating a health facility based on ecologically designed building plans and resource efficiency while sustainable buildings are the end products of applying this processes throughout the lifecycle of the building.

Sustainability in building production is a subset of sustainable development aimed at restoring or maintaining a balance between built environment and the eco-system to create a settlement that promotes economic and social equity. Kibert (2012) in Figure 2.1 illustrates the framework for sustainable construction which is applicable throughout the construction phase of a building. Accordingly, Vatalis *et al.,* (2013), highlighted that the principles of sustainable construction is attainable where the construction resources are efficiently utilized and planned for at every phase of construction. Abeysundara *et al.,* (2009) buttressed further that the construction resources, especially materials should be selected in line with the principles of sustainability as it is essential to note that buildings are characterised by the materials used in its construction. Thus, the adoption

of sustainable construction principles effectively reduces the negative impacts of conventional construction.

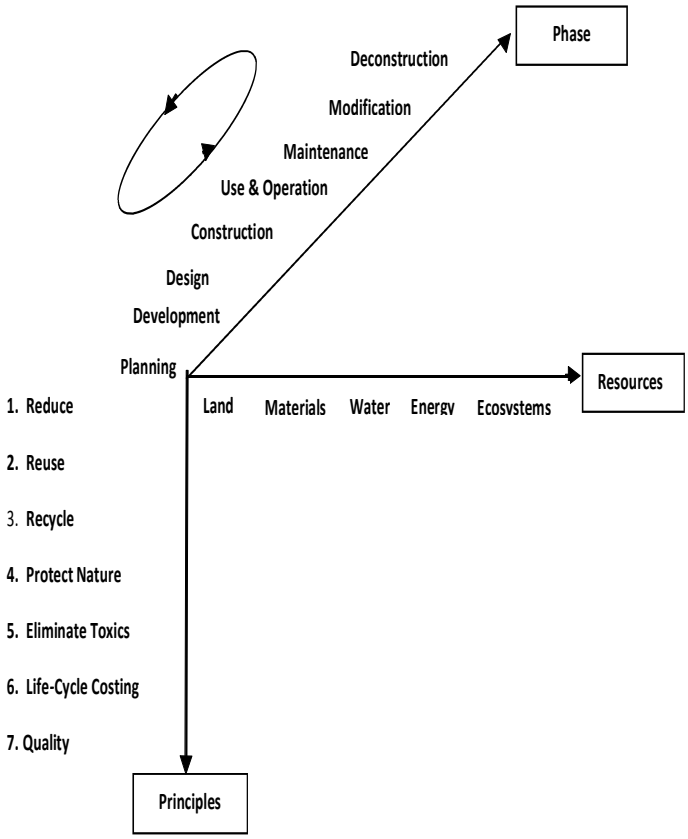

Fig. 1: Framework for sustainable construction (adapted from Kibert, 2012)

2.2: Barriers and Challenges of Sustainable building production

The construction industry has been faces with theoretical and practical issue that have lingered over the years as a result of rapid growth in construction projects. Doubtless, the rapid growth of construction activities in a particular jurisdiction has delivered social necessities as well as contributing significantly to the economic growth of that territory (Azis *et al.,* 2012). On the contrary, the process of constructing these facilities deters adverse environmental impacts, excessive resource wastes and budget overrun as a result of project schedule delays (Azis *et al.,* 2012). As a result, authors notably (the Construction Industry Development Board: CIDB, 2002; Häkkinen, & Belloni, 2011) identified the following as barriers to attaining sustainable buildings in South Africa as a developing country:

- Lack of capacity of construction sector to implement sustainable principles
- Poverty, high demographic growth and low urban investment
- Declining government investment in construction
- Lack of interest in sustainability issues among stakeholders
- Resistance to new technology
- Lack of effective enforcement on existing sustainability rules.
- Unforeseen high cost of production
- Lack of client understanding on the components of sustainability.

2.3 Significance of sustainable building production

Sustainable buildings basically built to create a balance between the social, economic and environmental statues of humans. As established earlier, the rapid growth of urbanization in developing countries such as South Africa has initiated an unprecedented opportunity for the provision of sustainable buildings by the government (Gan *et al.,* 2015). Du Plessis, (2007) highlighted that the conception of sustainable building production over the years has also afforded developing countries stable solutions to the challenges of urbanization through the production of adequate, safe, sufficient housing and social infrastructure for the populace. As a result, the social-economic and ecological development experienced by these countries enhances the eradication of poverty and deteriorating health conditions in that territory (Golubchikov & Badyina, 2012).

GBCSA, (2010) have noted global warming, along with rising temperatures and sea levels, severe climate events and the extinction of various species are also other persistent threats to our planet and according to experts we have ten years to reduce gas emissions or face the consequences. The CIDB (2009) reported that the operation of the building sector in South Africa accounts for 23% of greenhouse gas emissions, while emissions from the manufacture of the major materials for the building sector amounts to around 18mt CO2 per year, or around 4% of total CO2 emissions. This challenge can be brought under control by the implementation of sustainable principles at the planning and materials selection stage.

2.4 Benefits of sustainable building production

In a research study, the World Green Building Council (WGBC, 2013) reported that sustainability in building production have compelling benefits over the traditional or conventionally built structures. However, the benefits which included environmental, social and economic benefits seemed incomplete without the financial benefits, raised a controversial questionable issues amongst stakeholders in the industry. In an effort to

answer this controversial question, WGBC (2013), catalogued the following as benefits of sustainable buildings:

Table 1: Benefits of sustainable building

Environmental benefits	Social benefits	Economic benefits
Enhancing and protecting biodiversity and ecosystems	Enhance occupant health and comfort	Reduce operating costs
Improving air and water quality	Improve indoor air quality	Improve occupant productivity
Reducing waste streams	Minimize strain on local utility infrastructure	Enhance asset value and profits
Conserving and restoring natural resources	Improve overall quality of life	Optimize life-cycle economic performance

Financial benefits

Financially, sustainable buildings afford investors benefits that the traditional buildings cannot offer. The financial benefits of sustainable buildings to building owners, private investors, government investors or the population at large includes: provision of employment during construction, greater employee comfort/productivity, reduced employee health costs, energy and water savings, reduced waste, improved indoor environmental quality and lower operations and maintenance costs.

In summary, Azis *et al* (2012) and Gan, *et al.* (2015) buttressed that the adoption of sustainable principles in building production could either be long-term or intangible summed-up as follows: i). Reduced planning risk. ii) Reduction of building operation and maintenance cost during the building service span. iii) Enhancement of environmental performance. iv). Construction waste minimization. v) Provision of healthier working and living environments. vi). Enhances the efficient process of materials procurement with extended building lifespan .vii). Enhance asset value and profits.

2.5: Cost of producing sustainable buildings

Kats (2003) argues that there has been a common perception in the real-estate industry that the cost of green building is considerably more than a traditional method of development. Allegedly, the biggest barrier to the adoption of sustainable building principles is the perception that it cost more than conventional building (Kubba, 2012). In order to effectively attain sustainability in the production of buildings and social infrastructures,

Kubba (2012) bolstered that the following factors should be considered for implementation throughout the construction phase of the building:

- Setting clear cost values at the design stage. i.e. defining cost management rubrics.
- Implement the principles of sustainability at the materials selection phase to avert construction waste.
- Create awareness on the benefit sustainable building in by industry through seminars, workshops and practical integration in projects.
- Integrating government policies and regulations as an effective approach to enforcing economic, environmental, social and economically friendly construction activities.

3.0: METHODOLOGY AND RESULTS OF DATA ANALYSIS

A preliminary literature search was carried out to investigate the perception of the construction industry professionals regarding the cost benefits of producing sustainable building. From the information derived from the reviewed literatures, a well-structured questionnaire was developed and distributed amongst a randomly selected sample consisting of quantity surveyors, architects, engineers, developers and contractors operating in the Western Cape Province of South Africa. The questionnaire was distributed via E-mail to reputable companies which included a covering letter of invitation to participate in the study. From the total of fifty (50) questionnaires distributed, 32 (64%) questionnaires were completed and retrieved.

Questionnaires were completed anonymously to ensure a true reflection of the respondents' opinions and to meet the ethical criterion of confidentiality. It is therefore assumed that the respondents were sincere in their responses. The data collected were analysed with SPSS statistical software. Descriptive statistics was used to describe and summarise the data. Frequency analysis technique was used to for analysis in this study.

3.1: Background information of respondents

3.1.1: Professional affiliation of respondents

The respondent demography was included in the survey so as to review the proficiencies of the respondents in appraising issues relating to the cost-benefit of sustainable buildings. The first demography, Figure 2, illustrates the organisation of respondents. It was derived that majority of the respondents were Quantity surveyors, 28%, followed by Architects, 22%, Engineers, 19%, Contractors, 19%, Developers, 9%, and the lowest were denoted as others, 3%. As a result, Quantity Surveyors played a vital and influential role in this study.

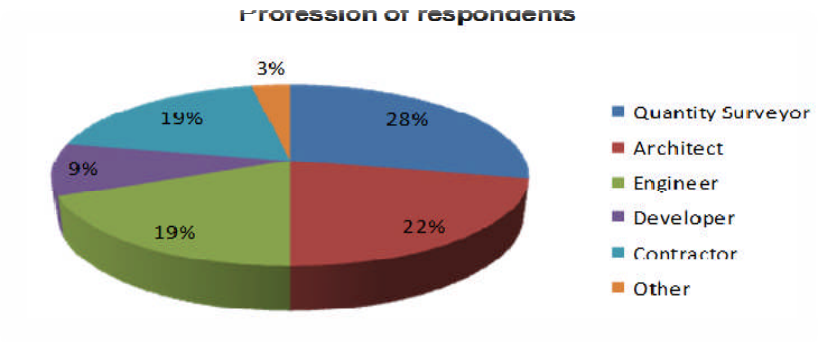

Figure 2: Professional affiliation of the respondents

3.1.2: Years of working experience

The working experience of the respondents in the construction industry was evaluated as well. It was discovered that two sets 25% of the respondents have the working experience of 0-5 years and 6-10 years respectively, followed by 22% having over 22years working experience, 16% of 16-20 years of experience and 12% of 11-15year work experience as illustrated in Figure 3. The chat (fig 3) indicates that 75% of the respondents have between 6 - over 20 years of work experience. This implies that majority of the respondents have the adequate knowledge on the concerns of the industry on the cost-benefits of sustainable buildings production.

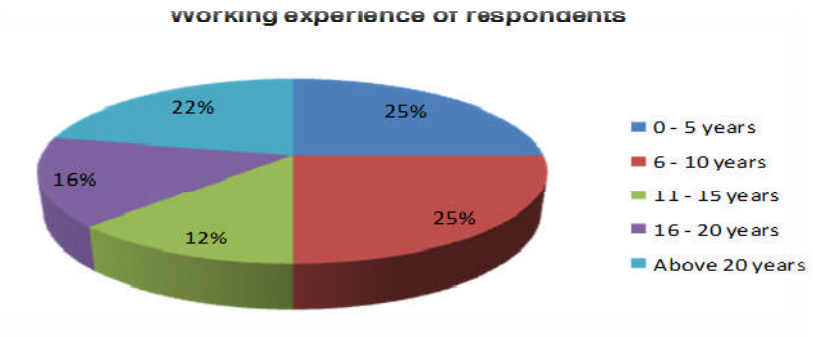

Figure 3: Working experience of respondents in construction

3.1.3: Respondents educational qualification

The highest qualification attained by the respondents as shown in figure 4, indicates that 69% of the respondents obtained Bachelor degrees, followed

by 19% of the respondents who are Diploma holders. The Masters' degree holders occupied the third largest position of 6%. The smallest percentages of respondents were Matric certificate and other qualification holders with 3% each. This indicates that the majority of the respondents obtained at least a Bachelors' degree, 75%. Hence, it could be deduced that the all the respondents were satisfactorily educated.

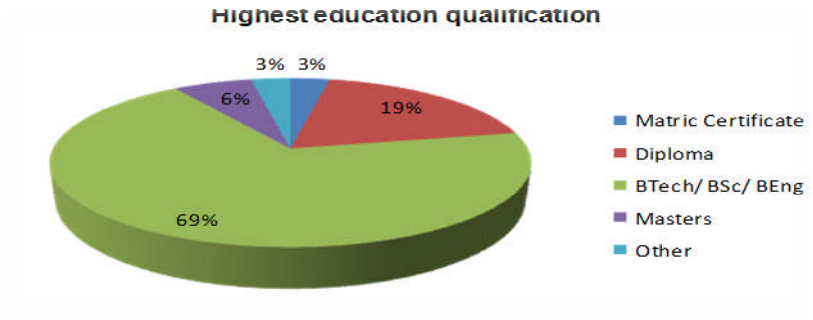

Figure 4: Highest qualification of qualification

3.2: Sustainable construction experience

The respondents were evaluated on the frequency of their participation in the adopting sustainable principles in construction. The responses are presented in Table 1.

Table 1 reveals that majority of the respondents, 65% "rarely" participate in sustainable construction. However, 22% of respondents indicated that they "often" participate in sustainable construction, followed by 9% indicating that they participate in sustainable construction "very often".

Table 2 Frequency of Participation in the adoption of sustainable principle in construction

			Frequency and numerical counts of participants				
			Not at all	**Rarely**	**Often**	**Very often**	**Total**
Profession	**Quantity Surveyor**	Count	0	7	0	**2**	**9**
		% within profession	0	77.8	0	22.2	100
	Architect	Count	1	5	1	0	7
		% within profession	14.3	71.4	14.3	0	100
	Engineer	Count	0	2	4	0	6
		% within profession	0	33.3	66.7	0	100
	Developer	Count	0	1	1	1	3
		% within profession	0	33.3	33.3	33.3	100
	Contractor	Count	0	5	1	0	6
		% within profession	0	83.3	16.7	0	100
	Other	Count	0	1	0	0	1
		% within profession	0	100	0	0	100
Total		**Count**	**1**	**21**	**7**	**3**	**32**
		% within profession	**3.1**	**65.6**	**21.9**	**9.4**	**100**

3.3: Cost-benefits of Sustainable Buildings

3.3.1: Benefits of sustainable buildings

The questionnaire survey explored respondents' perception of the perceived benefits of sustainable building. A summary of the responses is presented in Table 2

The table shows that majority, 63% of the respondent strongly agreed that they are assured of savings in energy and water as a result of sustainable building, followed by 34% that "Agree", then 3% "Disagree". This benefit was ranked 1$^{st.}$.. The analysis of other beneficial factors are as follows.

Table 3: Benefits of Sustainable buildings

Questions		Frequency	Mean value	Rank
Higher building value	Disagree	1	3.406	3
	Agree	17		
	Strongly Agree	14		
	Total	32		
Higher return on investment	Disagree	5	3.156	6
	Agree	17		
	Strongly Agree	10		
	Total	32		
Increase in employee productivity	Disagree	5	3.281	5
	Agree	13		
	Strongly Agree	14		
	Total	32		
Enhanced occupant comfort and health	Disagree	4	3.344	4
	Agree	13		
	Strongly Agree	15		
	Total	32		
Energy and water savings	Disagree	1	3.594	1
	Agree	11		
	Strongly Agree	20		
	Total	32		
Reduced waste	Disagree	2	3.438	2
	Agree	14		
	Strongly Agree	16		
	Total	32		

3.3.2: Cost of sustainable buildings

The questionnaire focused on evaluating the perspectives of respondents on the cost of producing and maintaining sustainable buildings. This evaluation was based on the derived information that 65% of the respondents are conversant with the concept of sustainable construction.

Table 3 clarifies that majority of the respondents “Strongly agreed and “agreed”, 46% respectively, with 6% of the respondents “disagreed” that initial cost of sustainable building construction are higher than the cost of conventional building. The respondents were also asked of their perspective on the decrease of operation cost based on the use of sustainable and cumulatively 87.5% of the respondent “agreed” and “strongly agreed” with only 12.5% disagreeing to this factor. Finally, A total of 68.7% of the respondents indicated that they “agree” and “strongly agree” that sustainable building design decreases maintenance cost, while 3.6% and 25% “disagree” and “strongly disagree”, respectively.

Table 4: Cost of sustainable building

Question		Frequency	Mean value	Rank
Initial costs of sustainable building	Disagree	2	3.406	
construction are higher than	Agree	15		1
cost of conventional building	Strongly agree	15		
	Total	**32**		
Sustainable building design	Disagree	4	3.125	
decreases operation costs	Agree	20		2
	Strongly agree	8		
	Total	**32**		
Sustainable building design	Strongly disagree	2	2.781	
decreases maintenance costs	Disagree	8		3
	Agree	17		
	Strongly agree	5		
	Total	**32**		

4.0: DISCUSSION OF RESULTS

The results from the study reveal the 5 factors as indicated by the Built Environment stakeholder as the perceived benefits of sustainable building in ranking order as: energy and water savings, reduced waste, higher building value, followed by enhanced occupant comfort and health, resulting in an increase in employee productivity. A study done by Katz in 2003, confirm these findings. The results also reveal that majority of the respondents (96%) are in agreement that sustainable building construction cost more initially compared to that of conventional building, The majority also agree that sustainable building design decrease the operation and maintenance costs which is a cost benefit and are confirmed by the literatures reviewed.

From the findings, it is interesting to note that despite the level of stakeholders' awareness on the benefits of sustainable building production, majority of construction professionals do not implement the principles of sustainable construction in their projects.

5.0: CONCLUSION.

The findings of this exploratory study has enhanced in identifying the long-term cost-benefits of producing sustainable building in developing countries. The most significant benefits of sustainable buildings are reduced construction waste, reduced operational and maintenance cost,

energy and water saving, higher building value, enhanced occupant comfort and health, resulting in an increase in employee productivity. Hence, these findings will give a better understanding to construction stakeholders, most especially the clients, who play an influential role in adopting the practice of sustainable buildings production in the construction industry for future construction projects.

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