

A comparative study of the adoption of sustainable construction by South African small, medium and micro enterprises and large enterprises



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Background: In South Africa, small, medium and micro enterprises (SMMEs) and large enterprises (LEs) share the same regulatory environment but differ in resources, capacity and market exposure.

Aim: This study compared knowledge, incentives, client demand, regulatory frameworks, behavioural intention (BI) and actual use of sustainable construction practices amongst South African SMMEs and LEs.

Setting: The study was conducted in South Africa's construction industry, with responses from firms across seven provinces.

Methods: This quantitative study used a self-administered online questionnaire completed by 211 construction professionals. Independent samples *t*-tests compared SMMEs and LEs across eight adoption-related constructs.

Results: Both SMMEs and LEs reported high BI and actual use of sustainable construction practices. Whilst both groups expressed positive BI, LEs reported significantly higher perceptions of usefulness, ease of use, incentives and client demand. Small, medium and micro enterprises demonstrated slightly higher levels of actual use, indicating experience-based adoption despite limited institutional support. No statistically significant differences emerged for knowledge of sustainable construction, regulatory standards or actual use. Effect size analysis revealed moderate to large practical differences for incentive- and demand-related constructs.

Conclusion: Although sustainable construction practices are implemented across firm sizes, the drivers of adoption differ substantially. Large enterprises benefit more from formal institutional and market mechanisms, whereas SMMEs report comparably high actual use despite lower perceptions of institutional support, a pattern consistent with, though not directly evidencing, practice-led or necessity-driven adoption.

Contribution: This study advances understanding of sustainable construction adoption in emerging economies and highlights the need for firm-size-specific policies and support.

Keywords: sustainable construction; SMMEs; large enterprises; technology adoption; construction industry.

Introduction

Gade, Larsen and Selman (2021:654) assert that a sustainability-focused construction industry is a crucial partner in achieving the United Nations Sustainable Development Goals (UN SDGs). Despite this, conventional construction consumes a significant amount of energy (38% of global energy production), contributes to pollution and emits 35% of carbon dioxide gas (Ahmed et al. 2023:1; Fitriani & Ajayi 2023:2029).

Furthermore, conventional construction uses fossil fuels during material production, transportation and actual construction. In addition, conventional construction consumes 25% of potable water and 30% of natural resources as raw materials (Fitriani & Ajayi 2023:2028–2029). Such scholarship suggests that the production of traditional construction materials like concrete and steel requires significant amounts of energy. Additionally, contemporary scholarship reports that inadequate waste management at construction sites often accounts for 30% of global waste (Ahmed et al. 2023:1; Fitriani & Ajayi 2023:2031). Construction waste releases harmful pollutants into soil and water bodies, thereby damaging surrounding ecosystems. The net result is that

conventional construction is associated with environmental degradation and greenhouse gas emissions (Ahmed et al. 2023:2). The negative outcomes of conventional construction, coupled with increasing demand for infrastructure, underscore an urgent need for sustainable construction (Zulu et al. 2023:2124).

Farhadi (2024:1) stipulates that the construction industry has the potential to contribute to achieving the UN SDGs related to sustainable cities and communities (SDG 11), responsible consumption and production (SDG 12), climate action (SDG 13) and life on land (SDG 15). Nonetheless, contemporary literature outlines five challenges the building sector would encounter in implementing sustainable construction practices (Oyewobi & Jimoh 2022:10; Yin et al. 2018:614). Firstly, there is a lack of awareness and understanding of sustainable construction methods. Secondly, there is an absence of client commitment to sustainable construction practices; some clients believe that environmentally friendly buildings are expensive, and misconceptions persist that consulting fees and material costs are higher for sustainable buildings. Thirdly, standards for sustainable construction technologies remain limited. Fourthly, the perceived complexity of green building classification systems tends to discourage architects and engineers from creating sustainable designs. Fifthly, as with adopting any innovation, there is a general resistance to change (Ayorinde, Ntebo & Mathe 2021:3; Durdyev et al. 2018:570; Hwang, Shan & Lye 2018:2233; Marsh, Brent & De Kock 2021:20; Oyewobi & Jimoh 2022:10).

Current efforts to facilitate the adoption of sustainable construction tend to adopt a general approach. The efficacy of policies, incentives and strategies applied to large enterprises (LEs) and small, medium and micro enterprises (SMMEs) is unknown, particularly for construction SMMEs, as they have fewer resources and experience than LEs. When considered as a group, such SMMEs represent a sizeable percentage of the South African construction industry. This study investigates the need for targeted interventions for construction SMMEs to adopt sustainable construction practices by comparing the perceptions of construction SMMEs and LEs on Knowledge of Sustainable Construction (KSC), Incentives to Adopt Sustainable Construction (IASC), Client Demand for Sustainable Construction (CDSC), Sustainable Construction Regulations and Standards (SCRS) and Behavioural Intention (BI) and Actual Usage (AU).

Literature review and hypothesis development

Several factors influence the adoption of sustainable construction. These factors interact to either facilitate or hinder the adoption of sustainable construction practices. If not adequately addressed, they can become significant barriers to sustainable construction practices and become the default construction methods (Dwaikat & Ali 2016: 401–402). Some significant factors relevant to developing

countries include incentives, client demand, knowledge, regulations and standards.

Knowledge of sustainable construction

Knowledge and awareness of sustainable construction practices are key enablers of the adoption of sustainable construction (Durdyev et al. 2018:570). However, there are considerable deficiencies in both developing countries (Durdyev et al. 2018:569; Fitriani & Ajayi 2023:2039; Oyewobi & Jimoh 2022:11; Sajjad et al. 2021:319). The deficiencies include limited professional expertise, low stakeholder understanding of the benefits of green building and poor information dissemination. These foster scepticism and resistance amongst professionals who are accustomed to conventional construction methods (Chan et al. 2018:1076). Akinshipe, Oluleye and Aigbavboa (2019:4) explain that, in most cases, construction professionals responsible for delivering projects lack adequate knowledge or experience in sustainable construction and its benefits. Osuizugbo et al. (2020:160) agree and indicate that there is general ignorance and a lack of understanding of sustainability within the construction sector. Some negative attitudes towards sustainable construction practices are attributed to ignorance (Osuizugbo et al. 2020:160).

Research indicates that awareness of sustainable construction practices amongst professionals is limited, primarily due to inadequate training and exposure (Zulu et al. 2023:2124). Chan et al. (2018:1074) note that construction professionals in developing nations tend to regard sustainable methods as non-essential. This viewpoint stems from the belief that sustainability is an environmental issue only. This misconception leads to a disjointed understanding of sustainable construction practices. In a Nigerian study, Okoye, Okolie and Odesola (2022:40) explain that one of the critical challenges in implementing sustainable construction practices in Nigeria is general unfamiliarity with the associated techniques, materials and benefits. As a result, the first hypothesis of this study is:

H_1 : There is no significant difference between SMMEs and LEs regarding KSC.

Incentives to adopt sustainable construction

Within the construction industry, there appears to be a perception that sustainable construction technologies are costly and risky, perhaps due to risk aversion and uncertainties associated with adopting new technologies (Chan et al. 2018:1074). The perceived high costs and risks of sustainable construction are sometimes referred to as the 'green cost premium' (Vaghefi-Rezaee et al. 2024:13). The literature suggests that sustainable construction technologies such as low-carbon concrete, energy-efficient glazing, solar panels and smart building systems are often more expensive than conventional alternatives (Vaghefi-Rezaee et al. 2024:13). The general consensus is that the perception of a premium discourages stakeholders who prioritise short-term financial returns over sustainable options (Dwaikat & Ali 2016:398).

According to Chan et al. (2018:1076), the 'green cost premium' has a bigger impact on developing countries due to restricted financial access. For this study, perceived premiums were identified as significant barriers to the adoption of sustainable construction practices. Zulu et al. (2023:2123) assert that stakeholders associate sustainable construction with increased capital investment. Whether real or not, this barrier could be minimised by increasing access to funding and providing incentives. Incentives include green loans or concessional credit lines for sustainable projects, the lack of which restricts developers' ability to invest in sustainability (Zulu et al. 2023:2124). In Ghana, lack of financing is one of the main barriers to sustainable construction (Chan et al. 2018:1074). Similarly, in Zambia, financial incentives and green financing options emerged as key enablers of the adoption of green practices (Zulu et al. 2023:2123). As such, the second hypothesis of this study is:

H₂: There is no significant difference between SMMEs and LEs regarding IASC.

Client demand for sustainable construction

Client demand plays a critical role in determining the pace and extent of sustainable construction adoption. When demand is weak or absent, it becomes a major obstacle to the adoption of sustainable construction. Mensah (2019:2) emphasises that governments are often the largest clients in the construction sector. As a result, government demand for sustainable practices in public projects could significantly accelerate adoption. Such a move would demonstrate political commitment and positively influence the attitudes of key stakeholders in the construction industry (Hwang et al. 2018:2234; Oyewobi & Jimoh 2022:11). The attitudes of clients play a pivotal role in determining whether sustainable construction practices are adopted (Chan et al. 2018:1074; Zulu et al. 2023:2124). When clients are not fully committed or hesitant to support or initiate sustainable construction initiatives, construction professionals face difficulties. It is challenging to implement sustainable practices under these conditions. Zulu et al. (2023:2118) report that many private clients are unwilling to support sustainable initiatives, citing high upfront costs, low awareness and unfamiliarity with green technologies as deterrents.

In many developing countries, weak demand is mainly due to low public awareness and a lack of incentives to pursue sustainable building practices. Ismael and Shealy (2018:12) found that insufficient public awareness about the advantages of sustainable construction results in low client interest and a lack of motivation within the sector to transition from traditional methods. Zulu et al. (2023:2118) found that developers in Zambia are reluctant to adopt sustainable practices, citing low market demand and insufficient financial incentives. Low demand is further compounded by the lack of national green building standards and minimal government intervention.

Regulations, standards and certifications are essential for raising awareness and accelerating the adoption of sustainable practices. Ahmed et al. (2023:8) note that the slow uptake of sustainable construction is partly due to the voluntary nature of most green standards, which are not legally mandated. This highlights the government's critical role in making such regulations compulsory. Hence, the third hypothesis of this research is:

H₃: There is no significant difference between SMMEs and LEs regarding CDSC.

Sustainable construction regulations and standards

Government and policy-related barriers are amongst the most significant obstacles to advancing sustainable construction in developing countries. Studies in Ghana and Zambia reveal that weak institutional frameworks, inadequate regulations and a lack of government incentives severely hinder the adoption of sustainable practices (Chan et al. 2018:1077; Zulu et al. 2023:2118). In Ghana, Chan et al. (2018:1077) identified government-related barriers as the most prominent amongst five major categories impeding the adoption of sustainable construction technologies. The absence of clear green building codes and regulations creates uncertainty and discourages innovation. Similarly, Zulu et al. (2023:2118) found that Zambia faces comparable policy-related challenges. The study found weak enforcement and limited availability of policies that promote sustainable construction practices. A lack of green certification systems and financial incentives further discourages adoption. Issues of this nature are compounded by poor institutional capacity and low prioritisation of environmental concerns compared to economic growth. Even when adequate policies exist, their impact is weakened by vague guidelines, complex implementation processes and inadequate information dissemination. As a result, the fourth hypothesis is:

H₄: There is no significant difference between SMMEs and LEs regarding SCRS.

Sustainable construction: Perception of usefulness and ease of use

Perceived usefulness and perceived ease of use (PEOU) influence the intention to adopt sustainable construction practices and the attitude of construction stakeholders towards sustainable construction. Construction professionals find the benefits of sustainable construction challenging to grasp. Unlike financial benefits, future gains from sustainable construction practices cannot be expressed in monetary terms or reduced to a present value (Bakar et al. 2018: 889–890). There appears to be a lack of knowledge about the benefits of sustainable construction practices and technologies (Zulu et al. 2023:2123). A significant advantage of sustainable construction practices, as identified by industry professionals, was the improvement of their companies' image (Zulu et al. 2023:2119).

The PEOU of sustainable construction practices influences construction professionals' attitudes towards them and their perceived usefulness (PU). Construction stakeholders find it difficult to operationalise sustainable construction goals into specific, measurable objectives that can be applied to individual projects (Gade et al. 2021:657). Where regulations address sustainable construction practices, they are often challenging to implement (Hwang et al. 2018:2235). In addition, the various tools and software required to implement sustainable construction practices are often not interoperable (Chan et al. 2024:5). According to Fitriani and Ajayi (2023:2044), the challenges of implementing sustainable construction practices are exacerbated by a lack of capacity for implementation. As a result, the fifth hypothesis is:

H₅: There is no significant difference between SMMEs and LEs regarding PU and PEOU.

Behavioural intention and actual adoption of sustainable construction practices

The intention to adopt sustainable construction practices and their actual use are influenced by several factors. One of the most influential and immediate factors is the attitude of construction professionals towards sustainable construction practices (Akinshipe et al. 2019:4; Hwang et al. 2018:2235). Literature suggests that construction stakeholders generally have negative attitudes or lack interest in adopting sustainable construction practices. It is postulated that this is due to resistance to change (Marsh et al. 2022:20; Oyewobi & Jimoh 2022:10). Construction stakeholders do not want to shift from conventional construction practices (Yin et al. 2018:616; Zulu et al. 2023:2123). In addition, there is inadequate support from various professional bodies within the built environment (Akinshipe et al. 2019:4). According to Zulu et al. (2023:2124), there is also a general lack of concern for the environment amongst construction professionals.

As a result, the sixth and seventh hypotheses are:

H₆: There is no significant difference in the BI to sustainable construction by SMMEs and LEs.

H₇: There are no significant differences in the AU of sustainable construction by SMMEs and LEs.

The role of firm size in the adoption of sustainable construction

Studies from other regions, such as Nigeria, indicate that it is reasonable to expect firm size to moderate adoption-related perceptions across most sustainable construction constructs (Otali, Oladokun & Anih 2020:114). Regarding KSC, awareness of sustainable construction principles may be broadly disseminated through professional training and industry networks. However, LEs are more likely to invest in structured professional development in sustainable construction. They are also more likely to employ dedicated sustainability or environmental officers (Otali et al. 2020:116). For IASC, LEs typically maintain closer institutional ties with government bodies and industry associations. They are also

better resourced to navigate grant and certification processes. In addition, they are more frequently targeted by formal incentive programmes because of their capacity to implement sustainable practices. As a result, they are more likely to perceive and benefit from existing incentive structures. For CDSC, LEs disproportionately serve public-sector clients, multinational corporations and institutional investors, who tend to embed sustainability requirements in procurement frameworks. In contrast, SMMEs typically serve price-sensitive private clients. Such clients rarely consider sustainability a primary procurement criterion. For SCRS, both firm sizes operate within the same regulatory environment, so awareness of regulations is expected to be broadly similar across both. Nevertheless, LEs may have greater legal and compliance capacity to interpret and apply those standards in practice. For PU and PEOU, LEs benefit from greater exposure to sustainability training, access to specialised software and experience with green building projects. These advantages are expected to produce stronger perceptions of both the usefulness and ease of use of sustainable construction practices, since resource access directly shapes evaluative beliefs in Technology Acceptance Model (TAM) (Venkatesh & Bala 2008).

Research methods and design

In this research, a quantitative approach consistent with positivist principles was adopted. Data were collected through an online survey and analysed using the independent samples test. The target population was South African construction companies, both SMMEs and LEs. According to the Department of Small Business Development (2023: 10–11), construction SMMEs are defined as businesses with fewer than 250 full-time equivalent paid employees or an annual turnover of less than R170 million. In this study, construction SMMEs were categorised as those having 250 or fewer employees.

Population and sampling

Self-selection sampling was employed in the study; this is where individuals voluntarily choose to participate, rather than being actively selected by the researcher (Saunders, Lewis & Thornhill 2023). This method falls under non-probability sampling. Probability sampling was not feasible for two main reasons. Firstly, it was impossible to construct a comprehensive sampling frame, that is, a complete list of the 386 909 construction SMMEs in South Africa, along with their owners and associated professionals. Secondly, without such a frame, ensuring the representativeness of any selected sample would be unachievable. Even if these challenges were addressed, the financial and time demands of probability sampling would still render it impractical for the study. Consequently, non-probability sampling, specifically self-selection sampling, was the only viable approach.

Whilst self-selection sampling enabled data collection under these constraints, it introduces the risk of volunteer bias. Those who chose to participate may have differed from those who did not, for example, by being more engaged with

sustainability or more motivated to respond to industry association communications. In addition, the response rate could be calculated because it was not known how many association members received the email. These factors limit the representativeness of the sample and were taken into account when interpreting the findings. In view of this, the study pursued analytical rather than statistical generalisation to the broader population of South African construction firms (Saunders et al. 2023).

Research instrument and data collection

A self-administered questionnaire was used to collect the data needed to test the seven hypotheses. The questionnaire consisted of two sections. The first section collected biographical information, whilst the second collected data on the constructs under investigation. Data for the study were collected using a structured online questionnaire. The questionnaire was created in Google Forms. The survey link was distributed through email to members of the South African Institution of Civil Engineering, the Association of South African Quantity Surveyors, the South African Institute of Architects and Master Builders South Africa. Each email briefly outlined the study's purpose and described the measures taken to ensure anonymity and confidentiality. A consent statement was included at the beginning of the questionnaire, and participation was entirely voluntary.

As is common with self-selection sampling, the exact number of invitations distributed is unknown. However, a total of 211 completed responses were received.

Measures

All constructs were measured using a seven-point Likert scale (1 = strongly disagree; 7 = strongly agree). Perceived ease of use and PU were each operationalised using four items adapted from Venkatesh and Bala (2008). Behavioural intention was measured with four items adapted from Davis (1989). Actual usage was adapted from Davis (1989). Its five items reflected specific sustainable practice areas: energy conservation, water conservation, waste reduction, environmental protection and occupant health and well-being. Knowledge of sustainable construction was developed from Oyewobi and Jimoh (2022), Akinshipe et al. (2019), Sajjad et al. (2021) and Fitriani and Ajayi (2023). Incentives to adopt sustainable construction were derived from Darko et al. (2017). Client demand for sustainable construction was derived from Chan et al. (2018). Sustainable construction regulations and standards were developed from Chan et al. (2018) and Zulu et al. (2023).

Indicator reliability and validity

This section outlines the measures that were used to ensure reliability and validity. Detailed reports of the various measures are presented in Appendix 1 (Table 1-A1, Table 2-A1 and Table 3-A1). Indicator reliability was assessed via outer loadings. The loadings were satisfactory across all constructs, ranging from 0.671 to 0.946. One item (IASC3)

loaded at 0.671, marginally below the 0.708 benchmark recommended by Hair et al. (2022). It was retained because its removal did not improve reliability, and it captures the government-incentive sub-dimension of IASC. Internal consistency was confirmed using Cronbach's alpha (range: 0.808–0.944) and composite reliability ρ_C (range: 0.870–0.957), both within recommended bounds. Convergent validity was established through average variance extracted (AVE). All values (0.630–0.840) exceeded the 0.50 threshold (Fornell & Larcker 1981). Discriminant validity was confirmed using both the Fornell–Larcker criterion and the heterotrait–monotrait (HTMT) ratio, with all HTMT values falling below the conservative threshold of 0.85. Common method bias was assessed using Harman's single-factor test, which extracted a single factor accounting for 42.56% of the total variance, well below the 50% threshold. When viewed alongside AVE and HTMT values, this suggests that common-method bias is not a serious concern.

Data analysis

The data was exported from Google Forms to Microsoft Excel, then imported into the Statistical Package for Social Sciences (IBM SPSS Statistics for Windows, [IBM Corp., Armonk, N.Y. US]) version 30.0 for cleaning, coding and analysis. An independent samples *t*-test was used to compare perceptions between respondents from SMMEs and LEs. This statistical test assesses whether there is a significant difference between the means of two independent groups on a given variable. The procedure begins with Levene's test for equality of variances. If the assumption of equal variances is met, the standard *t*-test is applied; otherwise, a version that does not assume equal variances is used. The test then evaluates the difference between group means using a two-tailed *p*-value.

Ethical considerations

Ethical clearance to conduct this study was obtained from the Faculty of Business and Management Science, Cape Peninsula University of Technology Research Ethics Committee (No. 2024_FBMSREC_ST04).

Results

Demographic profiles of respondents

The sample comprised predominantly experienced construction professionals. Most respondents were aged 31–50 years (48.4%), whilst a substantial proportion (22.3%) were aged 66 years and above, indicating strong representation from senior industry practitioners. Male respondents accounted for most of the sample (86.7%), reflecting the gender composition typically observed in the construction sector. (Norberg & Johansson 2021:3; Tijani, Jin & Osei-Kyei 2021:20).

In terms of firm characteristics, most respondents (Table 1) were affiliated with SMMEs (85.8%), with LEs representing 14.2% of the sample. The educational profile of participants was notably strong, with over half (57.3%) holding

postgraduate qualifications and a further 31.8% possessing undergraduate degrees or diplomas, suggesting a highly qualified respondent pool.

Industry experience was similarly pronounced, with 85.3% of respondents reporting 11 years or more of professional experience. Respondents were geographically distributed across seven provinces, with Gauteng (32.7%) and the Western Cape (30.3%) accounting for the largest shares. Regarding employment roles, technical staff (30.8%), managers (23.2%) and executives (22.7%) constituted dominant categories, indicating that responses were largely drawn from decision-makers and technically informed professionals within the construction firms.

Combined statistics for small, medium and micro enterprises and large enterprises

Table 2 presents the mean scores for the constructs and provides information on respondents' general attitudes and behaviours towards sustainable construction. Actual usage emerged as the construct with the highest rating, with a mean of 5.15 (standard deviation [SD] = 1.44), suggesting that sustainable construction practices are already being implemented to a significant extent amongst respondents. This high score indicates that sustainability has gone beyond the intention of many respondents and is being

operationalised in practice. Behavioural intention also recorded a relatively high mean of 4.94 (SD = 1.49), indicating strong intentions amongst participants to adopt or continue adopting sustainable construction practices. This is consistent with the theoretical expectation that intention is a key precursor to actual behaviour and supports the high observed usage levels. Knowledge of sustainable construction and PU were also highly rated, with mean scores of 4.81 (SD = 1.47) and 4.77 (SD = 1.23), respectively. These results indicate that respondents generally feel well-informed about sustainable construction and perceive it to offer tangible benefits. Perceived ease of use recorded a mean of 4.21 (SD = 1.19), indicating that sustainable construction is generally perceived as manageable or user-friendly, though with some variability. This result, when considered alongside the high PU and BI scores, suggests that usability may not be a major barrier for most participants.

In contrast, the mean score for IASC was markedly lower at 3.44 (SD = 1.51), the lowest amongst all constructs. This suggests that respondents do not perceive strong financial, regulatory or reputational incentives for adopting sustainable construction practices. Similarly, CDSC and SCRS yielded moderate mean values of 3.82 (SD = 1.48) and 3.59 (SD = 1.63), respectively. These results suggest that client pressure and regulatory enforcement are not yet strong drivers of adoption. The relatively low to moderate scores for IASC, CDSC and SCRS may reflect a systemic gap in institutional and market mechanisms supporting sustainability in construction.

In terms of distributional properties, the constructs showed varying levels of skewness and kurtosis. The skewness statistics for most variables fell within the acceptable range of ± 1 , indicating approximately symmetric distributions. Notably, AU and BI were negatively skewed (-0.861 and -0.495 , respectively), suggesting a leftward tilt consistent with high levels of endorsement. Conversely, IASC and SCRS exhibited a positive skew (0.398 and 0.335), indicating that fewer respondents rated these constructs at the higher end of the scale. Kurtosis values were also within acceptable bounds, with no values exceeding ± 1.0 except for AU (kurtosis = 0.636), indicating a slight concentration of responses around the mean.

TABLE 1: Summary of the provincial distribution of the respondents.

Characteristics	Category	Total (%)
Age (years)	18–30	2.4
	31–40	27.5
	41–50	20.9
	51–60	19.4
	61–65	7.6
	66 and above	22.3
Gender	Female	13.27
	Male	86.73
Company size	≤ 250 employees (SMMEs)	85.8
	≥ 251 employees (LEs)	14.2
Highest qualification obtained	High school completed (Matric or Grade 12)	2.8
	College certificate	5.7
	Undergraduate degree/Diploma	31.8
	Post-graduate degree	57.3
Years of experience	1–3	1.9
	4–6	5.2
	7–10	7.6
	11 or more	85.3
Province of residence	Mpumalanga	6.2
	Eastern Cape	8.1
	Gauteng	32.7
	North-West	0.5
	Western Cape	30.3
	Free State	6.2
	KwaZulu-Natal	16.1
Employment status of respondents	Field staff (<i>site agents and site engineers</i>)	5.7
	Technical staff (<i>engineers, quantity surveyors, architects and construction managers</i>)	30.8
	Manager	23.2
	Executive	22.7
	Owner	15.6
	Other	2.0

SMMEs, small, medium and micro enterprises; LEs, large enterprises.

TABLE 2: Summary of the combined statistics of small, medium and micro enterprises and large enterprises.

Items	Mean	SD	Skewness	Kurtosis
KSC	4.8069	1.47025	-0.254	-0.675
IASC	3.4467	1.50865	0.398	-0.746
CDSC	3.8167	1.47649	0.035	-0.258
SCRS	3.5877	1.63099	0.335	-0.464
PU	4.7713	1.22577	0.082	-0.595
PEOU	4.2050	1.19113	0.206	0.259
BI	4.9431	1.49355	-0.495	-0.589
AU	5.1469	1.44203	-0.861	0.636

SD, standard deviation; KSC, knowledge of sustainable construction; IASC, incentives to adopt sustainable construction; CDSC, client demand for sustainable construction; SCRS, sustainable construction regulations and standards; BI, behavioural intention; AU, actual usage; PU, perceived usefulness; PEOU, perceived ease of use.

Comparison of small, medium and micro enterprises and large enterprises

To examine potential differences in perceptions between SMME and LE groups, an independent samples *t*-test was conducted across eight key constructs relevant to sustainable construction. Table 3 presents the means and s.d.s of the two groups.

This table reveals important perceptual and behavioural differences between SMMEs and LEs. For IASC, LEs reported a markedly higher mean score ($M = 4.35$, $SD = 1.69$) compared with SMMEs ($M = 3.30$, $SD = 1.43$). This suggests that larger firms are more likely to perceive financial-, reputational- or compliance-related benefits associated with sustainable construction. The difference may reflect greater access to government incentives, stronger corporate governance structures or more active engagement with sustainability frameworks amongst LEs. A similar trend was observed for CDSC. Large enterprises reported a higher mean ($M = 4.79$, $SD = 1.95$) than SMMEs ($M = 3.66$, $SD = 1.32$), indicating that clients working with larger firms are more likely to express expectations for sustainability. This may be due to the types of clients served by LEs, such as multinationals, government bodies or institutional investors, who often incorporate environmental criteria into procurement decisions.

Perceived usefulness and PEOU of sustainable practices were also notably higher amongst LEs. For PU, LEs reported a mean of 5.38 ($SD = 1.58$), compared to 4.67 ($SD = 1.13$) for SMMEs. Similarly, for PEOU, LEs scored 4.83 ($SD = 1.55$) relative to 4.10 ($SD = 1.09$) for SMMEs. The differences indicate that LEs not only find sustainable construction more beneficial, but also perceive it as easier to implement. This may reflect differences in internal capacity, access to resources or exposure to sustainability training and technologies. Interestingly, BI scores followed this pattern. Large enterprises reported a substantially higher mean ($M = 5.72$, $SD = 1.43$) than SMMEs ($M = 4.81$, $SD = 1.47$),

TABLE 3: A comparison of means and standard deviations of the constructs for small, medium and micro enterprises and large enterprises.

Items	Company size	N	Mean	SD	SE mean
KSC	SMME	181	4.7970	1.47026	0.10928
	Large enterprise	30	4.8667	1.49386	0.27274
IASC	SMME	181	3.2970	1.42761	0.10611
	Large enterprise	30	4.3500	1.68743	0.30808
CDSC	SMME	181	3.6556	1.32073	0.09817
	Large enterprise	30	4.7889	1.95443	0.35683
SCRS	SMME	181	3.5635	1.50835	0.11211
	Large enterprise	30	3.7333	2.26188	0.41296
PU	SMME	181	4.6713	1.13024	0.08401
	Large enterprise	30	5.3750	1.58488	0.28936
PEOU	SMME	181	4.1008	1.09252	0.08121
	Large enterprise	30	4.8333	1.54576	0.28222
BI	SMME	181	4.8149	1.46804	0.10912
	Large enterprise	30	5.7167	1.43349	0.26172
AU	SMME	181	5.1890	1.36898	0.10176
	Large enterprise	30	4.8933	1.82982	0.33408

SD, standard deviation; SE, standard error; SMME, small, medium and micro enterprises; KSC, knowledge of sustainable construction; IASC, incentives to adopt sustainable construction; CDSC, client demand for sustainable construction; SCRS, sustainable construction regulations and standards; BI, behavioural intention; AU, actual usage; PU, perceived usefulness; PEOU, perceived ease of use.

suggesting that larger firms are more committed to adopting sustainable construction practices in the future. This finding aligns with their stronger perceptions of incentives, usefulness and client demand.

In contrast, AU presented a slightly more nuanced picture. Small, medium and micro enterprises reported higher actual use ($M = 5.19$, $SD = 1.37$) than LEs ($M = 4.89$, $SD = 1.83$). These differences are moderate and likely not statistically significant without further testing. This suggests that, despite lower perceived incentives or intentions, SMMEs may be adopting sustainable practices out of necessity, in line with industry standards, or through informal innovations not driven by strategic frameworks. Regarding KSC and SCRS, both groups reported similar levels. Small, medium and micro enterprises had a KSC mean of 4.80, whilst LEs reported 4.87, indicating comparable self-assessed knowledge. Sustainable construction regulations and standards were also fairly aligned, with means of 3.56 for SMMEs and 3.73 for LEs. These findings suggest that awareness of sustainable construction principles and regulations may be widespread across organisational sizes, although interpretation and application may differ.

Hypotheses testing for differences between small, medium and micro enterprises and large enterprises

Table 4 presents the results of the Levene's test for equality of variances and the *t*-test for equality of means (two-tailed *p*-value). The *t*-test results indicate statistically significant differences between the two groups in five of the eight constructs: IASC, CDSC, PU, PEOU and BI.

Table 5 presents the effect sizes calculated to evaluate the practical magnitude of the differences using Cohen's *d*, Hedges' *g* and Glass's delta. The effect size was interpreted according to Cohen's (1988) guidelines. $|d| \approx 0.2$ = small, ≈ 0.5 = moderate, ≥ 0.8 = large. These constructs also demonstrate moderate to large effect sizes, suggesting that the observed differences are not only statistically significant but also practically meaningful. The largest effects were observed for CDSC ($d = -0.795$) and IASC ($d = -0.718$), indicating that the groups differ considerably in their motivation to adopt sustainable practices and their responsiveness to client pressures. Moderate differences were found in PU, PEOU and BI, with *d* values ranging from -0.585 to -0.628 , suggesting that attitudes towards the usability and desirability of sustainable technologies varied meaningfully between the two groups.

Inspection of Table 4 and Table 5 shows that KSC, SCRS and AU exhibited no statistically significant differences, and their effect sizes are trivial or small ($d < 0.20$). This implies that both groups possess similar levels of knowledge, awareness of regulations and actual usage patterns of sustainable construction practices, regardless of their differing perceptions or intentions.

TABLE 4: Independent samples *t*-test for small, medium and micro enterprises and large enterprises.

Items	Levene's test for equality of variances		t-test for equality of means							
	F	Sig.	t	df	Significance		Mean difference	SE difference	95% confidence interval of the difference	
					One-sided p	Two-sided p			Lower	Upper
KSC										
Equal variances assumed	2.151	0.144	-0.240	209	0.405	0.811	-0.06971	0.29048	-0.64234	0.50293
Equal variances not assumed	-	-	-0.237	38.898	0.407	0.814	-0.06971	0.29382	-0.66406	0.52465
IASC										
Equal variances assumed	5.995	0.015	-3.643	209	< 0.001	< 0.001	-1.05304	0.28907	-1.62290	-0.48318
Equal variances not assumed	-	-	-3.232	36.207	0.001	0.003	-1.05304	0.32584	-1.71375	-0.39233
CDSC										
Equal variances assumed	8.272	0.004	-4.033	209	< 0.001	< 0.001	-1.13327	0.28102	-1.68727	-0.57928
Equal variances not assumed	-	-	-3.062	33.525	0.002	0.004	-1.13327	0.37009	-1.88577	-0.38077
SCRS										
Equal variances assumed	19.401	< 0.001	-0.527	209	0.299	0.599	-0.16980	0.32206	-0.80471	0.46511
Equal variances not assumed	-	-	-0.397	33.403	0.347	0.694	-0.16980	0.42791	-1.03999	0.70039
PU										
Equal variances assumed	9.357	0.003	-2.966	209	0.002	0.003	-0.70373	0.23727	-1.17147	-0.23599
Equal variances not assumed	-	-	-2.336	34.056	0.013	0.026	-0.70373	0.30131	-1.31602	-0.09144
PEOU										
Equal variances assumed	7.746	0.006	-3.187	209	< 0.001	0.002	-0.73250	0.22984	-1.18561	-0.27939
Equal variances not assumed	-	-	-2.494	33.964	0.009	0.018	-0.73250	0.29367	-1.32933	-0.13568
BI										
Equal variances assumed	1.443	0.231	-3.126	209	0.001	0.002	-0.90175	0.28845	-1.47040	-0.33310
Equal variances not assumed	-	-	-3.180	39.765	0.001	0.003	-0.90175	0.28355	-1.47494	-0.32856
AU										
Equal variances assumed	2.573	0.110	1.040	209	0.150	0.299	0.29562	0.28420	-0.26466	0.85589
Equal variances not assumed	-	-	0.846	34.582	0.202	0.403	0.29562	0.34923	-0.41366	1.00490

SE, standard error; *df*, degree of freedom; Sig., Significance; KSC, knowledge of sustainable construction; IASC, incentives to adopt sustainable construction; CDSC, client demand for sustainable construction; SCRS, sustainable construction regulations and standards; BI, behavioural intention; AU, actual usage; PU, perceived usefulness; PEOU, perceived ease of use.

The independent samples *t*-test results revealed statistically significant differences ($p < 0.05$) between the two groups on IASC, CDSC, PU, PEOU and BI. These are core constructs within the study's conceptual framework. Moreover, the effect size analysis, using Cohen's *d*, indicated that these differences were not only statistically significant, but also practically meaningful, with moderate to large effect sizes (Cohen's *d* ranging from -0.585 to -0.795). Such magnitudes suggest substantial divergence in perceptions, motivations and adoption-related attitudes between the two groups.

Hypotheses testing

Table 6 presents the results of the hypothesis testing for the study. The testing revealed statistically and practically significant differences in five of the eight constructs examined:

- The test results supported H_1 , indicating no statistically significant difference in KSC between the two groups ($t[209] = -0.240$, $p = 0.811$; Cohen's $d = -0.047$, trivial effect size).
- H_2 was rejected. A significant difference was found ($t[36.21] = -3.232$, $p = 0.001$), with LEs reporting higher perceived IASC than SMMEs. The effect size was moderate to large (Cohen's $d = -0.718$), suggesting practical significance.
- H_3 was also rejected. Large enterprises reported significantly greater CDSC ($t[33.53] = -3.062$, $p = 0.002$), with a large effect size (Cohen's $d = -0.795$).

- H_4 was supported. No significant difference was observed in perceptions of SCRS ($t[33.40] = -0.397$, $p = 0.694$; Cohen's $d = -0.104$, trivial effect size), suggesting shared scepticism or a lack of clarity regarding enforcement.
- H_5 was rejected for both dimensions. For PU, LEs scored significantly higher ($t[34.06] = -2.336$, $p = 0.026$; Cohen's $d = -0.585$, moderate effect). Similarly, for PEOU, the difference was significant ($t[33.96] = -2.494$, $p = 0.018$; Cohen's $d = -0.628$, moderate to large effect), indicating that LEs find sustainable construction both more useful and easier to implement.
- H_6 was rejected. Large enterprises reported significantly stronger BI to engage in sustainable construction ($t[209] = -3.126$, $p = 0.002$; Cohen's $d = -0.616$, moderate effect).
- H_7 was supported. No significant difference was found in AU ($t[209] = 1.040$, $p = 0.299$; Cohen's $d = +0.205$, small effect), suggesting that despite differing perceptions and intentions, both groups reported similar levels of practical engagement.

The test results supported H_1 . There was no statistically significant difference in the means between the two groups ($t[209] = -0.240$, $p = 0.811$), and the effect size was trivial (Cohen's $d = -0.047$). This suggests that both SMMEs and LEs reported a comparable level of awareness and understanding of sustainable construction practices. H_2 was rejected as the results indicated a statistically significant difference between

TABLE 5: Independent samples effect sizes for small, medium and micro enterprises and large enterprises.

Items	Standardiser†	Point estimate	95% confidence interval	
			Lower	Upper
KSC				
Cohen's <i>d</i>	1.47356	-0.047	-0.434	0.339
Hedges' correction	1.47887	-0.047	-0.432	0.338
Glass's delta	1.49386	-0.047	-0.433	0.340
IASC				
Cohen's <i>d</i>	1.46641	-0.718	-1.110	-0.325
Hedges' correction	1.47170	-0.716	-1.106	-0.324
Glass's delta	1.68743	-0.624	-1.038	-0.201
CDSC				
Cohen's <i>d</i>	1.42559	-0.795	-1.188	-0.400
Hedges' correction	1.43073	-0.792	-1.184	-0.399
Glass's delta	1.95443	-0.580	-0.989	-0.162
SCRS				
Cohen's <i>d</i>	1.63380	-0.104	-0.490	0.283
Hedges' correction	1.63969	-0.104	-0.489	0.282
Glass's delta	2.26188	-0.075	-0.461	0.312
PU				
Cohen's <i>d</i>	1.20363	-0.585	-0.974	-0.194
Hedges' correction	1.20797	-0.583	-0.971	-0.193
Glass's delta	1.58488	-0.444	-0.843	-0.038
PEOU				
Cohen's <i>d</i>	1.16598	-0.628	-1.019	-0.236
Hedges' correction	1.17019	-0.626	-1.015	-0.236
Glass's delta	1.54576	-0.474	-0.875	-0.065
BI				
Cohen's <i>d</i>	1.46329	-0.616	-1.006	-0.225
Hedges' correction	1.46857	-0.614	-1.003	-0.224
Glass's delta	1.43349	-0.629	-1.043	-0.206
AU				
Cohen's <i>d</i>	1.44175	0.205	-0.182	0.592
Hedges' correction	1.44695	0.204	-0.181	0.590
Glass's delta	1.82982	0.162	-0.228	0.549

Notes: Cohen's *d* uses the pooled standard deviation; Hedges' correction uses the pooled standard deviation, plus a correction factor; Glass's delta uses the sample standard deviation of the control (that is, the second) group.

KSC, knowledge of sustainable construction; IASC, incentives to adopt sustainable construction; CDSC, client demand for sustainable construction; SCRS, sustainable construction regulations and standards; BI, behavioural intention; AU, actual usage; PU, perceived usefulness; PEOU, perceived ease of use.

†, The denominator used in estimating the effect sizes.

the two groups ($t[36.21] = -3.232, p = 0.001$), with LEs reporting higher perceived incentives than SMMEs. The effect size was moderate to large (Cohen's $d = -0.718$), indicating that the difference is not only statistically meaningful, but also of practical importance. H_3 was also rejected, given that a significant difference was observed ($t[33.53] = -3.062, p = 0.002$), with a large effect size (Cohen's $d = -0.795$). These results suggest that client pressure or interest in sustainable construction is considerably more salient for LEs than for SMMEs. H_4 was supported since the test did not reveal a significant difference ($t[33.40] = -0.397, p = 0.694$), and the effect size was trivial (Cohen's $d = -0.104$). This also points to a shared doubt or lack of clarity regarding enforcement mechanisms. H_5 was rejected for both PU and PEOU. With respect to PU, the difference was statistically significant ($t[34.06] = -2.336, p = 0.026$), with a moderate effect size (Cohen's $d = -0.585$). Similarly, PEOU showed a significant difference ($t[33.96] = -2.494, p = 0.018$), with a moderate to large effect size (Cohen's $d = -0.628$).

TABLE 6: Hypothesis testing of constructs related to small, medium and micro enterprises and large enterprises.

Construct	Equal variance assumed	<i>t</i>	<i>df</i>	<i>p</i> -value (two tailed)	Mean difference	Independent sample <i>t</i> -test	Cohen's <i>d</i>	Effect size magnitude	Overall interpretation
KSC	Yes ($p = 0.144$)	-0.240	209	0.811	-0.070	No significant difference	-0.047	Trivial	No significant or practical difference; H_1 accepted
IASC	No ($p = 0.015$)	-3.232	36.21	0.001	-1.053	Significant difference	-0.718	Moderate to large	Significant difference: practical impact; H_2 rejected
CDSC	No ($p = 0.015$)	-3.062	33.53	0.002	-1.133	Significant difference	-0.795	Large	Significant difference; strong practical impact; H_3 rejected
SCRS	No ($p < 0.001$)	-0.397	33.40	0.694	-0.170	No significant difference	-0.104	Trivial	No significant or practical difference; H_4 accepted
PU	No ($p = 0.003$)	-2.336	34.06	0.026	-0.704	Significant difference	-0.585	Moderate	Significant difference; moderate practical impact; H_5 rejected
PEOU	No ($p = 0.006$)	-2.494	33.96	0.018	-0.733	Significant difference	-0.628	Moderate to large	Significant difference; practical impact; H_5 rejected
BI	Yes ($p = 0.231$)	-3.126	209	0.002	-0.902	Significant difference	-0.616	Moderate	Significant difference; meaningful practical difference; H_6 rejected
AU	Yes ($p = 0.110$)	1.040	209	0.299	+0.296	No significant difference	+0.205	Small	No significant difference; limited practical impact; H_7 accepted

df, degree of freedom

KSC, knowledge of sustainable construction; IASC, incentives to adopt sustainable construction; CDSC, client demand for sustainable construction; SCRS, sustainable construction regulations and standards; BI, behavioural intention; AU, actual usage; PU, perceived usefulness; PEOU, perceived ease of use; H_1 , hypothesis.

These results suggest that LEs find sustainable construction more useful and easier to implement compared to their SMME counterparts. H_6 was rejected as the analysis showed a statistically significant difference ($t[209] = -3.126, p = 0.002$), with a moderate effect size (Cohen's $d = -0.616$), indicating that LEs report a stronger intention to engage in sustainable construction activities. This supports H_7 and suggests that despite differing levels of intention and perception, both groups report relatively similar engagement with sustainable construction in practice.

Discussion

This study set out to compare the adoption of sustainable construction practices between SMMEs and LEs in South Africa, with particular attention to perceptual, institutional and behavioural dimensions. Outcomes highlight a differentiated adoption landscape shaped by firm size, institutional positioning and market exposure. Statistically significant differences were observed between SMMEs and LEs across key constructs. The differences between SMMEs and LEs were noticeable in IASC, CDSC and PU. These differences, supported by moderate to large effect sizes, suggest that LEs are better positioned to respond to formal sustainability drivers. For instance, IASC ($d = -0.718$) and CDSC ($d = -0.795$), with LEs scoring higher, were more responsive to incentives and client demand than SMMEs, concurring with extant scholarship such as Darko et al. (2017:391–392), which established that LEs are more responsive to institutional pressures and more integrated into global supply chains where sustainability expectations are formalised. The responsiveness of LEs is also reflected in a higher BI. Their responsiveness might be influenced by their better access to financial, technical and informational resources. These lower their perceived risk and cost of adopting sustainable construction practices.

On a positive note, SMMEs and LEs reported similar higher levels of AU. The difference between the two was not statistically significant. This corroborates the findings of a Cambodian study by Durdyev et al. (2018:2), who found that smaller firms adopted green practices informally. In this study, the high AU amongst SMMEs is consistent with, though not directly explained by, market-driven or practice-embedded motivations. This interpretation is plausible given the low mean scores on the SCRS ($M = 3.59$) and the IASC ($M = 3.45$). The low scores suggest that formal regulatory and incentive frameworks are not strongly perceived as drivers. However, as this study relies on self-reported perceptual measures and a cross-sectional design, it is not possible to confirm the underlying processes driving actual behaviour. This observation mirrors the findings of Zulu et al. (2023:2123). The authors highlight the inadequacy of policy enforcement in Zambia and the resulting reliance on voluntary compliance. Zulu et al. (2023:2116–2117) further contend that insufficient institutional enforcement frequently results in a 'soft law' context within sub-Saharan Africa. Thus, the high AU amongst SMMEs might result from industry factors that favour the application of sustainability principles.

No significant group effects were observed in KSC, SCRS or AU, suggesting that South Africa has a baseline level of awareness and practice of sustainable construction that cuts across firm size. It could also suggest that sustainability practices are spreading throughout the South African construction industry, probably through training institutions, professional networks or client expectations. This finding aligns with the 'bottom-up' adoption dynamics observed in Chan et al. (2018:1074) when firm-level initiatives often precede policy frameworks in catalysing sustainable change. In addition, the high levels of AU ($M = 5.15$) and BI ($M = 4.94$) observed suggest that sustainable construction practices are being implemented. This observation is consistent with the finding of Chan et al. (2018:1077), namely, that in emerging markets, practitioners are increasingly recognising the operational benefits of sustainability, even where regulatory enforcement remains limited. Similarly, Oke et al. (2019:3250) found evidence of uptake in Zambia despite policy and knowledge gaps, suggesting that sustainability adoption may sometimes proceed through practice-led, rather than policy-led pathways.

Implications

The respondents' high levels of BI and AU indicate a strong foundational willingness to adopt sustainable construction practices. The findings also revealed that PU and PEOU were significantly higher amongst LEs than SMMEs. Practical implementation is still constrained amongst smaller firms. It implies there is a need for tailored capacity-building interventions for SMMEs, such as simplified guidelines, technical training and context-relevant toolkits that demystify sustainable practices and demonstrate their cost-effectiveness.

Incentives to adopt sustainable construction and SCRS recorded a low mean score, indicating policy misalignment or ineffectiveness. Respondents from SMMEs do not perceive sufficient financial motivation or regulatory pressure to invest in sustainability. This perception is consistent with research in other African contexts. For example, in Zambia (Zulu et al. 2023:2118) and Ghana (Darko et al. 2017:391), a lack of structured incentives and weak enforcement mechanisms has undermined the policy environment. Therefore, government and regulatory authorities need to strengthen both the visibility and credibility of existing sustainable construction policies. Policies must be enforced consistently and accompanied by tangible incentives, such as green certification schemes, tax rebates, or preferential procurement, that lower the entry barriers to adoption, particularly for resource-constrained SMMEs.

The findings also suggest an underutilised lever in CDSC, which was significantly higher amongst LEs. To enhance the sustainability orientation of the broader market, public and private sector clients should be encouraged to set clear sustainability expectations in their procurement frameworks. This could create demand-pull pressures that

motivate firms, especially SMMEs, to align with green standards to remain competitive. Public procurement can be a powerful tool for driving widespread adoption if sustainability criteria are embedded as non-negotiable requirements in tender processes.

Limitations of the study

Whilst this study provides valuable insights into the adoption of sustainable construction practices amongst SMMEs and LEs in South Africa, several limitations are acknowledged. Firstly, the use of a cross-sectional survey design limits the ability to infer causality between constructs. Secondly, reliance on self-reported data may have introduced social desirability bias, particularly for constructs such as AU and BI, where respondents might have overstated their engagement with sustainable practices. Future research could enhance validity by triangulating the survey responses with project documentation, observational methods, or interviews. Thirdly, the sample was unevenly distributed, with the urban provinces of Gauteng (32.7%) and the Western Cape (30.3%) accounting for the bulk of the responses. Consequently, the findings may not be generalisable to firms in rural provinces, where contextual challenges may differ. Fourthly, the sample is substantially imbalanced between the two comparison groups, with SMMEs accounting for 85.8% ($n = 181$) and LEs for 14.2% ($n = 30$). This imbalance reduces the statistical power of group comparisons for the LE subgroup. Thus, the findings attributed to LEs should therefore be treated as indicative rather than definitive. The small LE subsample is also unlikely to be representative of the full diversity of construction LEs operating in South Africa. Fifthly, self-selection sampling was employed because no comprehensive national sampling frame exists for construction firms; participants volunteered in response to a survey invitation distributed through industry associations. As the exact number of invitations sent is unknown, the response rate cannot be calculated. Furthermore, the risk of volunteer bias, in which participants may systematically differ from non-participants, cannot be ruled out. Sixthly, the findings are based on responses from seven South African provinces. They may therefore not be generalisable to firms in other emerging-economy contexts where regulatory environments, market structures and institutional frameworks differ substantially from those in South Africa.

Conclusion

The results demonstrate that whilst both SMMEs and LEs exhibit positive attitudes and BI towards sustainable construction, LEs perceive greater ease of use, usefulness and client-driven demand, as well as stronger incentives. These findings suggest that LEs may be better positioned structurally and institutionally to capitalise on the benefits of sustainable practices. Conversely, the higher actual use reported by SMMEs, despite lower perceived incentives and regulatory pressure, is consistent with a pattern of practice-embedded or necessity-driven adoption, though the cross-sectional, self-report design of this study does

not permit direct inference about the motivational processes underlying this observation. The study's findings have implications for both policy and practice. Interventions to promote sustainability in the construction sector must be differentiated to address LEs' strategic readiness whilst concurrently supporting SMMEs through accessible resources, capacity-building programmes and simplified regulatory frameworks. Strengthening client demand, improving policy enforcement and amplifying knowledge dissemination will be essential in bridging the intention-action gap across both enterprise types.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

CRediT authorship contribution

Virginia S. Ngonda: Conceptualisation, Data curation, Formal analysis, Methodology, Validation, Writing – original draft. Hilary K.N. Bama: Supervision, Validation, Writing – review & editing. All authors reviewed the article, contributed to the discussion of results, approved the final version for submission and publication and take responsibility for the integrity of its findings.

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Data availability

The data that supports the findings of this study are available from the corresponding author, Virginia S Ngonda, upon reasonable request.

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Appendix 1

Reliability and validity measures

TABLE 1-A1: Outer loadings, reliability and validity statistics.

Construct	Cronbach's α	ρ_A	CR (ρ_c)	AVE	Min OL	Max OL	Items
Actual usage	0.944	0.945	0.957	0.818	0.871	0.946	5
Behavioural intention	0.937	0.939	0.955	0.840	0.894	0.936	4
Client demand for sustainable construction	0.851	0.866	0.909	0.768	0.844	0.908	3
Incentives to adopt sustainable construction	0.808	0.871	0.870	0.630	0.671	0.872	3
Knowledge of sustainable construction	0.918	0.939	0.942	0.801	0.860	0.918	4
Perceived ease of use	0.893	0.897	0.926	0.760	0.841	0.904	4
Perceived usefulness	0.859	0.875	0.905	0.706	0.800	0.882	4
Sustainable construction regulations and standards	0.808	0.912	0.909	0.833	0.900	0.925	2

Min, minimum; Max, maximum; OL, outer loading; CR, composite reliability; AVE, average variance extracted.

TABLE 2-A1: Fornell–Larcker criterion.

Items	AU	BI	CDSC	IASC	KSC	PEOU	PU	SCRS
AU	0.904	-	-	-	-	-	-	-
BI	0.663	0.917	-	-	-	-	-	-
CDSC	0.359	0.400	0.877	-	-	-	-	-
IASC	0.487	0.466	0.592	0.794	-	-	-	-
KSC	0.591	0.438	0.320	0.643	0.895	-	-	-
PEOU	0.548	0.695	0.444	0.588	0.538	0.871	-	-
PU	0.432	0.632	0.460	0.482	0.360	0.593	0.840	-
SCRS	0.397	0.285	0.582	0.652	0.362	0.294	0.449	0.913

Note: Diagonal values are the square root of AVE.

KSC, knowledge of sustainable construction; IASC, incentives to adopt sustainable construction; CDSC, client demand for sustainable construction; SCRS, sustainable construction regulations and standards; BI, behavioural intention; AU, actual usage; PU, perceived usefulness; PEOU, perceived ease of use; AVE, average variance extracted.

TABLE 3-A1: Heterotrait–monotrait ratio.

Items	AU	BI	CDSC	IASC	KSC	PEOU	PU
BI	0.701	-	-	-	-	-	-
CDSC	0.394	0.431	-	-	-	-	-
IASC	0.527	0.495	0.759	-	-	-	-
KSC	0.626	0.466	0.354	0.677	-	-	-
PEOU	0.593	0.759	0.497	0.654	0.582	-	-
PU	0.474	0.702	0.540	0.541	0.386	0.669	-
SCRS	0.445	0.308	0.726	0.824	0.385	0.332	0.544

Note: All values below the conservative HTMT threshold of 0.85.

KSC, knowledge of sustainable construction; IASC, incentives to adopt sustainable construction; CDSC, client demand for sustainable construction; SCRS, sustainable construction regulations and standards; BI, behavioural intention; AU, actual usage; PU, perceived usefulness; PEOU, perceived ease of use; HTMT, heterotrait–monotrait.