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Evaluating Challenges in Implementing SDG 7 in Existing Buildings in Johannesburg

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Abstract

This study investigates barriers to effective energy management in existing buildings within Johannesburg, South Africa, in the context of Sustainable Development Goal 7 (SDG 7). Despite policy commitments and growing awareness, energy-efficiency implementation in existing buildings remains limited, indicating a gap between policy intent and practical execution. The study adopts a quantitative research approach, using a structured questionnaire distributed to construction professionals at 10 selected companies. Data were analyzed using Mean Item Score (MIS) and standard deviation to identify and rank key barriers. The findings reveal that inadequate investment in clean energy, continued reliance on fossil fuels, and high energy costs are the most critical constraints affecting energy management in buildings. Additional barriers include regulatory inefficiencies, skills shortages, and low stakeholder awareness. The consistency of responses suggests systemic challenges rather than isolated issues. The study contributes by reframing SDG 7 implementation challenges as an energy management problem and provides context-specific insights for developing economies. The paper recommends strengthening financial mechanisms, improving regulatory enforcement, enhancing technical capacity, and promoting Public-Private Partnerships (PPPs) to improve energy management practices. These interventions are essential to bridge the gap between sustainability policy and real-world implementation in the built environment.

Keywords
Sustainable Development Goal 7 (SDG 7), Energy Efficiency, Sustainability, Renewable Energy, Construction

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1. Introduction

Achieving United Nations Sustainable Development Goal 7 (SDG 7) requires overcoming persistent challenges in providing affordable, reliable, sustainable, and modern energy, especially in countries like South Africa, where power shortages, aging infrastructure, and limited funding hinder progress. Existing buildings account for most energy use in the built environment, so improving their efficiency is critical. In cities like Johannesburg, the adoption of sustainable energy is further hampered by rapid population growth, rising energy demand, and frequent power cuts. While new buildings often incorporate energy-saving technologies, retrofitting older buildings faces technical, financial, and regulatory obstacles. Insufficient investment, limited stakeholder awareness, and fragmented policies worsen these challenges. This study focuses on addressing these barriers in the construction sector, where closing the gap between national plans and real action for existing buildings is essential. Gaining insight from construction professionals is crucial to identifying practical solutions.

Despite various policy initiatives, the main challenge to implementing SDG 7 in South Africa's existing buildings persists: low investment in renewables and slow technological integration. This study focuses on identifying these persistent financial and regulatory barriers from the perspectives of construction professionals in Johannesburg, aiming to deliver evidence-based insights to overcome them. Moreover, this study contributes to the existing body of knowledge by providing empirical evidence from construction professionals in Johannesburg and offering context-specific insights into barriers to SDG 7 implementation in developing environments.

1.1 Objectives

The objective of this study is to identify and examine the key barriers to implementing UN SDG 7 in existing buildings. This involves exploring the financial, technical, regulatory, and institutional challenges that hinder the adoption of energy-efficient and sustainable practices within the built environment. The study further seeks to explore how these barriers affect the transition to affordable, reliable, and modern energy systems within existing infrastructure, with the aim of informing strategies to enhance energy efficiency and support the implementation of sustainable energy.

2. Literature Review

The global transition toward sustainable energy has positioned the building sector at the center of climate action and development. Buildings account for approximately 40% of global energy consumption and contribute significantly to greenhouse gas emissions, making them a critical focus for sustainability efforts (Jagarajan et al., 2017). SDG 7 aims to ensure access to affordable, reliable, and modern energy by 2030, while also increasing the share of renewable energy and improving energy efficiency (Salimon et al., 2025).

In South Africa, these challenges are intensified by structural energy constraints, including a heavy reliance on coal-fired power generation, persistent electricity shortages, and deep socio-economic inequalities, all of which continue to hinder the adoption of energy-efficient solutions. Coal still accounts for approximately 80% of electricity generation, while ongoing capacity limitations and aging infrastructure contribute to recurring supply instability and load shedding (OECD, 2025; ASSAf, 2023). Furthermore, the country's prolonged electricity crisis, characterized by frequent outages and system unreliability, has significantly constrained economic activity and energy transition efforts (Energy Policy, 2025). These systemic challenges reinforce earlier findings on structural inefficiencies in the energy sector (Milford, 2009), highlighting the continued difficulty of achieving effective energy management in the built environment.

Recent studies highlight that financial constraints, regulatory inefficiencies, technological limitations, and low stakeholder awareness collectively undermine energy efficiency in buildings (Oguntona et al., 2023; Okorafor et al., 2021; Idowu et al., 2024). These barriers do not operate independently but interact to weaken energy planning, implementation, and monitoring processes. Therefore, the literature suggests that the core challenge is not only the adoption of sustainable technologies but the failure of integrated energy management systems in existing buildings.

2.1 Financial Barriers

Financial constraints remain one of the most critical barriers to improving energy management in existing buildings. High upfront costs associated with energy-efficiency upgrades and renewable energy installations limit building owners' ability to invest in sustainable solutions (Oguntona et al., 2023). Retrofit projects often require substantial capital investment, making them less attractive in environments with limited access to financing. A key issue is the perceived financial risk associated with energy-efficiency projects. Financial institutions often regard these projects as uncertain due to long payback periods and unclear returns (Zhang et al., 2020). Additionally, the split-incentive problem discourages investment, as building owners bear the cost of upgrades while tenants benefit from reduced energy consumption. These dynamics weaken decision-making processes related to energy management investments.

Recent studies further emphasize that financial uncertainty and complex financing structures hinder the implementation of high-performance energy solutions such as nearly Zero Energy Buildings (Zidar et al., 2025). Similarly, the lack of accessible incentives and financing mechanisms continues to limit large-scale adoption of energy-efficient technologies (Budakov et al., 2023; Idowu et al., 2024). Although mechanisms such as energy performance contracting and green financing exist, their limited application in South Africa constrains their impact.

2.2 Regulatory and Policy Barriers

Regulatory and policy frameworks play a central role in shaping energy management practices within the building sector. In South Africa, existing standards such as SANS 204 and SANS 10400-XA provide guidance for energy efficiency; however, their enforcement in existing buildings remains inconsistent (Okorafor et al., 2021). This inconsistency creates uncertainty and weakens compliance, ultimately undermining effective energy management. A major challenge is the lack of clear and coordinated regulatory frameworks. Complex approval processes, overlapping policies, and unclear retrofit requirements delay project implementation and increase costs. Furthermore, the absence of mandatory retrofit policies means that energy-efficiency improvements are largely voluntary, thereby reducing their overall impact (Idowu et al., 2024).

In addition, bureaucratic inefficiencies and limited incentives discourage investment in sustainable energy solutions (Oguntona et al., 2023). Conflicts between sustainability objectives and other regulatory requirements, such as zoning or heritage restrictions, further complicate implementation. These issues collectively limit stakeholders' ability to implement structured and consistent energy management strategies.

2.3 Technological Challenges

Technological constraints significantly affect the implementation of effective energy management systems in existing buildings. Unlike new developments, retrofit projects must integrate modern technologies into outdated infrastructure, creating compatibility and performance challenges (Salimon et al., 2025). Older buildings often contain inefficient systems, including outdated HVAC systems, poor insulation, and limited electrical capacity. Upgrading these systems requires specialized technical expertise and careful planning to ensure compatibility with new technologies. The integration of smart energy systems and renewable energy solutions adds further complexity and cost.

Studies highlight challenges such as system integration difficulties, lack of interoperability, and the need for advanced technical skills (Iwuanyanwu et al., 2024). In the South African context, these challenges are exacerbated by a shortage of skilled professionals and limited technical capacity within the construction sector (Oguntona et al., 2023). Renewable energy integration, particularly solar photovoltaic systems and battery storage, also introduces technical and financial constraints. These challenges affect the reliability and performance of energy systems, ultimately limiting the effectiveness of energy management strategies.

2.4 Lack of Awareness and Expertise

Human capacity constraints play a critical role in shaping energy management outcomes. Limited awareness among building owners, occupants, and professionals reduces the demand for energy-efficient solutions and affects the quality of implementation (Idowu et al., 2024). Many stakeholders lack sufficient understanding of energy consumption patterns and the benefits of energy efficiency, leading to underinvestment in retrofit projects. This knowledge gap weakens decision-making processes and limits the adoption of effective energy management practices (Budakov et al., 2023).

The construction industry also faces significant skills shortages, particularly in energy-efficient design and retrofit implementation (Oguntona et al., 2023). This lack of expertise affects both planning and execution, resulting in inefficient systems and reduced performance outcomes. Efforts to address these challenges include training programs, stakeholder engagement, and awareness campaigns to improve technical capacity and knowledge. However, these initiatives remain insufficient in scale and impact.

In synthesis, lack of awareness and expertise contributes to energy management failure by limiting informed decision-making, reducing implementation quality, and constraining the adoption of efficient energy practices.

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2.5. Public-Private Partnerships (PPPs) in Driving Innovation
Public-Private Partnerships (PPPs) have emerged as a strategic mechanism to address the complex barriers affecting energy management in buildings. These partnerships combine public-sector policy support with private-sector expertise, innovation, and financing capabilities (Idowu et al., 2024). PPPs can facilitate investment in energy-efficient technologies through models such as energy performance contracting, where private entities finance and implement energy improvements in exchange for a share of the resulting savings. This approach reduces financial risk and supports the implementation of structured energy management systems.

Despite their potential, PPPs remain underutilized in South Africa due to limited institutional capacity, lack of standardized frameworks, and insufficient experience in managing such partnerships. However, their application in public buildings presents significant opportunities to demonstrate the benefits of effective energy management. In addition to financing, PPPs can support knowledge transfer, technical capacity development, and innovation, contributing to long-term improvements in energy performance.

In summary, PPPs offer a viable solution to energy management failures by integrating financial, technical, and institutional resources to enable more effective and scalable energy-efficiency interventions.

2.5. Literature Synthesis and Research Gap
The reviewed literature confirms that financial, regulatory, technological, and social barriers significantly affect the implementation of sustainable energy in buildings. However, most studies address these barriers in isolation and lack empirical validation within specific urban contexts such as Johannesburg. Furthermore, limited research explicitly links these barriers to energy management performance in existing buildings, a critical factor for achieving SDG 7.

This study addresses this gap by providing empirical evidence from construction professionals and analyzing how these barriers collectively contribute to energy management failure. By shifting the focus from general sustainability challenges to energy management performance, the study offers a more practical and context-specific contribution to the existing body of knowledge.

3. Methods
This study adopts a quantitative research design, utilizing a structured questionnaire to collect data from construction professionals. The quantitative approach was selected to measure and rank perceived barriers through statistical analysis. A purposive sampling technique was employed to select 10 construction companies involved in energy-related projects in Johannesburg. The participants comprised professionals such as project managers, engineers, and quantity surveyors with relevant industry experience. The inclusion criteria required respondents to be actively working in construction or energy-related roles, to have experience with building projects in Johannesburg, and to possess familiarity with energy-efficiency or sustainability practices. Conversely, non-construction professionals, individuals without relevant project experience, and incomplete questionnaire responses were excluded from the study. The questionnaire was developed based on barriers identified in the literature and utilized a 5-point Likert scale for responses. Content validity was ensured by aligning with existing literature, while internal consistency was assessed using Cronbach's alpha.

4. Data Collection
Data was collected using a structured questionnaire administered electronically via Google Forms. An invitation letter explaining the purpose of the study, along with a link to the questionnaire, was distributed via email to employees of the ten selected construction companies. With permission from company representatives, the questionnaire link was further shared internally through organizational communication platforms to reach relevant professionals. Participation was voluntary, and respondents were required to provide informed digital consent before completing the survey. The data collection process was conducted remotely over a specified period, allowing participants to respond at their convenience. Completed responses were automatically recorded and stored securely for subsequent analysis.

5. Results and Discussion
5.1 Descriptive Analysis (background information)
Figures 1 to 9 provide background information about the respondents. To enhance visual interpretation, histograms were generated to illustrate the distribution of responses across barrier categories. Figure 1 shows the types of

qualifications held by the respondents, with the majority holding a bachelor's degree. Figure 2 shows the professional background by job title, with the largest number of project managers. Figure 3 shows the respondents' years of experience in sustainable energy, with the majority having 0-3 years, followed by those with 4-6 years. Figure 4 shows the type of organization the respondents worked for, with the contractor being the majority. Figure 5 shows company size by number of employees, with the largest group being companies with 6-20 employees. Figure 6 shows the types of projects the organizations specialize in, with the installation of affordable and clean energy in schools, hospitals, and similar facilities being the most common. Figure 7 shows that the majority of respondents performed one project, followed by two projects. Figure 8 shows the number of projects executed by the majority of respondents, more than 13 projects, and lastly, Figure 9 shows the project value executed by the majority of respondents, ranging from 6.6 to 20 million rands.

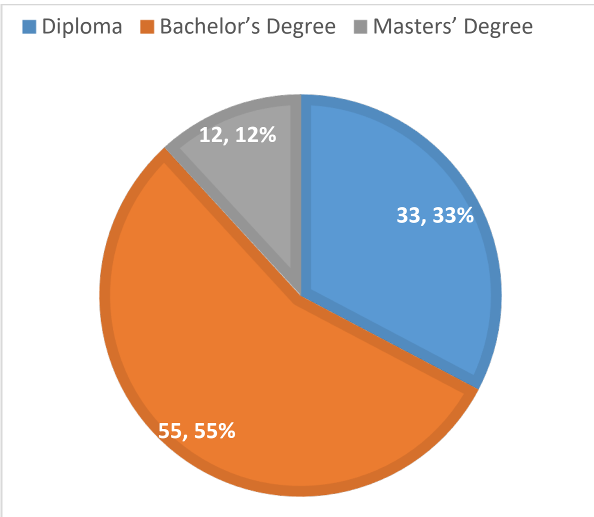

Figure 1: Type of qualification

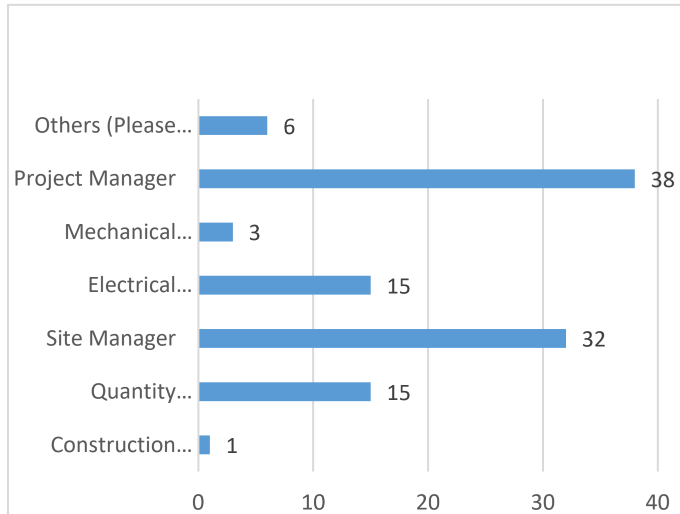

Figure 2: Professional background

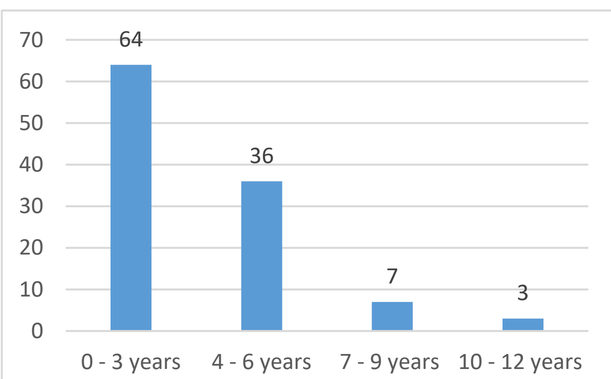

Figure 3: Years of experience

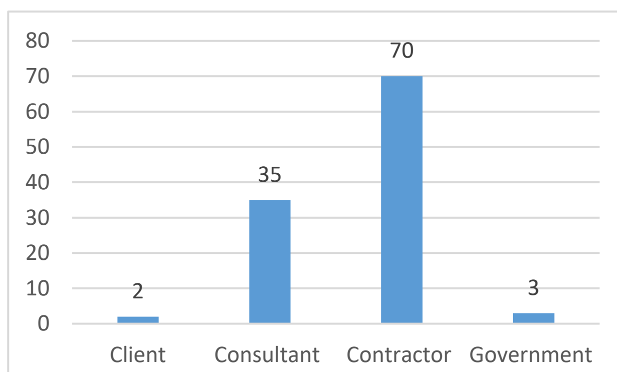

Figure 4: Types of organization

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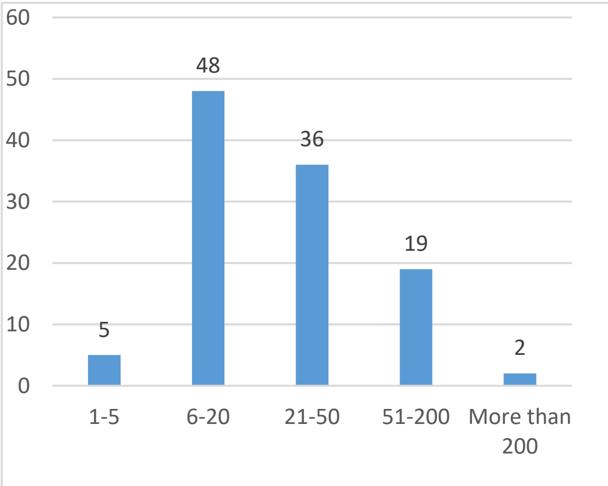


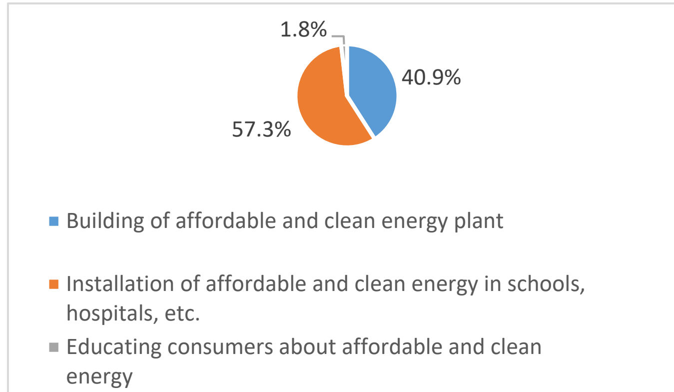
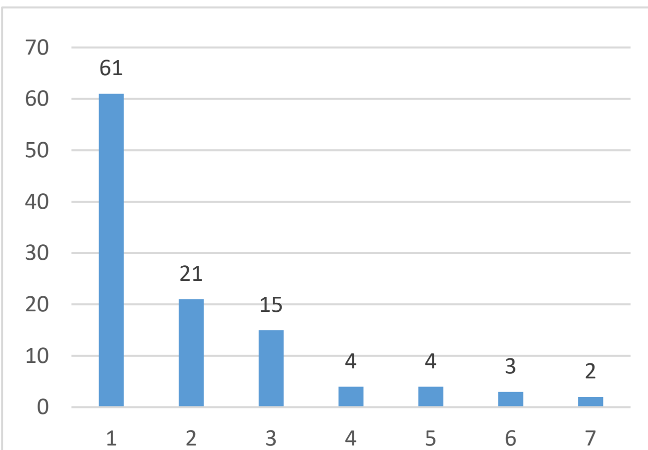


Figure 5: Company size

Figure 6: Types of Projects



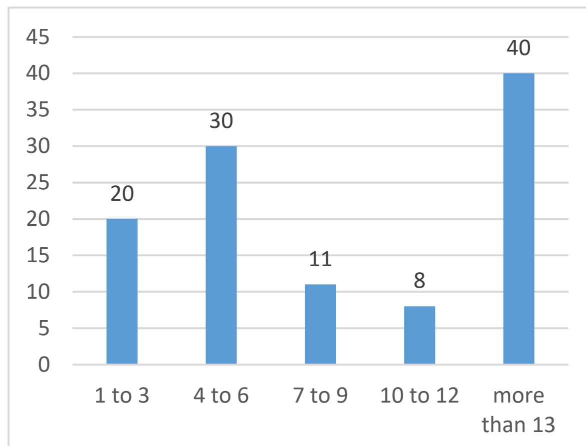


Figure 7: Number of projects

Figure 8: Number of projects executed

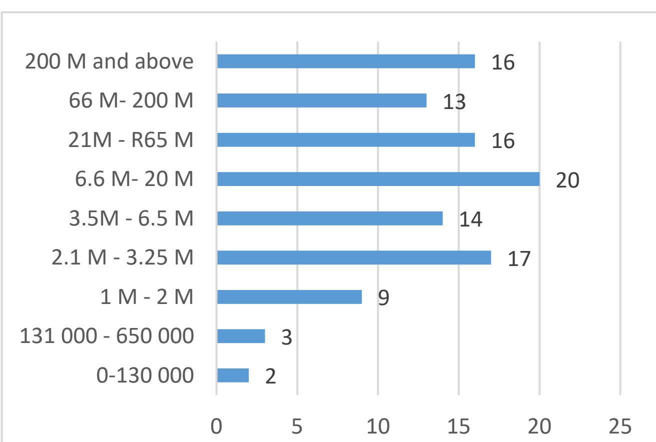


Figure 9: Project value

5.2 Analysis of the barriers to implementing SDG 7

The survey of 28 barriers to implementing sustainable energy in Johannesburg's construction sector yielded comprehensive data from professionals. The high mean scores across all variables suggest a possible response centralization bias, in which respondents rated most barriers as highly significant. Table 1 presents the complete descriptive statistics for all barriers, ranked by mean significance rating.

Table 1. Descriptive analysis for all 28 barriers

Barriers	**$\bar{x}$**	**σX**	**R**
Lack of investment in affordable and clean energy	4.65	0.724	1
Dependence on fossil fuels	4.61	0.779	2
High Energy Prices	4.56	0.953	3
Lack of Skilled labour	4.53	0.751	4
Financial constraints to projects	4.48	0.726	5
Lack of government energy subsidies	4.47	0.798	6
Lack of bureaucratic licensing and procedures	4.47	0.798	7
Lack of incentives	4.46	0.798	8
Political gridlock	4.45	0.841	9
Lack of commitment among stakeholders	4.44	0.830	10
Corruption within the construction industry	4.44	0.796	11
Lack of client demand for sustainable products or structures	4.43	0.840	12
Affordable and clean energy availability	4.43	0.760	13
Limited knowledge on affordable and clean energy	4.42	0.806	14
Policy and regulatory challenges	4.42	0.759	15
Institutional incapacities for research and development	4.41	0.902	16
Lack of awareness and information	4.41	0.870	17
Reliance on traditional biomass	4.38	0.846	18
High Taxes. duties. and customs	4.38	0.835	19
Market competition and failure	4.38	0.824	20
Prolonged implementation phase of the new practices	4.38	0.813	21
Limited availability of sustainable products	4.38	0.790	22
Poor implementation strategy	4.38	0.778	23
Public opposition to affordable and clean energy	4.35	0.971	24
High Energy poverty rate	4.35	0.840	25
Limited access to electricity	4.33	0.996	26
Stakeholders' resistance to change	4.30	0.894	27
Insufficient Infrastructure	4.28	0.910	28

Notes: $\bar{x}$ = Mean item score; σX = Standard deviation; R = Rank`

All 28 barriers received mean ratings above 4.28 on the 5-point scale, indicating that construction professionals perceive them as significant obstacles to implementing sustainable energy. The narrow range of mean values (4.28-4.65) suggests that multiple barriers operate simultaneously rather than a single dominant obstacle. The top five barriers span three of the four categories, with Economic/Financial barriers (3 of the top 5) and Political/Governance

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barriers (1 of the top 5) featuring most prominently. Notably, the highest-rated barrier-lack of investment in affordable and clean energy (mean = 4.65)-directly relates to SDG 7 objectives and reflects the fundamental challenge of mobilizing capital for sustainable energy projects. Standard deviations ranged from 0.724 to 0.996, indicating moderate variability in professional perceptions.

5.3 Thematic Clustering

To identify underlying thematic structures within the 28 barriers, a factor analysis approach was employed. Thematic Categorization, on the barriers were grouped into four theoretically grounded categories based on their conceptual nature and alignment with established frameworks in the sustainable building literature (Table 2):

1. Economic/Financial: Barriers related to costs, investment, financing, and economic incentives
2. Political/Governance: Barriers related to policy, regulation, governance structures, and institutional frameworks
3. Technical/Infrastructure: Barriers related to technology, infrastructure, skills, and technical capacity
4. Social/Behavioural: Barriers related to awareness, attitudes, stakeholder engagement, and behavioural factors

Table 2: Summary statistics by barrier category

Category	**Number of Barriers**	**Average Mean**	**Average SD**	**Mean Range**
Economic/Financial	8	4.466	0.812	4.35-4.65
Political/Governance	6	4.462	0.792	4.38-4.61
Social/Behavioral	6	4.392	0.868	4.30-4.44
Technical/Infrastructure	8	4.390	0.846	4.28-4.53

Economic/Financial and Political/Governance categories show the highest average ratings (4.466 and 4.462, respectively), indicating that construction professionals perceive economic and governance-related barriers as the most significant obstacles. The difference between the highest-rated category (Economic/Financial) and the lowest-rated category (Technical/Infrastructure) is only 0.076 points, suggesting that all four barrier types are perceived as similarly significant. Social/Behavioural barriers exhibit the highest average standard deviation (0.868), indicating greater variability in professional perceptions of these obstacles than in other categories. Political/Governance barriers show the lowest average standard deviation (0.792), suggesting a stronger consensus on the significance of policy and governance challenges. These findings align with the "split incentive" problem identified in the literature, where upfront costs deter investment despite long-term savings (Milford, 2009; Zhang et al., 2020). The prominence of subsidy and incentive-related barriers (ranks 6 and 8) highlights the critical role of government financial support mechanisms in enabling sustainable energy adoption. The distinction of corruption (rank 11, mean = 4.44) as a significant barrier is particularly noteworthy in the South African context, where governance challenges have been widely documented, including regulatory coordination, policy alignment, and institutional capacity constraints. This finding aligns with literature emphasizing the importance of transparent, accountable governance structures for sustainable development (Idowu et al., 2024). The higher variability in this category (average SD = 0.868) suggests that professional experiences with social and behavioral barriers vary more widely than with economic or political barriers. This may reflect differences in project types, client profiles, or organizational contexts. The prominence of awareness and knowledge barriers (ranks 14 and 17) aligns with literature emphasizing the critical role of education and capacity building in sustainable building transformation (Idowu et al., 2024; Oguntona et al., 2023). The prominence of skilled labor shortages aligns with literature documenting the need for technical capacity building in South Africa's construction sector (Idowu et al., 2024; Oguntona et al., 2019). The relatively high CV values for infrastructure-related barriers (21-23% for ranks 26 and 28) suggest varying professional experiences with infrastructure constraints, potentially reflecting differences between well-served and underserved areas within Johannesburg.

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5.4 Proposed Improvements

Based on the survey findings and supporting literature, this section presents improvement strategies organized by the four barrier categories. Each category includes specific, actionable interventions designed to address the identified obstacles while recognizing the interconnected nature of barriers across categories.

5.4.1 Economic/Financial Interventions

Economic and financial barriers, rated the most significant category (mean = 4.466), require comprehensive interventions spanning investment mobilization, risk mitigation, and incentive design. The top-ranked barrier- lack of investment in affordable and clean energy-requires innovative financing mechanisms that address the unique characteristics of sustainable energy projects, including high upfront costs, long payback periods, and split incentives. Zhang et al. (2020) demonstrated that dedicated green financing mechanisms significantly increase the adoption of building energy retrofits in Western China. Seeley (2012) advocated for innovative financing that shifts away from traditional paradigms to enable energy-efficiency investments. Antonini et al. (2014) identified ESCOs as effective mechanisms for overcoming financial barriers in building energy efficiency, particularly in public-private partnership contexts. This mechanism has been successfully implemented in various international contexts and addresses the financial constraints barrier to projects (rank 5) by eliminating upfront capital requirements.

The high ratings of "lack of government energy subsidies" (rank 6) and "lack of incentives" (rank 8) indicate that market forces alone are insufficient to drive sustainable energy adoption, necessitating government intervention. Budakov et al. (2025) emphasized the need for "simple and attractive state incentives" to overcome financial barriers in building renovation. Milford (2009) recommended government leadership to incentivize energy efficiency in the South African building sector. Performance-based approaches address the risk of "greenwashing" and ensure that financial incentives translate into actual sustainability outcomes (Terblanche et al., 2020). The barriers of "market competition and failure" (rank 20) and "high energy prices" (rank 3) reflect market imperfections that require strategic intervention. Develop insurance products that guarantee energy savings from efficiency investments, reducing perceived risk for building owners and lenders. This addresses the "high perceived business risk" identified by Milford (2009). Work with the real estate and financial sectors to develop standardized methodologies for valuing energy efficiency in building appraisals, addressing the underestimation of lifecycle cost benefits identified by Milford (2009). Carlson (2018) demonstrated that energy-efficiency retrofits create measurable value in commercial office buildings, but these benefits must be captured in valuation methodologies to influence investment decisions.

5.4.2 Political/Governance Reforms

Political and governance barriers, rated nearly as high as economic barriers (average mean = 4.462), require comprehensive policy reforms, regulatory streamlining, and governance strengthening. The barriers of "policy and regulatory challenges" (rank 15), "poor implementation strategy" (rank 23), and "dependence on fossil fuels" (rank 2) indicate the need for coherent, well-implemented policy frameworks. Milford (2009) emphasized the need to "translate policy into action" in South Africa's building sector, while van Reenen et al. (2025) documented the importance of clear policy frameworks for advancing net-zero carbon building. Moreover, Milford (2009) specifically recommended the mandatory implementation of SANS 204 (the South African energy efficiency standard) as a priority action. Terblanche et al. (2020) emphasized the importance of regulatory frameworks in enabling net-zero buildings. South Africa's renewable energy potential is well documented, but regulatory barriers have hindered its adoption (Terblanche et al., 2020). Clear policy frameworks are essential for transitioning from fossil fuel dependence.

The barrier of "lack of bureaucratic licensing and procedures" (rank 7) indicates that regulatory complexity creates friction in implementing sustainable energy projects. Mansfield (2011) identified regulatory hurdles as practical obstacles to sustainable refurbishment, emphasizing the need for streamlined processes. Okorafor et al. (2021) proposed frameworks to simplify the implementation of energy retrofit projects in South Africa. The barrier of "corruption within the construction industry" (rank 11) and "political gridlock" (rank 9) indicate governance challenges that undermine sustainable energy initiatives. While not extensively addressed in the building energy efficiency literature, governance and transparency are fundamental enablers of sustainable development. Idowu et al. (2024) emphasized the government's role in creating an enabling environment for implementing sustainable buildings. Antonini et al. (2014) emphasized the importance of effective governance structures in public-private partnerships for building energy efficiency.

5.4.3 Technical/Infrastructure Development

Technical and infrastructure barriers (average mean = 4.390) require investments in human capacity, research and development, and physical infrastructure. The barrier of "lack of skilled labor" (rank 4, mean = 4.53) ranks among the highest-rated obstacles overall, indicating a critical shortage of professionals with expertise in sustainable energy.

Idowu et al. (2024) specifically recommended "training professionals" as a solution to skills shortages in low-carbon retrofitting. Okorafor et al. (2020) emphasized the need for technical capacity building in South African retrofit projects. Salimon et al. (2025) emphasized the need for technical expertise to integrate emerging technologies with legacy systems in building services. The barrier of "institutional incapacities for R&D" (rank 16) indicates a weak capacity for innovation that limits the adaptation of sustainable energy technologies to local contexts. Trencher et al. (2017) documented innovative city programs for improving the energy efficiency of existing buildings, emphasizing the importance of local innovation and adaptation. Salimon et al. (2025) discussed the challenges of integrating emerging technologies with legacy systems, highlighting the need for R&D capacity to enable successful technology adaptation.

The barriers of "insufficient infrastructure" (rank 28), "limited access to electricity" (rank 26), and "affordable and clean energy availability" (rank 13) reflect constraints on sustainable building operations. Terblanche et al. (2020) emphasized infrastructure requirements for implementing and operating net-zero buildings in South Africa. The barriers posed by limited electricity access and insufficient infrastructure reflect South Africa's broader infrastructure challenges, which disproportionately affect underserved communities. Addressing these barriers is essential for an equitable, sustainable energy transition.

5.4.4 Social/Behavioral Change Strategies

Social and behavioral barriers (average mean = 4.392) require interventions that address awareness, attitudes, and stakeholder engagement. The barriers of "lack of awareness and information" (rank 17), "limited knowledge on energy" (rank 14), and "lack of client demand for sustainable products" (rank 12) indicate significant knowledge gaps and awareness deficits. Idowu et al. (2024) recommended "client enlightenment" as a solution to awareness barriers in low-carbon retrofitting. Oguntona et al. (2023) emphasized the need to address awareness deficits in the adoption of smart solutions. Budakov et al. (2025) identified "insufficient understanding of energy consumption and savings" as a major barrier, emphasizing the need for stakeholder education. The barrier of "lack of client demand for sustainable products" (rank 12) indicates that market demand is insufficient to drive sustainable energy adoption without intervention. Mandatory disclosure requirements create market transparency and stimulate demand for energy-efficient buildings. Carlson (2018) demonstrated that energy efficiency creates measurable value in commercial buildings, but this value must be visible to market participants. Trencher et al. (2017) documented the effectiveness of demonstration projects in innovative city programs for building energy efficiency.

The barriers of "lack of commitment among stakeholders" (rank 10) and "stakeholders' resistance to change" (rank 27) indicate the need for strategies that build buy-in and overcome inertia. D'Oca et al. (2018) emphasized the importance of addressing "differing interests among building owners and users" through stakeholder engagement processes. Community engagement and social influence are important drivers of behavioral change in sustainable energy adoption, addressing the barrier of public opposition (rank 24).

5.5 Literature Validation

The survey's identification of economic and financial barriers as the most significant obstacle category is strongly supported by literature across multiple contexts. The top-ranked barrier-lack of investment in affordable and clean energy- directly corresponds to findings from Zhang et al. (2020), who identified financing difficulties as the primary obstacle to building energy retrofits in Western China. Similarly, Zidar et al. (2025) emphasized financial challenges and risk assessment as the most critical factors affecting the achievement of nearly Zero Energy Building (nZEB) standards in deep energy renovation projects. In the South African context, Idowu et al. (2024) identified financial issues and high retrofitting costs as key barriers to low-carbon retrofitting of educational buildings. The high rating for "lack of government energy subsidies" (rank 6) aligns with the literature emphasizing the critical role of financial incentives in enabling the adoption of sustainable building. Budakov et al. (2025) identified "lack of simple and attractive state incentives" as a major barrier in European contexts, while Seeley (2012) advocated for innovative financing mechanisms to shift the traditional paradigm for building energy-efficiency investment.

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The survey's political/governance findings align closely with the literature on regulatory and institutional obstacles. The second-highest-ranked barrier overall, dependence on fossil fuels, reflects South Africa's structural energy challenge. Milford (2009) documented that South Africa's coal-dependent energy system creates path dependency that hinders the transition to renewable energy. This finding is particularly relevant given South Africa's ongoing electricity supply challenges and the slow pace of renewable energy integration. The survey's identification of "poor implementation strategy" (rank 23) and "policy and regulatory challenges" (rank 15) aligns with Milford's (2009) emphasis on the need to "translate policy into action" in South Africa's building sector. The gap between policy intent and implementation effectiveness is a recurring theme in South African sustainable building literature (Terblanche et al., 2020; van Reenen et al., 2025).

The survey's social and behavioral findings align with the literature, emphasizing the human dimensions of sustainable building transformation. Stakeholder Commitment and Demand: The top-ranked social barrier, lack of commitment among stakeholders (rank 10), aligns with findings from D'Oca et al. (2018), who identified "differing interests among building owners and users" as a major obstacle to deep building renovation in European contexts. The closely related barrier of "lack of client demand for sustainable products" (rank 12) reflects the market demand challenges documented by Oguntona et al. (2019) in South Africa.

The survey's technical and infrastructure findings align with literature on capacity and technology challenges. The fourth-highest-ranked barrier, overall, the lack of skilled labour, is extensively documented in South African literature. Idowu et al. (2024) identified "lack of skilled workers" as a key barrier to educational building retrofitting. Oguntona et al. (2019) emphasized skills deficits in South African building energy efficiency. Okorafor et al. (2020) documented the need for technical capacity building in retrofit projects. This finding reflects broader skills challenges in South Africa's construction sector. The survey's identification of institutional incapacities for R&D (rank 16) aligns with literature emphasizing the importance of research and innovation capacity. Salimon et al. (2025) discussed the challenges of integrating emerging technologies with legacy systems in electrical building services, highlighting the need for R&D capacity to adapt technologies to local contexts. Lastly, the survey's identification of insufficient infrastructure (rank 28) and limited access to electricity (rank 26) as barriers reflects South Africa's specific infrastructure challenges. While these barriers ranked lower than others, they represent fundamental constraints particularly relevant to underserved areas within Johannesburg.

The study findings were validated through comparison with existing literature. The consistency between empirical findings and previous studies confirms the reliability of the identified barriers. Additionally, the relatively low standard deviation values indicate agreement among respondents, strengthening the credibility of the results. However, the small sample size remains a limitation.

6. Conclusion

This study provides empirical insight into barriers affecting energy management in existing buildings in Johannesburg. While the findings align with existing literature, the study is limited by its sample size and reliance on descriptive analysis. Future research should incorporate larger datasets and advanced statistical techniques, such as regression or structural equation modeling, to enhance analytical depth.

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