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BARRIERS TO THE ADOPTION OF EMERGING TECHNOLOGIES FOR SUSTAINABLE CONSTRUCTION IN SMES.

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ABSTRACT

The construction industry activities contribute to and impact the environment; hence the industry continuously strives to adopt sustainable principles into its process and products. Another critical aspect to achieving this in the current technological revolution is the adoption of technology for achieving sustainable construction. Various technologies are available and have been explored to achieve sustainable construction. However, there is a dearth of studies on adopting technology for sustainable construction by construction SMEs and from the perspective of developing countries. This study investigates the adoption of technology for sustainable construction by SMEs in the South African construction industry. A total of eighty responses were collected through well-structured questionnaires administered randomly. It was observed that all barriers are significant, but the most significant barrier is the high cost of adopting technologies. The study recommends the provision of financial incentives and support for SMEs. Also, SMEs must not resist change birthed by the adoption of technology for sustainable construction.

***Keywords**: SMEs; South Africa; Sustainable construction; Sustainability; Technology Adoption.*

1. INTRODUCTION

Sustainable construction practices are becoming progressively vital as the world shifts towards a greener future. This involves a total commitment to adopting practices supporting economic, environmental, and social sustainability (Hussin et al., 2013) in every facet of the construction process. Achieving sustainable construction, therefore, requires fulfilling the basic principles of sustainability in the construction process and products. Hill & Bowen (1997) classified the principles of sustainability into four social sustainability, economic sustainability, biophysical sustainability and technical sustainability. Achieving sustainability preserves and promotes the quality of life and the environment. In addition, it promotes prudence in the utilisation of the earth's resources. From literature, drivers for achieving sustainable construction practices in the construction industry include implementation of research outcomes, legislation framework supporting implementation, and awareness among others (Oke et al., 2019).

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In the framework for enabling sustainable construction in developing countries, Du Plessis (2007) posited that technology is a critical enabler for achieving sustainable construction. Technology plays a vital role in achieving sustainable construction (Miyatake, 1996); it is an essential ingredient to achieving sustainable construction. The integration and adoption of emerging technologies by the construction industry have also been identified to promote sustainability in the construction industry (Adekunle et al., 2021; Ejohwomu et al., 2021). Some of the technologies that have been identified and explored for sustainable construction include 3D printing (Hager et al., 2016), the Internet of Things (Arowoiya et al., 2020; Oke & Arowoiya, 2021), cloud computing (Oke et al., 2021; Oke et al., 2021), data mining (Aghimien, 2019).

However, despite the benefits of technology adoption, its implementation has numerous barriers. Generally, the barriers to technology adoption in the construction industry include high initial costs, lack of awareness, and resistance to change (Adekunle, et al., 2021; Aghimien et al, 2019; John et al., 2022). However, there is a dearth of research on technology adoption by SMEs. SMEs are generally given less attention in the adoption of innovations and technologies, and hence many struggle to be competitive (John et al., 2023). Many factors impact the adoption of technology by construction SMEs; for instance, Hardie & Newell (2011) identified regulatory climate as being critical in Australia. This study explores the barriers to the effective adoption of technology for sustainable construction by SMEs in South Africa. Articulating these barriers supports and accelerates the adoption of sustainable technologies.

2. SMALL AND MEDIUM-SIZED ENTERPRISES (SMES)

Since the introduction of SMEs in the late 1940s, they have become an integral and important aspect of economies around the world. Although the size, classification, and contribution to the economy vary from economy and context (Keskin & Şentürk, 2010), their importance is not disputable. SMEs, including those in the construction industry, create jobs, and generate income. According to Keskġn et al. (2010), they are anti-poverty enterprises, Robu (2013) describes them as the engine of the modern economy. In South Africa, SMEs contributed 22% to the total turnover in 2019 (Statistics South Africa (STATSSA), 2020). Therefore, the importance of SMEs cannot be overemphasised. Despite the critical role construction SMEs play, they face various challenges in the South African construction industry, including difficulty securing projects and failure to gain cost advantage, among others (Wentzel et al., 2016). The adoption of emerging technologies for sustainable construction will help SMEs gain a competitive advantage(Aghimien et al., 2021) and be more profitable.

3. METHODOLOGY

The study's objective was to investigate the barriers to adopting emerging technologies for sustainable construction by SMEs in the South African construction industry. The data for this study was collected through a structured questionnaire administered to industry professionals in the South African construction industry (the respondents' information is presented in Table 1). The questionnaire was administered through an online survey platform randomly; this allows all respondents equal chances of being selected for the study. The administered instrument contained a cover letter explaining the study objective and assuring the respondents of the ethical considerations and their anonymity. Eighty questionnaire responses adequately filled were received and considered suitable for the study; this satisfies a minimum of thirty sample size requirement (Ott & Longnecker, 2010). Structured questionnaires have been adopted in previous construction industry studies to collect data from industry professionals (Adekunle et al., 2022; Akinradewo et al., 2022; Aliu et al., 2022;

Ikuabe et al., 2022) and understand various industry phenomena. The questionnaire was designed to collect respondents' background information (section A). The other section collected respondents' perspectives on the barriers to adopting emerging technologies for sustainable construction (designed for ratings on a five-point Likert scale). The approach is considered suitable for causal relationship testing and generalisation. The Cronbach's Alpha was computed for reliability, and a value of 0.985 was achieved, which is above the threshold (Pallant, 2010).

4. FINDINGS

4.1 RESPONDENTS BACKGROUND

The respondents for the study consist of different professionals; the professional composition consists of 5.0% Architects, 30% Quantity Surveyors, 8.8% Civil Engineers, 7.50% Project Managers, 12.50% Construction Managers, 2.50% Structural Engineers, 2.5% Land Surveyors, 2.50% are Site Surveyors, 11.30% are Health and Safety Officers, 2.50% are Site Agents, 7.50% are Foreman, 6.3% are Site Engineers, and 1.30% are other professionals. These professionals possess different experience levels in the construction industry, measured in years. 28.21% possess 0-1 year of industry experience, 37.5% have 1-5 years of working experience, 16.30% have 6-10 years of experience, 10% have been working for 11-15 years, 2.50% have 16-20 years working experience, while 5.00% have been working for 20 years and above. Other information about the respondents is presented in Table 1. The respondents' background provides a blend of diverse experience and expertise required for the study.

Table 1: Respondent background

Professional qualification	**%**
Structural Engineer.	2.50%
Site Surveyor.	2.50%
Site Foreman.	7.50%
Site Engineer	6.30%
Site Agent.	2.50%
Quantity Surveyor.	30.00%
Project Manager.	7.50%
Other.	1.30%
Land Surveyor.	2.50%
Health and Safety Officer.	11.30%
Construction Manager.	12.50%
Civil Engineer.	8.80%
Architect.	5.00%
Years of experience	**%**
6 – 10 years.	16.30%
20 years & above.	5.00%
16 – 20 years.	2.50%
11 – 15 years.	10.00%
1 - 5 years.	37.50%
0 – 1 year.	28.70%

Educational qualification	%
Matric	5.00%
Master's Degree	11.30%
Honours Degree.	12.50%
Doctorate	1.30%
Diploma.	12.50%
Bachelor's Degree.	57.50%
Location of the organisation	**%**
Western cape.	3.80%
Northwest.	1.30%
Northern cape.	2.50%
Mpumalanga.	7.50%
Limpopo.	8.80%
Kwa-Zulu natal.	6.30%
Gauteng.	60.00%
Free state.	2.50%
Eastern cape.	7.50%

From the data analysed (Table 2), the respondents reveal the top ranking barriers include high cost with a mean item score of 3.83 and standard deviation of 1.271, budgetary priorities with a mean item score of 3.77 and standard deviation of 1.154, resistance to learning new technologies with a mean item score of 3.67 and standard deviation of 1.248 and lack of Incentives with a mean item score of 3.66 and standard deviation of 1.292. The least ranked barriers are Organizational Size (MIS =3.46, SD=1.377), Organizational Culture (MIS=3.39, SD=1.285), Proof of value (MIS=3.38, SD=1.38) and Complex Operation (MIS=3.32, SD=1.455). It is worth noting that all barriers presented in this study are significant to the adoption of emerging technology for sustainable construction.

Table 2: Barriers to emerging technology adoption for sustainable construction.

Barriers	Mean	Std. Deviation	Ranking
High Cost.	3.83	1.271	1
Budgetary priorities.	3.77	1.154	2
Resistance to learning new technologies.	3.67	1.248	3
Lack of Incentives.	3.66	1.292	4
Understanding of and ability to implement.	3.62	1.38	5
Accessibility of Technical Knowledge.	3.62	1.251	6
Lack of required skill.	3.61	1.319	7
Lack of Experience.	3.61	1.463	8
Availability of technologies.	3.6	1.27	9
Maintenance.	3.56	1.227	10
Lack of available information on technology reliability.	3.55	1.364	11
Lack of Top Management Support.	3.55	1.456	12

Difficulty of technologies.	3.54	1.396	13
Structure Of the Organization	3.53	1.224	14
Lack of Financial Support	3.53	1.404	15
Time to make changes and adjust.	3.51	1.273	16
Return on investment not clear.	3.51	1.331	17
Lack of client mandate.	3.5	1.331	18
Lack of Knowledge.	3.5	1.467	19
Updating the Technologies periodically	3.49	1.326	20
Legal and contractual constraints.	3.49	1.375	21
Reliability.	3.49	1.421	22
Social implications (changes in collaboration communication styles)	3.48	1.302	23
Long lead time required for full-scale implementation.	3.47	1.346	24
Government regulations.	3.47	1.367	25
Organisational Size.	3.46	1.377	26
Organisational Culture.	3.39	1.285	27
Proof of value.	3.38	1.38	28
Complex Operation.	3.32	1.455	29

Despite construction SMEs' importance and critical role, access to finances and weak financial strength are characteristics. It is, therefore, not surprising that the major barrier to adopting technology for sustainable construction is the issue of high cost. These findings align with Aghimien et al (2019) whereby high cost was identified as a critical barrier to adopting emerging technologies. Also, Cant et al. (2016) opined that a lack of financial resources is a critical barrier to the adoption of technology by SMEs. To overcome this, there is a need for financial support, incentives and access for SMEs. SMEs should also consider sharing technology and leasing. Secondly, there is a need for a change in stakeholders' perspective from viewing the adoption of technology for sustainable construction as an investment instead of viewing it as a cost. This enables stakeholders to consider the economic benefits of adoption instead of the short-term cost of procurement. SMEs must also prioritise the adoption of emerging technologies to achieve sustainable construction in their budgeting. This is important, especially from the management perspective, during financial planning. However, this can only be achieved if the top management is receptive to technology adoption and the training of staff to acquire new skills and competencies (Adekunle et al., 2022; Aliu et al., 2022). Stakeholders need to be receptive to new technology adoption and abandon the traditional approach to the construction industry process (Adekunle et al., 2020).

5. CONCLUSION

This study assessed the barriers to the adoption of technologies for sustainable construction by SMEs. From the data gathered and analysed, it was observed that all the barriers studied were significant; however, the most significant barrier was high cost. Other barriers identified by the study include budgetary priorities, resistance to learning new and lack of Incentives. To overcome these barriers and adopt technology for sustainable construction by SMEs there must be increased investment in emerging technologies by SMEs. Furthermore, SMEs should consider partnering, technology sharing and leasing to ease the cost requirements. SMEs must

also be incentivised to adopt emerging technologies to overcome the resistance to the adoption. There is also the need for stakeholders to be receptive to the adoption of innovations and technologies. It is worth of note that SMEs play a critical role and are important to achieving sustainable construction in the construction industry. Consequently, there is a need for government support for SMEs in this regard to overcome the identified barriers. Future research can explore which technologies SMEs adopt and how they are being adopted for sustainable construction in developing countries. It should be noted that the results of the study are specific to the South African construction industry where it was conducted.

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