

PAPER 78 – A PRELIMINARY EVALUATION OF THE CHALLENGES OF SUSTAINABLE CONSTRUCTION PRACTICES IN SOUTH AFRICA

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ABSTRACT

The regular design and construction method negatively affect global sustainable development and project delivery. Its consequences on man and nature have advanced a serious global concern, necessitating the need to mitigate the negative impacts by adopting Sustainable Construction Practices (SCP). The South African construction industry has been compelled to adopt SCP to improve sustainable development. Notwithstanding, life evidence has shown that some challenges hinder the global adoption of SCP. Consequently, this paper aims to specifically investigate and evaluate challenges hindering the implementation of SCP among South African built environment professionals. The methodology approach involves a literature review and empirical field survey. The review found 20 challenges from published peer-reviewed articles which form the bases for the field survey questionnaire. 85 valid responses were received, the descriptive analysis classified the following 5 challenges as most critical: Additional cost on training; invite of ad-hoc; lack of awareness of sustainability principles; Employees' low knowledge and skills in sustainability; lack of client demand; and Lack of Standardization. The inferential analysis using factor analysis grouped the variables into 4 components: Planning related Challenges; Management and Contractual related challenges; Knowledge related factors; Financial related challenges. The study reveals the critical challenges facing the implementation of SCP adoption in the South African construction industry. The findings will promote and improve the adoption of SCP in South Africa and enhance global understanding of SCP.

KEYWORDS: Construction; Housing; Project management; Sustainability; South Africa.

26. INTRODUCTION

The huge to adopt sustainable construction practices in the built environment has received substantial attention, due to the global concern on the ecological system. An ecological system is a biological community made up of all the living things (including people) in a specific area as well as the non-living things that the living things interact with, such as the air, water, and mineral soil. The global concern on the ecosystem sustainability is a key driver that pushes every sector towards sustainability practices. Studies have proven that there are three pillars of sustainability. Those are planet or environment, social or people, and profit or economics. Several reviews on sustainability literature highlight the fact that more attention has been tailored towards the environmental aspect since it forms the base for the other aspects of sustainability. It is evident that human activities have drastically affected the ecosystem, leading to environmental problems such as undue climate change, shortage of raw materials, and ecosystem degradation, among others. As a result, the construction industry has a severe impact on the environment as a major contributor to these problems. The industry's conventional approach has been founded on the idea that investments and innovations stimulate economic growth while also meeting the requirements and wants of consumers (Baloi 2003). Nonetheless, it is important to acknowledge that the industry's processes and products have negative effects on the environment. Water, energy sources, and natural resources are all heavily used during construction. Governments, environmentalists, and other stakeholder groups that are aware of sustainability practices' advantages frequently seek out sustainable construction approaches. Almost 171 nations have now implemented environmental management frameworks and systems using the ISO (International Organization for Standardization) 4000 standard to address environmental problems brought on by greenhouse gas emissions (Ayarkwa et al. 2022). However, understanding sustainable construction practices in South Africa is at its infant stage of research which requires further exploration and study. For instance, the concept of sustainable construction practices is a new notion in developing countries such as South Africa and is hardly practiced by the construction industry in the country. Evidence shows some challenges undermine the implementation of sustainable construction practices in developing countries. Therefore, this study aims to evaluate those challenges faced during the implementation of Sustainable construction practices among South African built environment professionals.

27. LITERATURE REVIEW

2.1 SUSTAINABILITY

To achieve sustainability, structures, organizations, and resources must be managed in a way that balances meeting present and future demands with resolving an array of issues that arise from managing resources for both the short and long term. (Ayarkwa et al. 2022).

2.1 SUSTAINABLE CONSTRUCTION PRACTICE

The goal of sustainable construction practices is to reduce the industry's negative environmental impact. Using recyclable and renewable materials, reducing overall waste generated on site, lowering the finished building energy usage, and safeguarding natural habitats both before and after construction. The usage of energy and emissions by the building industry have a big impact on the environment. In addition to the damage of natural habitats brought on doing the construction phase, energy is required on the project site.

Heavy construction equipment continues to rely significantly on fossil fuels. The energy contained in the building materials and the energy demands of the structures when they are in use are also the responsibility of the built environment.

The construction sector is responsible for 40% of CO₂ emissions and 36% of the world's energy consumption. At the same time, the production and delivery of materials can have a big impact on carbon emissions. Mining of raw resources can contaminate water streams. Because of this, the annual CO₂ emissions from cement manufacturing are currently 2.8 billion tonnes worldwide, but if urbanization rates keep going at their current pace, they might reach over 4 billion tons. The International Council for Research and Innovation in Building and Construction published Agenda 21 for Sustainable Construction to minimize those impressions (Baloi 2003). Hence, the main principles of sustainable construction were highlighted as seen in figure 1.



Figure 1: Sustainable construction main principles

2.2 CHALLENGES OF SUSTAINABLE CONSTRUCTION PRACTICE

Over the years, there have been several difficulties with delivering sustainable construction projects. Insufficient awareness of sustainable construction procedures, employees' low knowledge, and skills in sustainability are the challenges that are frequently raised (Aghimien et al., 2019; Ogungbile and Oke 2018; Opoku and Ahmed, 2014). This resulted in hindrance to the rapid implementation of SCP in the construction industry. Notwithstanding, lack of support from the company managing board is another critical challenge Ahmed and El-Sayegh, 2022; Thomson and El-Haram, 2019; Zhou and Lowe, 2003). This will drastically hinder the adoption of SCP in such companies. In the same vein lack of standardization, and unclear contract requirements (Khalil et al. 2021; Ogungbile and Oke 2018; Opoku and Ahmed, 2014) may lead to mediocre quality control that could have a remarkable impact on the building and its environment. Table 1 reveals the summary of the challenges identified during the review process.

Table 1: Challenges of Sustainable construction practices adoption

Code	Challenges	Reference
CSCP1	Availability of sustainable construction materials.	(Abolore, 2012; Aghimien et al., 2018; Aghimien et al., 2019; Ahmed and El-Sayegh, 2022; Alqadami et al. 2020; Aigbavboa et al., 2017; Ayarkwa et al., 2022; Baloi, 2003; Hussin et al., 2013; Hwang and Ng 2013; Khalil et al. 2021;
CSCP 2	Lack of sustainability measures.	
CSCP 3	The cost associated with sustainability	
CSCP 4	Time constraints	
CSCP 5	Fear of return on investment in a short-term period	
CSCP 6	Incomplete complicated sustainable design	
CSCP 7	lack of performance information on sustainable buildings	
CSCP 8	lack of client demand	
CSCP 9	low profitability to the industry	

Code	Challenges	Reference
CSCP 10	Rigorous procurement process	Ogungbile and Oke 2018; Opoku and Ahmed, 2014; Thomson and El-Haram, 2019; Zhou and Lowe, 2003)
CSCP 11	Lack of sustainable product information	
CSCP 12	Lack of support from the company managing board	
CSCP 13	Employees low knowledge and skills in sustainability	
CSCP 14	Client requirement.	
CSCP 15	Contract requirement	
CSCP 16	Additional cost on training: ad-hoc invite	
CSCP 17	lack of awareness of sustainability principles	
CSCP 18	Technical difficulty during the construction process	
CSCP 19	Lack of budget to promote sustainability by the government	
CSCP 20	Lack of Standardization	

28. RESEARCH METHOD

The methodology approach adopted in this study is in two stages. The study begins by identifying the critical challenges hindering the adoption of sustainable construction practices in the construction sector using a qualitative method, by reviewing published empirical studies on the study focus. This included journal articles, book chapters, and conference papers discussing sustainable construction challenges. Studies were identified from the literature search for inclusion in the review using the following keywords string: “sustainable construction”; “challenges.” These studies' titles and abstracts were then scrutinized to remove any irrelevant data, and the remaining articles were further screened by reading their full text to determine whether they met the study's goals. These resulted in the identification of 20 crucial challenges deterring the adoption of sustainable construction practices in the construction industry. The selected SCP challenges are those that have been given significant consideration in the studies carried out in many nations, Toyin and Mewomo (2022) and Chan et al. (2018) used a similar approach. The authors concurred that using well-known characteristics is preferable for a statistical research study since it makes it easier for respondents to answer and enables more accurate feedback.

Thereafter, a statistical web-designed survey questionnaire was compiled to collect quantitative data. In other to check the relevance and reliability of the questionnaire, two main steps were followed. Firstly, the questionnaire was reviewed by 3 sustainable environment specialist who is construction managers with over 5years of practicing experience and an academic who specializes in sustainable construction. The process enables them to scrutinize the questionnaire to confirm that unclear terminologies were not contained in the survey and that appropriate technical terms were used. The questionnaire covers the challenges and remedies to address those challenges. To choose the appropriate respondent, the snowballing sampling technique was used, which was a similar strategy to that used by Gledson et al. (2016) and Toyin and Mewomo (2022). In total 190 target professionals received the questionnaire, thus 85 survey questionnaires were dully filled and returned. Thus, representing a 45% response rate as seen in table 2.

On a five-point Likert scale, 1 being "not significant" and 5 being "strongly significant," the SCP difficulties were evaluated. Using Cronbach's α techniques is one of the effective ways to verify the validity of the quantitative questionnaire's reliability (Toyin and Mewomo, 2022). These techniques establish the typical link or internal regularity between the variables/factors in a questionnaire. The alpha (α) value for the 20 SCPC was obtained using IBM SPSS (Statistical Package for Social Scientists), and it was 0.916. Based on the five-point Likert scale, they show that the measuring scale is accurate at a 5% significant level. The statistical information gathered can thus be used to perform further descriptive and inferential analysis. In this study, part A sought the respondents' demographic data whereas section B sought the SCPC. The professionals that work in the built environment in South Africa are the target audience.

3.1 DESCRIPTIVE ANALYSIS

The SCPC variables were ranked using the mean item score (MIS), and their level of significance was ranked using the relative importance index (RII). To determine the significance of each component, the 5-point Likert scale was used to evaluate the variables.

3.2 INFERENTIAL ANALYSIS

The data analysis used is Factor Analysis (FA) through Principal Component. This analysis was used to evaluate the perceived cluster where each variable resonates, from which a concise component of those challenges can be formed for easy understanding. FA is a data reduction and analysis method; it is used to extract information

regarding interrelations among a set of variables (Ahmed and El-Sayegh 2022). FA has been used in previous studies related to construction management. Toyin and Mewomo 2023 used FA to categorize and group barriers hindering the implementation of Building Information Modelling (BIM) in the Lagos Nigeria construction industry. Ahmed and El-Sayegh 2022 also used FA to group the challenges of sustainable construction project delivery in the UAE. Similarly, Khalil et al. (2021) utilized FA to group challenges for the implementation of SCP in Libya. FA comprises three distinctive steps. Firstly, assessment of data suitability. This is when the Kaiser-Meyer-Olkin (KMO) measurement of sample adequacy is higher than the limit of 0.5 and Cronbach's α , reliability is greater than 0.7, and when Bartlett's test of sphericity has a significant level of 0.05. Secondly, factor extraction. In this study, the PCA (Principal Component Analysis) was employed to produce a straightforward solution with the fewest variables necessary to explain the substantial variance in the original data. Lastly, is the factor rotation which helps give a clearer picture of the extracted factors? The factors are provided by SPSS 29 as groups of variables, and the researcher interprets these groups based on theoretical knowledge and earlier research.

29. RESULTS AND DISCUSSION

4.1 RESPONDENT PROFILE

Table 1 show the profile of the built professionals in South Africa with experience in sustainable construction who voluntarily took part in the survey.

Table 2. Respondents' demography

Category		Respondent (Total 85)	
		Number	Percentage
Gender	Male	65	76.5%
	Female	20	23.5%
Race	South African	60	70.6%
	Indian	11	12.9%
	White	7	8.2%
	Others African	7	8.2%
	Other	0	0%
Years of experience	1-5	5	5.9%
	6-10	29	34%
	11-15	34	40%
	16-20	5	5.9%
	21 years and above	1	1.1%
Current role on project	Site Manager	18	21.1%
	Contractor	9	10.6%
	Project Manager	24	28.2%
	Consultant	22	25.9%
	Sub-contractor	12	14.1%
Profession	Architect	18	21.2%
	Construction Manager	26	30.6%
	Engineer	24	28.2%
	Quantity Surveyor	17	20%
Company sector	Private	54	63.5%
	Public	31	37.5%

4.2 DESCRIPTIVE DATA PRESENTATION AND DISCUSSION

Table 3 presents the descriptive analyses of the data received from the survey. From this table, it could be summarized that five out of the identified challenges were perceived to be strongly significant. Those are SCPC16: Additional cost on training: ad-hoc invite. The extra cost incurred in bringing SCP experts to train the company staff was unanimously ranked first among others. Thus, the cost becomes a burden on the firm, this will have an effect since it will reduce the expected profit from the project. SCPC17: lack of awareness of sustainability principles. It is important for professionals to be aware of the latest development in their field of practice, although the participants are aware of SCP, most of them lack an understanding of SCP principles. SCPC13: Employees' low knowledge and skills in sustainability. It is expected of the construction firm to engage in regular training and workshop for their employee in other to catch-up with the innovation in the industry. SCPC8: lack of client demand. This challenge was ranked 4th among others, this indicated that cl that client decisions cannot be neglected in the choice of design, nevertheless, it will significantly boost the implementation of SCP if client can quickly

realise the profound benefit during the lifecycle of the building. Lastly, SCPC20: Lack of Standardization. In the construction industry, to curb differences in standards adopted, it is important to have a regulatory standard that will guide the professionals during the discharge of their duties. In the case of SCP, it is of important to have a regular standard that would guide the implementation of SCP in the South African construction industry.

Also, from Table 3, 3 (15%) of the variables were ranked least significant, those are SCPC10: Rigorous procurement process. At the present level of SCP adoption in South Africa, it can be reported that the procurement process is not really a significant challenge, notwithstanding, the mean weight is above the average mean, thus it connotes some level of importance. SCPC12: Lack of support from the company managing board. This was ranked 19th having a mean weight slightly above average, this evidence still indicates that there are some firm's board managers that still refused to fully embrace SCP. This could be because of several factors such as ignorance of acquiring desired Skills and competencies in their field of expertise (Toyin and Mewomo 2022). SCPC6: Lack of sustainability measures. This was ranked 20th which means is not much significant, also from the mean weight of 2.51 and Relative Importance Index (RII) of .05, it can be computed that the challenge is on the average bottom, thus regarded as neutral.

Table 3: Descriptive result

Code	Mean	Std. Dev.	RII	Ranking	Sig. Level
SCPC16	4.13	.768	0.83	1 st	SS
SCPC17	4.07	.784	0.81	2 nd	SS
SCPC13	4.06	.980	0.81	3 rd	SS
SCPC8	4.05	.830	0.81	4 th	SS
SCPC20	4.05	.785	0.81	5 th	SS
SCPC19	3.85	1.102	0.77	6 th	S
SCPC1	3.76	.972	0.75	7 th	S
SCPC3	3.69	1.091	0.74	8 th	S
SCPC2	3.68	.790	0.74	9 th	S
SCPC5	3.59	1.003	0.72	10 th	S
SCPC18	3.54	.825	0.71	11 th	S
SCPC14	3.51	.854	0.70	12 th	S
SCPC7	3.47	.959	0.69	13 th	S
SCPC9	3.44	.981	0.69	14 th	S
SCPC11	3.31	.976	0.66	15 th	S
SCPC15	3.20	.910	0.64	16 th	S
SCPC4	3.06	1.028	0.61	17 th	S
SCPC10	3.01	1.220	0.60	18 th	N
SCPC12	2.85	1.086	0.57	19 th	N
SCPC6	2.51	1.183	0.50	20 th	N
SIGNIFICANT LEVEL RATING					
Descriptive Statistic N=85	RII values		Significance level		
	0.81≤RII≤1.00		Strongly significant (SS)		
	0.61≤RII≤0.80		Significant (S)		
	0.41≤RII≤0.60		Neutral (N)		
	0.21≤RII≤0.40		Less significant (LS)		
0.00≤RII≤0.20		Not significant (NS)			

a. INFERENCE DATA PRESENTATION AND DISCUSSION

As previously explained, table 4 present the PCA of the variable, the principle is to reduce the factors into simple manageable clusters for proper understanding. Thus, the variables were then clustered into four components, namely: Planning related challenges; contractual and management related challenges; knowledge related challenges and financial related challenges.

Table 4: Rotated component cluster

CODE	Component				Communalities
	1	2	3	4	
Planning related Challenges					

SCPC10	Rigorous procurement process	.768		.875
SCPC8	lack of client demand	.768		.716
SCPC18	Technical difficulty during the construction process	.698		.681
SCPC19	Lack of budget to promote sustainability by the government	.693		.717
SCPC4	Time constraints	.662		.884
SCPC3	The cost associated with sustainability	.636		.728
Contractual and Management related challenges				
SCPC12	Lack of support from the company managing board	.704		.819
SCPC20	Lack of Standardization	.685		.720
SCPC6	Incomplete or complicated sustainable design	.629		.566
SCPC2	Lack of sustainability measures.	.595		.790
SCPC15	Unclear contract requirement	.555		.730
Knowledge related challenges				
SCPC11	Lack of sustainable product information		.790	.807
SCPC7	lack of performance information on sustainable buildings		.773	.751
SCPC13	Employees low knowledge and skills in sustainability		.681	.699
SCPC1	Unavailability of sustainable construction materials.		-.663	.775
SCPC17	lack of awareness of sustainability principles		.639	.638
Financial related challenges				
SCPC16	Additional cost on training: ad-hoc invite		.652	.833
SCPC9	Low profitability to the industry		.592	.622
SCPC5	Fear of return on investment in a short-term period		.579	.590
SCPC14	Client requirement		.544	.726

4.3.1 Planning related Challenges

The Six challenges under this component explain the planning-related challenges which affect the adoption of sustainable construction practices. These are rigorous procurement process; lack of client demand; Technical difficulty during the construction process; Lack of budget to promote sustainability by the government; Time constraints and the cost associated with sustainability. Adequate planning is important before embarking on any construction project. Aigbavboa et al. (2017) found that professionals in South Africa believe there is going to be increase in costs to comply with the standards of sustainability. This mind-set had a negative effect on the adoption of SCP in South Africa. As a result, it is expected the professionals are enlightening on the understanding of the long-time benefits that would be realised during the life circle of the project. Aghimien et al. 2019 suggested that to improve sustainable construction practices, a change from the norm to adopting innovative ideas is necessary for the construction industry. Thus, proper enlightenment of construction clients and professionals in terms of sustainable construction is needed to alienate the client's fear of an increase in investment cost and create a proper understanding of its inherent benefits. This will not only increase client interest, but it will also accelerate the provision of funds by the government and developers toward sustainable construction practices in South Africa.

4.3.2 Management and Contractual related challenges

The five challenges clustered under this component explain the contractual and management challenges hindering the quick acceptance of SCP in the South African construction environment. These are Lack of support from the company managing board; Lack of standardization; Incomplete or complicated sustainable design; Lack of sustainability measures; Unclear contract requirements. The acceptance of any innovative practice in the construction industry lies on the top management's decision. Therefore, it is important that such an idea is accepted by the managing board member. Khalil et al. (2021) opined that the leadership of any construction organisation should be at the forefront of enforcing sustainable construction practice. Contracts should also include incentives for the adoption of sustainable construction practices, according to Ahmed and El-Sayegh (2022); Ogungbile and Oke (2018). These authors recommended cost-plus-fee arrangements with special features that encourage contractors to submit bids for sustainable projects and do away with the requirement of including a green risk premium in contract.

4.3.3 Knowledge related factors

The five challenges extracted for factor 3 were Lack of sustainable product information; lack of performance information on sustainable buildings; Employees' low knowledge and skills in sustainability; Unavailability of

sustainable construction materials; lack of awareness of sustainability principles. This finding is in line with the findings of Ahmed and El-Sayegh (2022). Experience plays a key role in the construction industry. Being a knowledgeable skilled or unskilled labour in the construction process will aid smooth delivery of the project. Toyin and Mewomo (2022) found that construction management graduate finds it difficult to secure a job due to their low level of knowledge about innovative practices. Therefore, it is important to sensitize the workers and conduct training/workshops with SCP to ensure they understand the process and principles. Project managers should also schedule regular meetings to update the entire team on the status of the project.

4.3.4 Financial related challenges

The four extracted for factor 4 were the challenges that are cost related. This cluster explains the financial challenges encountered during the process of practicing sustainable construction. The need to hire experts to train the employee on the principle of SCP may have a significant implication on the budget of the project (Hussin 2013). Low profitability to the industry after investing heavily on the project tends to discourage the managing board from practicing sustainable construction (Alqadami et al. 2020). Fear of return on investment in a short-term period is a critical challenge that developers look at before investing in any innovative means of construction (Hwang and Ng 2013). Client requirements play a key role in the cost implication of the project. Introducing new principles or methods of construction as against what was initially agreed on before the start of the project may result in the abandonment of the project or increase the project's total cost.

30. CONCLUSION AND RECOMMENDATION

This study examines the challenges limiting the adoption of sustainable construction practices in the South African built environment. The study through the preliminary literature review highlights the challenges facing the acceptance of SCP. Through the empirical survey, the most critical challenges to South African built environment professionals were identified. The results of this study have important practical implications because they show that most employees have low knowledge and skills in sustainability, there is lack of awareness of sustainability principles, there is a lack of client demand for SCP, built professionals are unfamiliar with SCP, Additional cost on training; ad-hoc invite and Lack of Standardization are what majorly discourage the adoption of SCP in South Africa from a preliminary view. Those critical challenges were related to Planning; Knowledge; Management and Contractual; and Financial challenges.

The following recommendation could be suggested to enhance the future adoption of SCP in the South African construction industry and other related developing countries who also faces similar challenges:

- There may be a research focus on the development of SCP framework which will guide through the design and construction phases and also beyond those phases.
- The government may provide supporting funds towards sustainable practices: for materials, services and knowledge impacts to the workers.
- The top managers may organise regular training on the latest update as regards innovations towards sustainable development.

It is believed that the implementation of those recommendation will drastically provide an enable environment for the practice of sustainable construction practice in South Africa and beyond, thereby, contributing richly to the global sustainable development.

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