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Critical project delivery strategies for sustainable building construction in South Africa

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Certain practices have been linked with the delivery of projects related to sustainable building construction (SBC). Prior research has underscored the necessity of enhancing SBC project delivery. There have been contentions in the literature regarding the best strategy for successful SBC project delivery. Consequently, this study explored the project delivery strategies (PDS) for SBC in South Africa (SA). The original data was obtained from practitioners in the built environment, primarily in Gauteng province. A quantitative approach was employed with a questionnaire as a data collection tool. The data analysis involved descriptive and inferential statistics, including percentage frequency, mean score, analysis of variance (ANOVA), and principal component analysis (PCA). PCA showcases the key PDS components. Three principal PDS components were identified: *sustainable tendering and contracting*, *integrated project delivery*, and *sustainable public and private financing*. The constituent variables' factor loadings varied between 0.562 and 0.833. The Cronbach Alpha scores of the components' measuring variables indicated high reliability and internal consistency exceeding the 0.7 benchmark. The study's findings are novel and offer PDS insights for SBC project deployment in SA. The analysis uncovered three fundamental project delivery factors for achieving resilient and successful SBC projects. The study recommends prioritising the principal factors. Furthermore, researchers, industry experts, and policymakers can use this study as a roadmap to help them in their coordinated, cooperative, and strategic efforts to identify the critical/principal PDS and establish improvement initiatives to actualise successful SBC project delivery. The study will stir a shift from traditional building approaches to more sustainable, integrated and collaborative project delivery.

KEYWORDS

project delivery, strategies, sustainable building construction, green building, principal component analysis, South Africa

1 Introduction

The construction industry (CI) is known for its complexity, unpredictability, and fragmentation and is subjected to demands for increased quality and speed (Assaf et al., 2023). Besides, this complicated and hard domain demands meticulous preparation and implementation to ensure a successful project completion (Aktuna and Eskici, 2024). These demands are critically associated with projects involving the construction of sustainable buildings that call for sophisticated design and materials, increased teamwork, and specialised contractor capabilities (Ahmed and El-Sayegh, 2023). SBC is the solution to reducing the serious threat and detrimental impacts of the CI's traditional practices on the environment, human health, climate, and national economies (Omopariola et al., 2022). It is widely acknowledged that the activities of the CI led to 40%–45% energy consumption, 50%–55% of raw materials depletion, massive environmental pollution and waste, and ozone layer depletion (Simpeh et al., 2023). According to Emere et al. (2024), "building construction at least leads to 23% of greenhouse gas (GHG) emissions, while emissions from its material production account for 18mtCO2 annually, accounting for about 4% of the total CO2 emissions". With the industry facing major sustainability challenges, SBC project delivery is critically required to enhance building methods globally, especially in SA. Besides, the SBC is a factor in actualising sustainable development goals (SDGs) (Emere et al., 2024).

However, SBC project delivery in SA is fraught with many challenges, including but not limited to reluctance to adopt contemporary building methods, lack of adoption of best practices, cost overruns, quality issues, undue wastage, delays, and limited demand for sustainable/green buildings (Aghimien et al., 2019; Emere et al., 2020; Marsh et al., 2021; Simpeh et al., 2023). Consequently, there is a crucial need to adopt the right project delivery strategies to improve SBC. Design-Build Institute of America (DBIA) (2018) states that critical decisions to improve construction project delivery involve choosing the appropriate project delivery mechanism, procurement techniques, and contract type for the building project. Hence, these three key areas summarise this study's project delivery strategies (PDS). Oke et al. (2018) affirm that PDS are crucial levers to re-engineer construction projects. Similarly, several studies affirmed that the selected project delivery/procurement/contract method significantly impacts the project's performance (Mehany et al., 2017; Hashem et al., 2018; Agbaxode et al., 2024; Aktuna and Eskici, 2024; Emere, 2024). However, literature suggests that no delivery strategy fits all types of construction projects (Ahmed and El-Sayegh, 2023b). Nonetheless, it is still ambiguous to which delivery strategies (PDS) are most critical for implementing SBC in SA. Hence, this study aims to evaluate and establish the critical PDS for SBC projects in SA. This study contributed theoretically by exploring the PDS for SBC projects in the South African construction industry (SACI), which has not been done. The findings shed light on the principal PDS components that construction companies should prioritise enhancing the delivery of SBC projects. Also, this area of discovery of the principal delivery strategies for SBC has not been considered in SACI. Hence, this study filled this gap using the PCA technique to reveal the principal PDS for SBC in SA. This will eliminate ambiguity on the most important PDS construction companies must adopt for SBC projects. Additionally, the cognisance of the main PDS components will enable the SACI practitioners and stakeholders to make informed decisions in choosing the best strategy for SBC projects in any given setting. Furthermore, this study's findings foster adequate knowledge sharing for sustainable built environment.

Abbreviations: CI, Construction Industry; DBIA, Design-Build Institute of America; KMO, Kaiser Meyer Olkin; PCA, Principal Component Analysis; PDS, Project Delivery Strategies; SA, South Africa; SACI, South African Construction Industry; SBC, Sustainable Building Construction.

2 Literature review

2.1 SBC in SA

SBC is described as "the construction of buildings in a sustainable and green way" (Emere et al., 2024: 2). It is the process of constructing buildings to reduce environmental impact while guaranteeing the achievement of social and economic objectives (Krizmane et al., 2016; Emere et al., 2025). However, SBC has not been fully embraced in SA compared to developed countries (Aboginije et al., 2020). According to Aboginije et al. (2020), green and sustainable buildings that do exist in SA's building stocks make up a very tiny percentage of the nation's building market. Similar, in contrast to industrialised nations, the acceptance of green and sustainable buildings by clients and property developers is still in its early stages (Masia et al., 2020). Conventional building construction has resulted in at least 23% of greenhouse gas emissions and 27% of energy consumption in SA (Wright and Godfrey, 2015; Emere et al., 2025). Similarly, 18 million metric tons of CO2 are released annually, or about 4% of total CO2 emissions, during the building materials manufacturing process (Simpeh and Smallwood, 2020). Additionally, estimated 42 million cubic meters of solid waste are produced in SA each year, especially in Gauteng province, with the CI being a major source (Aboginije et al., 2020). Consequently, there is great pressure to deliver green buildings in SA to mitigate climate change, the energy crisis, persistent shortages of water and so on (Simpeh et al., 2023; Emere et al., 2023). Also, more green/sustainable buildings are required to meet the demand for the growing urbanisation in SA. Hence, there is a pressing necessity to transition to better construction techniques/strategies that align with SBC and ensure successful project delivery in SACI (Emere et al., 2024).

2.2 SBC project delivery challenges in SA

SBC demands that buildings be constructed to meet environmental, social, and economic needs. However, its project delivery is often very robust and complex and demands contemporary approaches and the best strategies (Owoha et al., 2022; Emere, 2024). Over the years, project delivery in SACI has been predominantly based on fragmented project delivery models. There is a great need to adopt strategies that will favour the actualisation of sustainability goals and integrate all stakeholders. Also, many projects fail to integrate sustainability early when designing, which reduces the potential for optimising energy efficiency and minimising environmental impacts.

Besides, SA construction industry faces difficulties with performance and procurement in project execution (Emere et al., 2020). Low productivity, ineffective project management, technological difficulties, significant cost and time overruns, unnecessary waste, failure to adopt best practices, ineffective methods, insufficient application of laws and regulations, inexperienced and unskilled personnel, and similar issues are the causes of poor performance (Windapo and Cattell, 2013; Ogunsanya, 2018; Emere et al., 2020; Emere, 2024). Furthermore, procurement issues comprise lack of green procurement, corruption, bid-rigging, an excessive dependence on foreign firms and donor capital, exorbitant labor, construction material expenses, difficulties recruiting and training a skilled local workforce, inability to provide fully integrated solutions, difficulties locating timely and necessary funding, usage of procurement systems that prioritise price and preference over quality and functionality, and inadequate information for choosing skilled personnel and contractors who will meets the specifications (Windapo and Cattell, 2013; Ogunsanya, 2018; Emere, 2024). These obstacles ultimately result in low profitability and unsustainable business growth (Emere et al., 2020). The problem of the absence of cooperative working methods and practices among participants in the construction supply chain in project delivery was also brought to light by Kwofie et al. (2017). Furthermore, the nature of PDS that would generate the performance required for the effective delivery of sustainable/green buildings in SA is another area where stakeholders and practitioners in the construction industry cannot agree. Therefore, there is a need to extract the critical/principal strategies for efficient SBC project delivery in SA. Consequently, implementing the most effective delivery tactics/strategies is necessary.

2.3 SBC project delivery research gap

Notwithstanding continuous initiatives to enhance South African construction methods, the industry still confronts many obstacles, especially regarding sustainability and project completion (Bowen et al., 2012; Emere, 2024). The nation's sustainability aims are undermined by traditional building methods, which frequently lead to waste, excessive energy use, and environmental deterioration (Ofori, 2019). Thus, there is a growing need for SBC. While there is a growing market for green and sustainable buildings, the global CI, including SACI, is starting to realise that certain extra requirements are needed in the whole delivery process of these types of buildings (Korkmaz et al., 2011; Ahmad and Aibinu, 2017). In several pieces of literature, it has been indicated that the composition of project teams, the relationships formed, the project organisation, and the contracts used can impact how projects are carried out (Hanks, 2015; Ahmad and Aibinu, 2017). This is because the successful delivery of green/sustainable buildings is more complex than normal conventional buildings, involving more stakeholders' interactions. Consequently, there is a need to explore the PDS that could increase the chances of successfully delivering sustainable buildings.

Many related studies (reviews and empirical) on SBC project delivery have been conducted globally and a few in SA. Most studies have focused on the barriers to adoption (Rasekh and McCarthy, 2016; Darko and Chan, 2017; Masia et al., 2020) while others on benefits and drivers (Darko et al., 2017; Marsh et al., 2021; Kineber and Hamed, 2022; Oguntona et al., 2024). Similarly, some have focused solely on procurement (Akiner and Akiner, 2018) while some on certain delivery systems (Kantola and Saari, 2016; Gunhan, 2019; Raouf and Al-Ghamdi, 2019a; Kahvandi et al., 2020) and some on performance-based standards, contracts and quality of specifications (Lam et al., 2010; Ahn et al., 2013; Darko et al., 2017). Some scholars have also ascertained the relationships of some of these project delivery attributes on project success criteria (Korkmaz et al., 2011; Raouf and Al-Ghamdi, 2019b). Unfortunately, research in SBC has not given equal attention to all the PDS or attributes. This claim is further confirmed by a thorough literature review by Ahmad and Aibinu (2017) on project delivery attributes influencing green building project outcomes. Ahmad and Aibinu (2017) identified that not every project delivery attribute has received the same amount of attention in this field of study. Notably, this is the only study that combined the facets of PDS (delivery methods, procurement systems, contract formats, and tactics) to identify and classify the principal PDS for SBC project delivery. Likewise, no study in South Africa has explored the PDS for SBC in South Africa. The findings of this study are expected to help decision makers and stakeholders plan effectively in steering the successful delivery of sustainable buildings in SA.

2.4 Project delivery strategies (PDS)

PDS is defined as the tactics, delivery methods, procurement and contract formats adopted for construction projects (Hashem et al., 2018; Emere, 2024). Project delivery strategies are essential for meeting project performance objectives including both the traditional (time, cost, and quality) and sustainability metrics and stakeholders/client expectations (Agbaxode et al., 2024; Aktuna and Eskici, 2024). The performance of the project is affected by the chosen PDS. However, the best approach will rely on several variables, including complexity, money, schedule, and the degree of control the owner wants to retain (Hamzeh et al., 2019; Agbaxode et al., 2024). The PDS are discussed in the following subsections.

2.4.1 Client needs assessment

This tactic is crucial with a lot of implications moving forward in any project undertaking. It provides a chance to delve deeply into the particulars of what a client is seeking. As minor as it may seem, proper diligence has not been given to this aspect of project delivery resulting in client needs and satisfaction not being met (Folorunso and Awodele, 2015). Properly evaluating the needs of the client enables a thorough grasp of the objectives and expectations of the client. With this knowledge, services will be tailored to their requirements and raise the likelihood that they will be satisfied. Client needs include but are not limited to time, cost and quality-related factors (Ghadamsi and Braimah, 2012).

2.4.2 Design-bid-build

A separate contract is signed by the client and the design team, which creates the design document, and afterwards requests a fixed cost quotation for the job from the builder (Hashem et al., 2018). Following the plans and requirements, one builder is selected (often the lowest-bidder) and agrees with the client to undertake the project (Gunhan, 2019). Since the builder is not involved in the design phase because they are hired independently, this approach has drawn criticism for fostering silos among project participants (Gunhan, 2019; Emere, 2024). DBIA (2018) confirmed that with this approach, if construction input is the project's constructability and efficacy may be jeopardised.

2.4.3 Design and build (DB)

This method provides the client with a single contracting point as the client agrees with a single entity to execute both the design and construction of the building (Olanike et al., 2020). This technique provides room for the medium-to-high-level integration of important project participants earlier (Gunhan, 2019). This approach is frequently seen as suitable when the client is not familiar with the construction process and the project is technically demanding (Ghadamsi and Braimah, 2012).

2.4.4 Construction management/general contractor method

Early in the design phase, the client hires the general contractor to do preconstruction and construction services (Hashem et al., 2018). In addition to carrying out duties like material ordering and subcontractor coordination ahead of time, the general contractor can counsel the design team on cost and schedule issues (Hanks, 2015). This approach is like design and build, according to Akiner and Akiner (2018), in that it views the project planning, design, and construction phases as a single, integrated process. DBIA (2018) claims that project delivery is faster than DBB. Nevertheless, there is no direct contractual contact between the contractor and the designer (DBIA, 2018).

2.4.5 Integrated project delivery system

Through a mutual contract that shares all risks and rewards, this project delivery technique seeks to improve collaboration among key stakeholders (Aknar, 2016; Gunhan, 2019). IPD is the only system designed with a project collaborative approach in mind (Aknar, 2016). This is so that the project team can work together, share expertise, and exchange ideas to achieve the project's objectives. IPD is founded on nine essential tenets. They include "mutual respect and trust, mutual benefit and reward, collaborative innovation and decision-making, early involvement of key participants, early goal definition, intensified planning, open communication, appropriate technology, and organisation and leadership" (Emere, 2024). Adel et al. (2022) confirmed that it is the most suitable for achieving sustainability in construction projects as it had a positive outcome on cost and time reduction and the community.

2.4.6 Turnkey

The term means that the client receives a key, turns it in the door, and enters the completed project once all operational requirements have been met (Ogunsanya, 2018; Emere, 2024). It is also referred to as an in or package contract (Olanike et al., 2020). Under this approach, all tasks related to the construction, commissioning, completion, and handover of the project are assigned to a contractor (Olanike et al., 2020). Its key advantage is that it offers a single point of accountability, which can lead to an increase in productivity, a decrease in risk, and more predictable costs and timelines (Olanike et al., 2020). According to Lesniewski and Berkebile (2020), integrating sustainable building with turnkey delivery can improve project outcomes by guaranteeing that sustainability objectives are considered from the outset and throughout the full project lifecycle.

2.4.7 Public-private partnership (PPPs)

This approach refers to cooperative service delivery partnerships between the public and commercial sectors (Emere, 2024). Whereby a private party undertakes the major financial, operational, and technical risks in the project's design, funding, building, and operation on behalf of a municipality or public sector organisation (National Treasury, 2015). In this connection, profit and risk can be allocated either equally or unequally. Akomea-Frimpong et al. (2023) posit that there is a strong connection between PPPs and sustainable infrastructure development. Likewise, Wu (2017) affirms that a PPP long-term contract may promote attention to the sustainability of infrastructure. Moreover, payments are usually connected to performance metrics and sustainability goals. As a result, private partners are motivated to meet or exceed these objectives (Wu, 2017).

2.4.8 Delivery methods with a single contracting point

Having a single contracting point can improve project efficiency and streamline the process when it comes to sustainable construction (Hashem et al., 2018; Babalola et al., 2024). These may include but are not limited to DB, IPD and PPP. Through enhancing resource efficiency, decreasing waste, and encouraging integrated planning and execution, these strategies can guarantee that sustainability goals are accomplished (Gunhan, 2019).

2.4.9 Early involvement of stakeholders

This involves bringing all project stakeholders together early when making decisions. In other words, it involves incorporating the trades and the construction team into the design process to enhance project outcomes (Ferme et al., 2018). This strategy can lead to better decisions, risk reduction, improved collaboration, cost savings, resource optimisation and regulatory compliance towards SBC (Bal et al., 2013; Othman and El-Saeidy, 2024).

2.4.10 Collaboration of project participants

According to Miller (2024), Collaborative delivery creates a pathway for sustainable construction methods by encouraging open communication and common goals among all project stakeholders early on. In addition, it can stimulate early ingenuity and innovative approaches to optimise resource efficiency, reduce environmental impact, and enhance building performance throughout their lifetime (Miller, 2024).

2.4.11 Open tendering

For the job, any contractor may submit a bid. To notify prospective tenderers, a public advertisement is typically posted by the client or their agents (consultants), and upon requesting a contract document, monetary deposits are typically needed (Mathonsi and Thwala, 2012). By guaranteeing equitable competition among all eligible contractors, open tendering can foster a competitive atmosphere. It may incentivise contractors to present their best deals and solutions, resulting in the completion of projects at a reasonable cost (Gamage, 2023). It encourages openness, which strengthens stakeholder trust. Additionally, it lowers the possibility of corruption and favouritism by following an organised and open procedure (Ranganath, 2024).

2.4.12 Selective tendering

A select group of contractors are invited to make a bid, chosen based on their qualifications, level of technical expertise, and availability of resources (Mathonsi and Thwala, 2012). This procurement method can be advantageous for SBC projects in terms of quality control, efficiency, risk reduction and innovation (Cost Estimator, 2024; Riso and Trinidad, 2024). By selecting contractors that have a track record in sustainable practices, the project owner guarantees top-notch work that complies with sustainability standards (Cost Estimator, 2024).

2.4.13 Negotiated tendering

One contractor is chosen by the client to submit a bid (Mathonsi and Thwala, 2012). This strategy allows early contractor involvement, which can result in improved planning and early integration of sustainable practices. This strategy can shorten the tendering process and save money by minimising the competitive bidding procedure. Furthermore, negotiated tendering places an emphasis on value and quality rather than just the lowest proposal, which is important for sustainable building projects that frequently call for larger upfront investments for long-term returns (Ellis et al., 2021).

2.4.14 Targeted procurement

With this strategy, environmental, social, and economic considerations can be strategically integrated into the procurement process (McKinsey and Company, 2023). Also, this strategy is utilised to promote involvement of targeted businesses and targeted labour in government infrastructure contracts, especially in SA (Ofori, 2009; Adediran and Windapo, 2017).

2.4.15 Lump sum contracts

This type of agreement bases the amount paid for the work done on the end product (Hashem et al., 2018; Emere, 2024). During the bidding process, an estimate of the project's total cost is provided. According to Hashem et al. (2018), it functions best when the project scope is clearly defined or described concerning the drawings, specifications, and cost, thereby lowering the possibility of a change order.

2.4.16 Cost-reimbursable contracts

In this instance, the contractor is paid the agreed-upon amount in addition to the actual cost of the work (Hashem et al., 2018; Emere, 2024). According to Raouf and Al-Ghamdi (2019a), the owner bears the full cost of the project, including any fixed or variable fees necessary to meet the project's requirements for time and cost. Cost-reimbursable payment clauses make it easier to incorporate project modifications since they reduce the contractor's contingency during the bidding process (Raouf and Al-Ghamdi, 2019b). This strategy permits changes to the project's materials and scope, which is advantageous when utilising novel or experimental sustainable technologies (Landau, 2021).

2.4.17 Multiple criteria selection

This procurement technique, also known as competitive sourcing or multi-sourcing, is asking several vendors or suppliers to submit bids or compete for a project or contract. This strategy creates a competitive atmosphere where suppliers aim to close the transaction by providing the best terms, costs, and quality (Emere, 2024; Jackson, 2024).

2.4.18 Usage of government budgetary allocations

Project delivery depends heavily on government budgetary allotments, guaranteeing that public funds are used wisely to accomplish intended results (Ogunsanya, 2018). This distribution is frequently predicated on thorough project proposals specifying goals, objectives, and anticipated results. Redistributing resources may be necessary for governments to adapt to shifting conditions or new objectives. According to McKinsey and Company (2018), flexibility guarantees that key projects receive the required assistance and facilitates the efficient use of funds.

2.4.19 Usage of private sector funds

Private sector funds may be essential in delivering SBC projects through green financing, innovative financing mechanisms, etc. (Shamanina, 2023; Yun, 2024). Fundraising for projects with good environmental benefits is known as "green financing." One example of this would be green bonds, which are designated especially for environmental and climate-related initiatives (Shamanina, 2023). Similarly, to raise money from the private sector, strategies such as credit enhancement and social impact bonds may be useful (Yun, 2024).

3 Research methodology

Figure 1 indicates the methodological process. This study took a positive philosophical stance to evaluate the PDS influencing SBC projects in the built environment through empirical evidence. The philosophical paradigm informed the adoption of a quantitative approach with a questionnaire survey. The literature review guided the selection of questionnaire variables. Creswell (2014) states that this research is suitable for collecting numerical data that may be categorised, ranked, or assessed using measurement units. Consequently, a close-ended questionnaire was used to gather information from professionals in the built environment in Gauteng, SA. The questionnaire is characterised by two sections. Section A involved background information on education, profession, project role, and industrial experience. Section B involved the PDS with questions structured in a 5-point Likert Scale "1 = No extent, 2 = Low extent, 3 = Moderate extent, 4 = High extent and 5 = Very high extent". Respondents were asked to indicate the extent to which the variables influence SBC for project delivery success in SA.

Convenience sampling was utilised for this research. This sampling technique has been acknowledged as beneficial when studying hard-to-reach populations or when time and resources are limited (Etikan et al., 2016). It is also useful when randomisation (relying on chance) is impractical, such as when the population is enormous (Etikan et al., 2016; Emere et al., 2025). Initially, the questionnaire was circulated across professional bodies in SA, such as the "South African Council for the Project and Construction Management Profession (SACPCMP)", "the South African Council for the Quantity Surveying Profession (SACQSP)" and so on, to reach out to the broader population. However, because of the small number of replies, the study

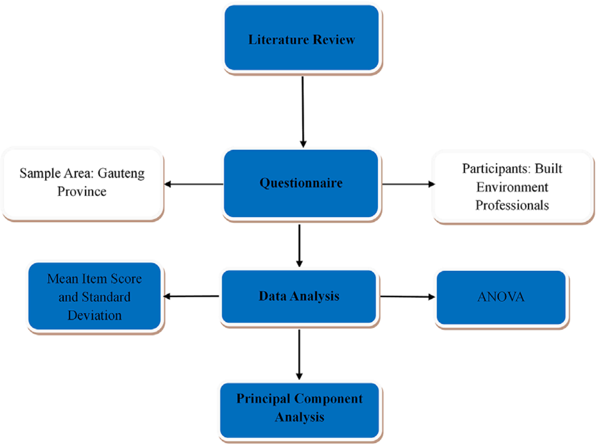

FIGURE 1
Research methodology process.

mostly concentrated on the suitable and reachable experts in the Gauteng province of SA using convenience sampling. Although convenience sampling has been criticised for unclear generalisability and bias (Obilor, 2023), its application in this study was deemed appropriate. It was selected due to the nature of the research, time constraint, and difficulty finding relevant respondents with the requisite training, experience, and willingness to participate. Also, randomisation may not be able to provide the educated responders that the current study requires. Furthermore, convenience sampling is appropriate because the researcher(s) aimed to create hypotheses that would be carefully examined in later research, and the data collected was based on respondents' impressions (Golzar et al., 2022).

However, to curb the bias and generalisability issues associated with convenience sampling, several measures were adopted. Firstly, the researchers ensured that knowledgeable/experienced participants responded to the questionnaires. The respondents also acknowledged their knowledge of the subject area/questionnaire content. Responders included professionals with experience in "project management," "construction management," "engineering (civil, electrical and mechanical)," "quantity surveying," "architecture," and "town and regional/urban planning." Secondly, the choice of Gauteng province. Gauteng was chosen because most building operations take place in this province and it has over 333,000 construction professionals (Statista, 2023; Emere et al., 2025). Gauteng is home to major cities like Johannesburg and Pretoria. It serves as the nation's economic center/powerhouse contributing about 33.9% to the country's GDP (Department of Economic Development, 2020; South African Government, 2025). It is the most populous province with a population of over 15 million people (South African Government, 2025). Besides, in comparison to other South African regions, its strategic location, expanding urban population, governmental support, and environmental consciousness are additional factors (Department of Economic Development, 2020; Statistics SA, 2022; Emere et al., 2025). Thirdly, the sampling size. In all, 281 completed surveys were obtained, which exceeded the 150 respondents' threshold for factor analysis (Pallant, 2020). Therefore, the study's sample size was ideal, and it was less likely to produce unfavorable results. Fourthly, to get a representative sample of the intended audience, the researchers distributed the surveys across different domains and places at different times (Golzar et al., 2022). The questionnaire was circulated electronically through emails and Google Forms. A reliability test of the questionnaire variables revealed that they were sufficient, with a high Cronbach alpha value of 0.943.

Data was analysed using the Statistical Package for Social Sciences (SPSS) version 29 software. Frequency was used to analyse the respondents' demographic data while mean and standard deviation were used to rank the variables according to the respondents' responses. Mean score was used to rank the PDS, because the data was normally distributed. Besides, analysis of variance (ANOVA) test was conducted to find out if there was a significant difference in the mean responses of the respondents based on their project role. Conversely, PCA was used to reduce the large datasets of PDS into components by examining the underlying theoretical structure of the variables, maximising interpretation while reducing data loss (Jolliffe and Cadima, 2016; Pallant, 2020). PCA aids in highlighting the relationship structure between the respondents and each variable (Pallant, 2020).

Furthermore, using Cronbach's alpha criterion of 0.70, the acquired data's dependability and internal consistency were evaluated. The collected data can be deemed reliable, as indicated by the average value of 0.943 for the variables (Pallant, 2020). Likewise, the extracted principal factors were evaluated independently using Cronbach's alpha test, and the outcomes were found to be adequate. This enhanced the study's discriminatory validity.

4 Findings

4.1 Background information

Table 1 presents the demographic data of the respondents. Data regarding Academic Qualification revealed that most respondents had "honours/btech degrees" (44.8%), trailed by "master's" (24.2%), "bachelor's" (14.6%), "national diplomas" (10.7%) and "doctorates" (5.7%). Regarding Professional Background, 21.4% were from "construction management", 20.6% from "engineering," 19.6% from "quantity surveying," 17.1% from "project management," 14.6% from "architecture," and 6.0% from "town/urban and regional planning." For Industrial Experiential, 19.6% practised between "six to 10 years," trailed by "one to 5 years" (18.1%), "eleven-to-fifteen years" (15.7%), "sixteen-to-twenty years" (14.6%), "twenty-one to 25 years" (11.4%), "twenty-six to 30 years" (8.1%), "less than 12 months" (6.8%) and "more than 30 years" (5.7%). Lastly, the respondents predominantly participated in the Roles of "project managers" (33.1%), "construction managers" (17.1%), and "quantity surveyors" (16.4%). Other roles include "project engineers" (14.9%), "principal agents" (8.9%), and "town planners" (5.7%).

4.2 Descriptive statistics and anova-test

Table 2 portrays the PDS influencing SBC in SA. The respondents were asked to rate the extent to which the variables

TABLE 1 Demographic background.

Category	Features	Frequency	Percentage
Academic Qualification	Honours/Btech. degree	126	44.8%
	Master's degree	68	24.2%
	Bachelor's degree	41	14.6%
	National diploma	30	10.7%
	Doctorate	16	5.7%
Professional Background	Construction management	60	21.4%
	Engineering	58	20.6%
	Quantity surveying	56	19.6%
	Project management	48	17.1%
	Architecture	41	14.6%
	Town and urban/regional planning	17	6.0%
	Other	1	0.4%
Industrial Experience	6–10 years	55	19.6%
	1–5 years	51	18.1%
	11–15 years	44	15.7%
	16–20 years	41	14.6%
	21–25 years	32	11.4%
	26–30 years	23	8.1%
	Less than 12 months	19	6.8%
	More than 30 years	16	5.7%
Project Role	Project Manager	93	33.1%
	Construction Manager	48	17.1%
	Quantity Surveyor	46	16.4%
	Project Engineer	42	14.9%
	Principal Agent	25	8.9%
	Town Planner	16	5.7%
	Other	11	3.9%

influence SBC project delivery on a 5-point Likert scale ranging from 1 (no extent) to 5 (very high extent). The measuring variables were ranked using the outputs of the mean score (M) and standard deviation (SD). Table 2 shows that all the variables recorded M values ranging from 3.34 to 4.36. This indicates that all variables are statistically significant at 3.0 mean threshold (Kothari and Garg, 2014). Nonetheless, the overall top five rated variables included the "early involvement of stakeholders" (M = 4.36), "collaboration of project participants" (M = 4.25), "client needs assessment" (M = 4.21), "integrated project delivery system" (M = 3.95), and "public-private partnerships" (M = 3.94). Conversely, the least ranked variables included "usage of open tendering method" (M = 3.54), "usage of lump sum contracts" (M = 3.41) and "Design-Bid-Build" (M = 3.31).

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TABLE 2 PDS influencing SBC (Mean Ranking and ANOVA Test).

Variable	PM		CM		PE		PA		QS		TP		O		Total			ANOVA	
	M	R	M	R	M	R	M	R	M	R	M	R	M	R	M	R	SD	F	Sig
Early involvement of stakeholders	4.42	*1*	4.19	*1*	4.31	*1*	4.56	*1*	4.41	*1*	4.44	*2*	4.09	*1*	4.36	1st	0.795	1.024	0.410
Collaboration of project participants	4.25	*2*	4.06	*3*	4.31	*1*	4.48	*2*	4.30	*2*	4.38	*3*	4.00	*2*	4.25	2nd	0.768	1.201	0.306
Client needs assessment	4.17	*3*	4.17	*2*	4.19	*3*	4.24	*3*	4.28	*3*	4.50	*1*	4.00	*2*	4.21	3rd	0.808	0.592	0.737
Integrated project delivery system	4.06	*4*	3.85	*4*	3.95	*5*	4.04	*7*	3.85	*9*	4.00	*6*	3.55	*8*	3.95	4th	0.893	0.872	0.516
Public-private partnerships	3.97	*5*	3.83	*5*	3.81	*10*	4.20	*4*	4.00	*4*	4.19	*5*	3.45	*9*	3.94	5th	0.922	1.335	0.241
Delivery methods with a single contracting point	3.86	*6*	3.56	*11*	4.02	*4*	4.16	*5*	4.00	*4*	4.25	*4*	3.64	*7*	3.90	6th	0.898	**2.365**	**0.030**
Construction management/general contractor method	3.77	*7*	3.69	*7*	3.90	*6*	3.92	*9*	3.87	*8*	3.94	*7*	3.82	*4*	3.82	7th	0.894	0.396	0.881
Usage of targeted procurement method	3.73	*8*	3.58	*10*	3.76	*11*	3.92	*9*	3.93	*6*	3.62	*14*	3.73	*5*	3.75	8th	0.887	0.827	0.550
Turnkey system	3.71	*10*	3.69	*7*	3.83	*9*	4.08	*6*	3.59	*15*	3.81	*12*	3.18	*17*	3.72	9th	0.938	1,528	0.169
Usage of government budgetary allocations	3.68	*12*	3.62	*9*	3.67	*15*	3.96	*8*	3.80	*12*	3.88	*8*	3.18	*17*	3.70	10th	0.979	1.043	0.398
Design and build system	3.73	*8*	3.71	*6*	3.76	*11*	3.80	*11*	3.57	*16*	3.81	*9*	3.36	*14*	3.70	10th	0.904	0.563	0.760
Usage of multiple criteria selection method	3.70	*11*	3.44	*14*	3.88	*7*	3.68	*14*	3.74	*13*	3.81	*9*	3.45	*9*	3.68	12th	0.872	1.223	0.295
Usage of private sector funds	3.57	*16*	3.54	*12*	3.76	*11*	3.76	*13*	3.89	*7*	3.69	*13*	3.73	*6*	3.68	12th	0.952	0.837	0.542
Usage of negotiated tendering method	3.63	*13*	3.35	*17*	3.86	*8*	3.68	*14*	3.83	*10*	3.44	*19*	3.27	*15*	3.63	14th	0.985	1.683	0.125
Usage of the selective tendering method	3.59	*14*	3.40	*15*	3.69	*14*	3.80	*12*	3.83	*10*	3.56	*15*	3.27	*15*	3.62	15th	0.931	1.324	0.246
Usage of cost-reimbursable contracts	3.51	*17*	3.50	*13*	3.60	*16*	3.72	*16*	3.76	*12*	3.56	*15*	3.45	*9*	3.58	16th	0.990	0.506	0.804
Usage of open tendering method	3.56	*15*	3.35	*17*	3.57	*17*	3.60	*18*	3.54	*17*	3.81	*9*	3.45	*9*	3.54	17th	1.049	0.463	0.835
Usage of lump sum contracts	3.31	*19*	3.29	*19*	3.48	*18*	3.64	*17*	3.63	*14*	3.56	*15*	2.82	*19*	3.41	18th	1.059	1.430	0.203
Traditional project delivery system (Design-Bid-Build)	3.37	*18*	3.40	*15*	3.05	*19*	3.44	*19*	3.35	*18*	3.50	*18*	3.45	*9*	3.34	19th	1.043	0.701	0.649
Group Mean	3.77		3.64		3.81		3.93		3.85		3.88		3.52		3.78				
Cronbach's Alpha	0.943																		

Note: PM, project managers; CM, construction managers; PE, project engineers; PA, principal agents; QS, quantity surveyors; TP, town planners; O = other roles; M-mean; R = rank; SD, standard deviation; F = F-statistic; Sig. = significant ($p < 0.05$).

TABLE 3 KMO and Bartlett's test for project delivery strategies (PDS).

Kaiser-meyer-olkin measure sampling adequacy		0.926
Bartlett's Test of Sphericity	Approx. Chi-Square	3713.124
	Df	171
	Sig	<0.001

Similarly, the top overall five rated variables were also the most rated variables for respondents who played the role of project managers respectively. For construction managers, the top-five rated variables were "early involvement of stakeholders," "client needs assessment," "collaboration of project participants," "integrated project delivery system" and "public-private partnerships (PPPs)." For project engineers, *"early involvement of stakeholders"* and "*collaboration of project participants*" were bracketed with the first position. This was followed by "*client needs assessment," "delivery methods with a single contracting point" and "integrated project delivery system." For principal agents and quantity surveyors, the top five included "early involvement of stakeholders," "collaboration of project participants," "client needs assessment," PPPs,* and "*delivery methods with a single contracting point*". Similarly, town planners prioritised clients' needs assessment, followed by "early involvement of stakeholders," "collaboration of project participants," "delivery methods with a single contracting point," and "PPPs." However, respondents with other roles in the project prioritised "early involvement of stakeholders", "collaboration of project participants," "client needs assessment," "construction management/general contractor method" and "usage of targeted procurement method" as their top five variables.

Table 2 indicates that the overall group mean for all respondents is 3.78. However, the individual group mean for respondents who participated as "project managers," "construction managers", "project engineers," "principal agents," "quantity surveyors," "town planners" and other roles are 3.77, 3.64, 3.81, 3.93, 3.85, 3.88 and 3.52 respectively. Also, the ANOVA test results indicated a significant difference in the opinions of the respondents concerning the variable "delivery methods with a single contracting point" (*p-value* 0.030 @0.05 threshold) based on the respondents' project roles. Furthermore, the Cronbach alpha value of 0.943 portrays strong reliability of the research instrument and the internal consistency of the measurement variables.

4.3 PCA for PDS

PCA was further conducted on the identified PDS to help determine the correlation patterns within them. The nineteen PDS variables subjected to the factorability test were found adequate. According to Table 3, the Kaiser-Meyer-Olkin (KMO) sample adequacy test result (0.959) is higher than the 0.6 minimal requirement to move forward with factor analysis (Pallant, 2020). Factorability was further reinforced by the 0.001 result of Bartlett's test of sphericity. Besides, PCA was used for the extraction process and the varimax rotation approach was used to rotate the variables. The varimax rotated component matrix was employed to create a straightforward, reliable structure and findings that were easier to recognise and understand (Emere, 2024).

Table 4 indicates that three primary component factors attained values over one and were retrieved with a total percentage variance of 65.559 higher than the 50% minimum threshold (Field, 2009; Emere, 2024). Of the variance explained, component 1 (1) accounted for 49.995% with an eigenvalue of 9.499, whereas components 2 and 3 accounted for 6.267% (eigenvalue 1.767) and 9.297% (eigenvalue 1.191), respectively. Similarly, Table 4 indicates the findings of the rotated component matrix and presents the factor loadings of the PDS measuring variables as categorised under their respective principal components. The variables with values above 0.5 in each extracted principal component were significant. Likewise, several factors in the retrieved components indicated plausible outcomes (Field, 2009). After removing variable(s) with cross-loadings, the reliability and appropriateness of the items in each principal component were evaluated using Cronbach's alpha test, as indicated in Table 4.

5 Discussions

Three components were found from the explored PDS as portrayed in Table 4. These components have been named because of the common qualities/interrelationships among them, which are detailed in the following subsections. Component 1 was named *Sustainable Tendering and Contracting;* Component 2 was called *Integrated Project Delivery*; and Component 3 was named *Sustainable Public and Private Financing.*

5.1 Component 1 – sustainable tendering and contracting

Eleven variables were contained in this component with their loadings in descending order, namely, *selective tendering* (0.833), *negotiated tendering* (0.812), *targeted procurement* (0.772), *lump sum contracts* (0.691), *cost-reimbursable contracts* (0.684), *open tendering* (0.666), *DBB* (0.657), *multiple criteria selection* (0.656), *private sector funds* (0.626), *DB* (0.579), and *Construction management/general contractor* method (0.562). This component confirms that priority should be given to choosing the right tendering and contractual techniques in each setting for SBC projects. Sustainability requirements/objectives should be integrated into contract specifications and emphasised in tender evaluations and selections (Ogunsanya, 2018). The three top-ranked variables in this component suggest that technical expertise, quality of workmanship and focus on delivery are highly recommended for the SBC projects. The findings, therefore, correspond with the hypothesis of this study. Also, the findings correspond with Riso and Trinidad (2024) who affirm that *selective tendering* can be advantageous for quality control, efficiency, risk reduction and innovation in SBC project delivery. Ellis et al. (2021) further underscore that *negotiated tendering* will improve the value and quality of SBC projects because the emphasis is not on the lowest bid. McKinsey and Company (2023) also propose that *targeted*

TABLE 4 Rotated component matrix for PDS.

Variable	Component			Eigen value	% Of variance
	1	2	3		
Usage of the selective tendering method	0.833			9.499	49.995
Usage of negotiated tendering method	0.812				
Usage of targeted procurement method	0.772				
Usage of lump sum contracts	0.691				
Usage of cost-reimbursable contracts	0.684				
Usage of open tendering method	0.666				
Traditional project delivery system (Design-Bid-Build)	0.657				
Usage of multiple criteria selection method	0.656				
Usage of private sector funds	0.626				
Design and build system	0.579				
Construction management/general contractor method	0.562				
Collaboration of project participants		0.758		1.767	9.297
Early involvement of stakeholders		0.747			
Client needs assessment		0.713			
Delivery methods with a single contracting point		0.697			
Public-private partnerships			0.732	1.191	6.267
Turnkey system			0.724		
Usage of government budgetary allocations			0.659		
Cronbach's alpha	0.932	0.820	0.766		

procurement is conducive to strategically integrating environmental, social and economic considerations into the procurement process. However, SA has been fraught with many challenges regarding sustainable tendering. One of the key challenges is budgetary constraints that limit public procurement leading to an emphasis on cost rather than sustainability in tendering processes (Ambe and Badenhorst-Weiss, 2012). This challenge often leads to the selection of cheaper, less sustainable options. For instance, the pressure to meet short-term financial targets limits the capacity to integrate sustainability goals, such as environmental protection and social inclusion, into the tendering process (Mothibi, 2020; Caswell, 2021).

The findings on contractual techniques such as *lumpsum* and *cost-reimbursable contracts* tally with Hashem et al. (2018) and Landau (2021). Hashem et al. (2018) posit that a lumpsum contract is beneficial when used with a clearly defined project scope as it provides predictability to the client and contractor. This implies that project specifications and requirements for the use of sustainable building techniques, energy-efficient systems, environmentally friendly materials, etc. should be clearly stipulated to avoid incurring unforeseen expenses. Conversely, *Cost-reimbursable* was preferred to lumpsum by Landau (2021) due to its flexibility, allowing modifications which is advantageous when using novel or experimental sustainable technologies. The findings also revealed that *open tendering* is a vital factor in SBC as it may incentivise contractors to present their best deals and solutions, resulting in the completion of projects at a reasonable cost (Gamage, 2023). *DBB, DB*, and *construction manager/general contractor* methods were also acknowledged as influencing factors. *DBB* although was the lowest ranked in Table 1 and has been criticised for creating silos among project participants had some significance. According to Mollaoglu-Korkmaz et al. (2013), *DBB* has a reasonable chance of offering enough degrees of integration for achieving sustainability goals if the contractor is participating informally. However, *DB* and construction manager at risk (CMAR)/general contractor were affirmed to have less cost growth and can guarantee cost certainty than *DBB* (Antoine et al., 2019). Furthermore, Hanifi's (2024) findings demonstrate that both Design-Build and CMAR considerably improve project efficiency, promote stakeholder communication, and reduce the incidence of contractual conflicts. However, some challenges hinder the selection of the right contractual techniques in SA. For instance, there is political interference, especially in public procurement for infrastructure delivery, which can lead to corruption (Bangani, 2024). Corruption frequently results in contracts being given to suppliers that do not fulfill sustainability standards or who show little consideration for the effects their operations have on society and the environment (Munzhedzi, 2016). Consequently, public mistrust of government procurement procedures rises, undermining initiatives to support sustainable contracting practices (Munzhedzi, 2016). Other challenges include lack of skills and training and poor cash flow management to manage contracts effectively and competitively, especially among emerging contractors (Bangani, 2024).

5.2 Component 2 - integrated project delivery

This involved four variables, namely, "collaboration of project participants" (0.758), "early involvement of stakeholders" (0.747), "client needs assessment" (0.713), and "delivery methods with a single contracting point" (0.697). The study's hypothesis is supported by the attention placed on these factors, demonstrating their significance. These variables are essential principles of integrated project delivery. *Collaboration of Project Participants* as the top-ranked in this component corresponds with Miller (2024), who confirmed its vitality for creating a pathway for sustainable construction methods by encouraging open communication and common goals among all project stakeholders early on. This implies that collaboration can stimulate early ingenuity and innovative approaches to optimise resource efficiency, reduce environmental impact, and enhance building performance throughout their lifetime for SBC projects in SA (Miller, 2024). Similarly, the results concerning the *early involvement of stakeholders* in this component and Table 1 provide evidence of its cruciality for SBC and tallies with the study's hypothesis. It supports Bal et al. (2013) findings that the early involvement of all the project stakeholders improves the decision-making process and fosters the attainment of sustainability initiatives in construction projects. The results are likewise in line with those of Ferme et al. (2018), who emphasised the importance of early contractor involvement in assisting the principal contractor as well as trade contractors in collaborating directly with other stakeholders to guarantee the accomplishment of green credentials. Othman and El-Saeidy (2024) further confirmed that early supplier involvement can reduce construction waste during the design process.

The revelation regarding *Client needs assessment* in this study aligns with Babalola and Harinarain (2024) who stressed the importance of keeping policies simple to clearly understand clients' and end users' expectations to strategically implement sustainable construction practices. The finding also corroborates with Folorunso and Awodele (2015) who posit that this area has been neglected and should be given proper diligence. This, therefore, corresponds with the study's hypothesis that a client's needs assessment is essential for SBC project delivery. On another note, *delivery methods with a single contracting point* align with the study's hypothesis to influence SBC. It was avowed to enhance project efficiency and streamline the process when it comes to sustainable construction (Hashem et al., 2018; Gunhan, 2019). This approach enables clear accountability and easy management of project risks ensuring that sustainability objectives are effectively actualised (Babalola et al., 2024).

However, this component does not come without a challenge. Inter-alia, juggling the interests of multiple parties, such as private investors, business forums, and local communities, can make decision-making more difficult and result in delays and cost overruns if not properly managed (Department of Public Works, 2024). Hence, effective management of diverse teams and contractors is crucial for mitigating risks such as poor quality of works, cost overruns, and project cancellations (DPW, 2024). These difficulties show that to increase the sustainability and effectiveness of Integrated Project Delivery in SA, comprehensive measures are required.

5.3 Component 3 – sustainable public and private financing

This comprised three variables, namely, "public-private partnerships" (0.732), "turnkey system" (0.724), and "usage of government budgetary allocations" (0.659). This component sheds light on the vitality of public and private procurement. The results regarding public-private partnerships are consistent with Akomea-Frimpong et al. (2023). Private partners can be motivated to meet or exceed sustainability goals due to payments usually connected to performance metrics (Wu, 2017). However, proper measures should be taken to address the critical challenges of PPPs such as political support, the private sector's financial strength and risk allocation (Almeile et al., 2024). Nonetheless, access to private-sector financing can make room for increased investment in public infrastructure without the need for governments to raise additional funds (Liu et al., 2024). Moreover, the expertise and incentives of the private sector can result in more efficient and timely project delivery, improving total value for money (Wu, 2017; Liu et al., 2024). The findings also revealed that a turnkey system is beneficial for sustainable public and private financing. For instance, the possibility of cost overruns is decreased since the cost is established upfront, which is advantageous for public projects with constrained budgets (Lesniewski and Berkebile, 2020; RDash, 2024). Because the contractor handles all aspects of the project, including legal and technical complexities, turnkey can lead to time efficiency and reduce hassle for public officials, allowing them to focus on other priorities. This further provides value for money. On the other hand, the findings revealed that the *usage of government budgetary allocations* is critical for SBC project delivery. Proper budgetary allocations guarantee that public funds are used wisely to accomplish intended results (Ogunsanya, 2018). This entails thorough project proposals tailored to specific sustainability goals, objectives, and anticipated results.

Generally, challenges to implement Sustainable Public and Private financing are similar with the ones mentioned in component 1, which includes the issue of balancing the interest of various stakeholders, poor project management coordination, regulatory hurdles and so on. Addressing these challenges requires coordinated efforts from the government, private sector, and international organisations to create a stable and supportive environment for sustainable investments.

6 Practical implications and recommendations

The practical consequences of this study come from its capacity to give stakeholders and decision-makers insight into the principal PDS component to propel SBC project delivery in SA. It is affirmed that the consciousness of the three components will stir positive measures to improve project delivery in SA towards meeting sustainability objectives. Hence, construction practitioners and stakeholders are advised to prioritise the principal factors diligently. Additionally, being aware of the factors connected to the main components will enable the SACI practitioners and stakeholders to make informed decisions in choosing the best strategy for SBC projects in any given setting. The study recommends adequate knowledge sharing to keep clients informed on the characteristics of each PDS and its applicability to SBC projects. This will curb the difficulties in procurement leading to the adoption of the best practices and methods.

Moreover, the findings on *Sustainable Tendering and Contracting* imply that priority should be given to the incorporation of sustainability criteria into contract specifications/conditions. Sustainability should be emphasised in the evaluation and selection of tenders. Tenderers may be urged to provide creative concepts and solutions to advance sustainability objectives. Similarly, the study recommends the adoption of *Integrated Project Delivery* for SBC projects. There is a need to shift from traditional delivery methods to more collaborative project delivery (Babalola et al., 2024). Contractors and key stakeholders should be involved early in the project for better decision-making and transparency in design and construction. With IPD project risk can be shared and reduced, and resources can be optimised leading to cost savings and efficiency (Othman and El-Saeidy, 2024). Besides, project participants should always have streamlined communication to mitigate misunderstandings, disputes and project delays. There is also an interdependence between the IPD, and modern building techniques like building information modelling (BIM) and lean construction which can help to foster collaboration, design efficiency and waste minimisation (Emere et al., 2024; Rashidian et al., 2024). Additionally, by utilising IPD or collaborative project delivery, uncertainties in construction projects may be controlled more effectively by project parties resulting in better project results and client/stakeholder satisfaction.

Furthermore, *sustainable public and private financing* revealed in this study implies that the SACI practitioners, policymakers and the government should create strategic means for funding SBC projects. There should not be overreliance on one funding agency and foreign companies. Hence, public and private funding alternatives can be adopted (Agyekum et al., 2021). The public and private sectors are required to work hand in hand to foster the implementation of the SBC project in the SACI. Similarly, policymakers in the built environment should incorporate the provision of incentives for contractors or suppliers who are diligent in incorporating sustainable principles in their modus operandi. Adequate resources should be mobilised to procure sustainable materials and innovative technologies for efficient SBC project delivery. Researchers, industry experts, and policymakers can use this study as a roadmap to help them in their coordinated, cooperative, and strategic efforts to identify the principal PDS to actualise successful SBC project delivery. Successful SBC project delivery will immensely contribute to the attainment of sustainable development objectives and the provision of affordable, sustainable housing for the whole of SA.

7 Conclusion

SBC project delivery is anticipated to revolutionise the CI operations in SA. Several strategies for its deployment have been revealed. Respondents with a questionnaire survey evaluated the measuring variables in order of criticality. The strategies were grouped into three principal components: *Sustainable Tendering and Contracting*, *Integrated project delivery and Sustainable Public and Private Financing.* These components provide structure on respondents' opinions on the approaches to the SBC projects in SA.

This study contributed theoretically by exploring the PDS for SBC projects in the SACI, which has not been done. This was done to improve SBC project delivery. It also added to the conversation on SBC in SA and provided a strong theoretical framework for additional research. To the authors' knowledge, this is one of the most recent South African studies offering PDS insights for SBC project deployment. Consequently, the study shed light on the principal PDS that construction companies should prioritise to enhance the delivery of SBC projects. Methodologically, the PCA technique was used to reveal the principal PDS of SBC project delivery in SA. Therefore, the findings added to knowledge by revealing *Sustainable Tendering and Contracting*, *Integrated project delivery and Sustainable Public and Private Financing* as fundamental PDS components for the SBC project delivery in SA. This study, therefore, fosters knowledge sharing among construction stakeholders on the efficacy of choosing the right delivery strategy. This study *inter alia* recommended capacity building and skill development especially among emerging contractors, corruption mitigation as well as adequate budgetary allocations especially in public procurement.

However, this study has some limitations. This study predominantly considered built environment professions in Gauteng, SA. Future studies may accommodate other provinces to have a broader view of the subject. Similarly, this study's findings may not be generalised to other developing countries. Furthermore, this study used PCA to group the PDS variables, capturing only the most significant variance in the data. Consequently, confirmatory factors analysis may be used to further clarify the respondents' opinions on the approaches for SBC projects in SA.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

The studies involving humans were approved by Faculty of Engineering and the Built Environment Ethics Committee, University of Johannesburg, South Africa. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

CE: Conceptualization, Funding acquisition, Methodology, Writing–original draft, Writing–review and editing. CA: Conceptualization, Methodology, Supervision, Writing–review and editing. OO: Methodology, Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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