

Making the case for sustainable buildings: Evidence from the limitations of conventional buildings

John Smallwood¹, Lungelo Dube² and Eric Simpeh³

¹⁻³Department of Construction Management, Nelson Mandela University, South Africa

DOI: 10.36108/cbpm/2026.0155

Abstract

Existing buildings face environmental, economic, and health-related challenges due to traditional construction methods, and the slow adoption of sustainable practices. The study investigates the impact this has on operating costs, marketability, indoor environmental quality (IEQ), and interior material durability for buildings in the Nelson Mandela Bay Metropole (NMBM). The quantitative approach entailed administering a Likert-type scale questionnaire among 65 East Cape Master Builders Association (ECMBA) general contractor (GC) members. The 21 surveys returned, resulted in a 32.3% response rate. The findings indicate that existing conventional buildings perform poorly compared to sustainable buildings in terms of operating costs, marketability, IEQ, and interior material durability. High operating costs were primarily attributed to inefficient occupant behaviour, frequent repairs or replacement of building systems, and dependence on grid electricity. The primary factors associated with reduced marketability include lower resale / rental value, outdated design or lack of modern visual appeal, and overall energy efficiency of the building. High internal humidity levels leading to dampness or mould, ventilation rate and air circulation, and inconsistent indoor thermal comfort were factors linked to IEQ and occupants' health in existing conventional buildings. Recommendations include targeted policy intervention, improved regulatory enforcement, and increased industry awareness to accelerate sustainable practices.

Keywords: Conventional buildings, Energy efficiency, Indoor Environmental Quality, Lifecycle performance, Sustainable buildings

1 Introduction

Buildings contribute significantly to global energy consumption and environmental degradation, accounting for approximately 40% of global energy use (Aridi & Yehya, 2022). In developing countries, this impact is intensified by continued reliance on conventional construction practices and slow adoption of sustainable transformation practices. As urbanisation and energy demand rises, existing conventional buildings are increasingly associated with high operating costs, declining market value, deteriorating IEQ, and harmful impacts on occupant health.

The construction industry is recognised as a major contributor to environmental degradation (Olubunmi, Xia & Skitmore, 2016), prompting a growing emphasis on sustainable construction practices (Aigbavboa, Ohiomah & Zwane, 2017). While energy efficient designs and sustainable construction approaches have demonstrated clear economic, environmental, and social benefits (Malik *et al.*, 2025), their implementation in developing countries remains slow due to high upfront costs (Du Plessis, 2007; Chipade *et al.*, 2025).

The aim of this study is to examine the economic, market, health, and material performance limitations of

existing conventional buildings in the NMBM, with the objective of generating evidence-based insights to support the adoption of non-demolition sustainable transformation practices, with a specific focus on factors contributing / influencing operating costs, marketability, IEQ, and interior material durability.

The paper proceeds by discussing the literature reviewed relative to the subject area, then outlines the research method adopted, next is presentation and discussion of the empirical findings, and concludes with the practical and policy-oriented recommendations to advance sustainable transformation of existing conventional buildings in the context of developing countries.

2 Literature Review

2.1. Energy Inefficiency and Escalated Operating Costs in Conventional Buildings

Energy inefficiency is a major limitation of conventional buildings, especially in developing countries experiencing rapid urbanisation (Nkini *et al.*, 2023; Zhang *et al.*, 2019). Global urbanisation is projected to be 68% by 2050, despite that many buildings continue to rely on outdated systems with minimal integration of energy-efficient technologies (Shuja, Gardezi & Idrees, 2021; Berardi, 2017). A

¹ Corresponding Author

Email address: john.smallwood@mandela.ac.za

study conducted by Nasr *et al.* (2023) and Cheekatamarla *et al.* (2022) revealed that conventional buildings are characterised by inefficient building envelopes, poor thermal performance, inadequate insulation, over-reliance on energy-intensive heating, ventilation and air conditioning (HVAC) systems, and limited integration of renewable energy technologies. For this reason, these buildings consume a lot of energy that translates into escalated operating costs throughout the building life cycle (Islam *et al.*, 2015). Another critical concern is occupant behaviour. Previous studies indicate that inefficient usage patterns can account for substantial energy waste, even in unoccupied buildings (Delzendeh *et al.*, 2017). While technologies such as smart HVAC systems and lighting systems can improve efficiency (Chen *et al.*, 2021), the gap between predicted and actual energy use in buildings suggests that behavioural factors remain insufficiently addressed.

Alberini (2018) opines that energy inefficiency directly causes an upsurge in utility costs through higher electricity and fuel consumption. Consequently, end-users are supposed to spend more on cooling, lighting, ventilation, and equipment operation to achieve desired comfort levels. In developing countries, the situation is exacerbated by higher electricity tariffs due to energy supply constraints and infrastructure deficits. Hence, inefficient buildings impose significant financial burdens on households and businesses. Consequently, sustainable interventions have demonstrated the potential to significantly reduce energy consumption, with reported savings of up to 40% in some contexts (Berardi, 2017; Nkini *et al.*, 2023). However, these findings reflect ideal conditions and do not account for real-world constraints in developing countries.

2.2 Marketability and Building Performance in Evolving Property Markets

Sustainability increasingly influences building valuation and market performance. Sustainably constructed and transformed buildings have been shown to achieve rental premiums and improved asset value over conventional buildings due to enhanced energy efficiency and occupant productivity (Zhang *et al.*, 2018). Hossain *et al.* (2023) further state that deficiencies, such as poor building design, inefficient technologies, and inadequate energy management practices associated with conventional buildings, contribute to increased energy consumption and higher operating costs. Consequently, having a negative effect on the marketability of existing conventional buildings

In developed countries, regulatory enforcement and green certification systems further accelerate sustainable transformation adoption (Evans, Roshchanka & Graham, 2017; Darko & Chan, 2018). However, in developing countries, barriers of weak enforcement of regulations, non-existent regulations, high upfront costs, and limited awareness constrain the

adoption of sustainable transformation practices (Vine, Williams & Price, 2017; Chan *et al.*, 2018)

2.3 Indoor Environmental Quality (IEQ) and Occupant Health

IEQ is a critical component of building performance as occupants spend over 90% of their time indoors (Mirzaei *et al.*, 2020). Poor IEQ in conventional buildings has been linked to sick building syndrome (SBS), which negatively affects occupant health and productivity (Valderrama-Ulloa *et al.*, 2020; Emetere *et al.*, 2024).

Conventional buildings rely on outdated ventilation systems and low-quality materials that contribute to indoor air pollution through volatile organic compounds (VOCs) (Kurmanbekova, Du & Sharples, 2025). Research indicates that transformed buildings can significantly reduce SBS symptoms and enhance occupant well-being (Allen *et al.*, 2015). For instance, MacNaughton *et al.* (2017) determined that occupants working in a sustainable building can report up to 30% less SBS symptoms and 46% better sleep quality than those working in a conventional building. However, these findings originate primarily from developed countries, with limited validation in developing contexts.

2.4 Material Durability and Lifecycle Performance

Material durability is a key determinant of lifecycle performance and maintenance costs. Conventional materials commonly used in developing countries are vulnerable to environmental degradation, which is further intensified by climate change (Phillipson, Emmanuel & Baker, 2016; Ferrara, La Noce & Sciuto, 2023).

Emerging research highlights the potential of sustainable materials to improve durability and performance. For instances, recycled concrete aggregates (RCA) and alternative composites have demonstrated enhanced strength and resilience under controlled conditions (Adams *et al.*, 2016). However, these findings are largely experimental, with limited large-scale real-world application in developing countries.

3 Research Methodology

This study adopted a positivist research paradigm using a quantitative research approach to generate objective and measurable evidence regarding the performance limitations of existing conventional buildings and the implications of limited adoption of sustainable transformation practices. The quantitative approach was adjudged suitable because it facilitates the collection of numerical data and enables the use of statistical techniques (i.e., descriptive and inferential) to examine and analyse the data as indicated by Almusaed *et al.* (2025).

A cross-sectional survey design was employed, with primary data collected using a structured questionnaire consisting of close-ended questions measured on a five-point Likert scale. The questionnaire items were developed based on variables identified in the literature review, including operating energy drivers, marketability determinants, IEQ indicators, and interior material performance. The questionnaire was distributed electronically to GC's affiliated with the ECMBA who have experience with both conventional and sustainably transformed buildings in the NMBM. Purposive sampling was considered appropriate because it enabled the researchers to target individuals who could provide informed responses in relation to the subject matter, thereby enhancing the relevance and quality of the data collected (Leedy & Ormrod, 2015).

A total of 65 GCs were identified, of which 21 completed the survey, yielding a response rate of 32.3%. This response rate is deemed acceptable for industry-based survey research, where participation is often constrained by the availability of practitioners. More so, respondents were informed to relate their responses to selected projects (i.e., existing conventional buildings and sustainable buildings) that they have been involved in. This is the case because the findings of the study were intended to provide context-specific insights rather than support broader statistical generalisations to a larger population. Therefore, the responses were deemed reliable as they reflect the perspective of experienced professionals. Consequently, the quality and relevance of responses are more critical than the number of respondents.

high operating costs, reduced marketability, poor IEQ, and rapid deterioration of interior materials in existing conventional buildings. Although the study provides valuable insights into industry perceptions, the findings are limited to the NMBM context and reflect practitioners' perspectives rather than direct performance measurements. Therefore, the results should not be interpreted as universally generalisable.

4 Findings and Discussion

Table 1 indicates the extent to which eleven factors contribute to higher operating costs in existing conventional buildings in terms of percentage responses to a scale of not at all to a very large extent, and MSs ranging between 1.00 and 5.00. It is notable that 8 / 11 (72.7%) MSs exceed the midpoint of 3.00, which indicates in general the factors contribute to high operating costs in existing conventional buildings to a large, as opposed to a limited extent. Furthermore, it is notable that none of the MSs are $> 4.20 \leq 5.00$. However, 7 / 11 (63.6%) of the MSs are $> 3.40 \leq 4.20$, which indicates the factors contribute between a moderate to a near large / near large extent. Only 2 / 11 (18.2%) MSs are $> 2.60 \leq 3.40$, namely outdated lighting systems, and older water fixtures, indicating they contribute to higher operating costs between a near limited to a moderate extent / moderate extent. The MSs of high insurance premiums, and lack of structured waste management systems are $> 1.80 \leq 2.60$, indicating they contribute to higher operating costs between not at all to a near limited / a near limited extent.

Table 1: The extent to which eleven factors contribute to higher operating costs in existing conventional buildings

Factor	U	Response (%)					MS	Rank
		Not.....Very						
		1	2	3	4	5		
Occupant behaviour	0.0	0.0	9.5	14.3	28.6	47.6	4.14	1
Frequent repairs or replacement of building systems	0.0	0.0	9.5	23.8	42.9	23.8	3.81	2
Dependence on grid electricity	0.0	0.0	9.5	28.6	47.6	14.3	3.67	3
Inefficient or outdated HVAC systems	0.0	0.0	19.0	14.3	47.6	19.0	3.67	4
Lack of renewable energy integration	0.0	0.0	14.3	33.3	28.6	23.8	3.62	5
Poor thermal insulation of building envelopes	0.0	0.0	14.3	38.1	19.0	28.6	3.62	6
Absence of automation for monitoring and controlling energy and water use	0.0	4.8	19.0	19.0	23.8	33.3	3.62	7
Use of outdated lighting systems	0.0	0.0	19.0	33.3	38.1	9.5	3.38	8
Use of older water fixtures that consume excessive water	4.8	0.0	19.0	14.3	42.9	19.0	2.65	9
High insurance premiums from increased risks of fire, flooding, or other damage	4.8	0.0	23.8	28.6	19.0	23.8	2.45	10
Lack of structured waste management systems	4.8	4.8	19.0	33.3	19.0	19.0	2.30	11

A measure of central tendency in the form of a mean score (MS) was computed for each variable to determine the relative significance of each variable. Then the variables were ranked in descending order based on their MSs, to identify the key contributors to

In terms of the mean ranking, occupant behaviour was ranked first, followed by frequent repairs or replace of building systems, dependence on grid electricity, and insufficient or outdated HVAC systems. These findings are consistent with the literature. Concerning occupant

behaviour, a previous study conducted by Delzendeh *et al.* (2017) indicates that inefficient usage patterns contributed to substantial energy waste due to unoccupied buildings. Nonetheless, Chen *et al.* (2021) revealed that while smart HVAC systems and lighting systems can improve efficiency, the gap between predicted and actual energy use in buildings associated with behavioural factors remains underexplored. With regard to dependency on grid electricity, Alberini (2018) opined that energy inefficiency directly increases utility costs through higher electricity and fuel consumption. In the developing countries context, the situation is compounded by higher electricity tariffs due to energy supply constraints and infrastructure deficits. In alignment with insufficient or outdated HVAC systems, Shuja, Gardezi and Idrees (2021) and Berardi (2017) contend that many buildings continue to rely on outdated systems with minimal integration of energy-efficient technologies, contributing to higher operational costs.

Table 2 indicates the extent to which eight factors negatively affect the marketability of existing conventional buildings in terms of percentage responses to a scale of minor to major, and MSs ranging between 1.00 and 5.00. It is notable that 4 / 8 (50.0%) of the MSs are > 3.00 , indicating the factors have a major as opposed to a minor negative effect on marketability of existing conventional buildings. It is notable the MS of lower resale / rental value is $> 4.20 \leq 5.00$, which indicates the factor has between a near major to a major / major negative effect on marketability. The MSs of outdated design and overall energy efficiency of building are $> 3.40 \leq 4.20$,

indicating between a moderate to a near major / near major negative effect on marketability. Then, 2 / 8 (25.0%) MSs are $> 2.60 \leq 3.40$, indicating between a near minor to a moderate / moderate negative effect - absence of formal building certification ranked fourth followed by perceptions toward inefficient buildings. Then, 2 / 8 (25.0%) MSs are $> 1.80 \leq 2.60$, namely absence of visible sustainability features ranked sixth followed by ineligibility for tax incentives, which indicates between a minor to a near minor / near minor negative effect on marketability. The MS of absence of automation is $> 1.00 \leq 1.80$, indicating between a minor to a near minor / near minor negative effect on marketability.

The findings in relation to the top ranked factors, such as the lower resale / rental value relative to conventional buildings, outdated design or lack of modern visual appeal, and overall energy efficiency of the building, are in consonance with the literature review and corroborated by Hossain *et al.* (2023) and Zhang *et al.* (2018). For instance, Hossain *et al.* (2023) stated that in most cases, conventional buildings are characterised by poor building design, inefficient technologies, and inadequate energy management, which has a negative effect on the marketability prospects of the property. In contrast, Zhang *et al.* (2018) argue that sustainably constructed buildings have been shown to achieve rental premiums and improved asset value, thereby enhancing their marketability prospects.

Table 3 indicates the extent to which eight factors influence the IEQ and occupant health in existing

Table 2: The extent to which eight factors negatively affect the marketability of existing conventional buildings

Factor	U	Response (%)					MS	Rank
		Minor.....Major						
		1	2	3	4	5		
The lower resale / rental value relative to conventional buildings	0.0	4.8	0.0	9.5	28.6	57.1	4.33	1
Outdated design or lack of modern visual appeal	0.0	4.8	0.0	33.3	28.6	33.3	3.86	2
Overall energy efficiency of the building	0.0	0.0	4.8	33.3	38.1	23.8	3.81	3
Absence of formal building certifications	0.0	14.3	14.3	38.1	14.3	19.0	3.10	4
Perceptions of buyers, tenants, and investors toward inefficient buildings	4.8	4.8	14.3	4.8	28.6	42.9	2.95	5
Absence of visible sustainability features	4.8	4.8	9.5	33.3	28.6	19.0	2.50	6
The ineligibility for tax incentives or rebates	4.8	9.5	9.5	28.6	28.6	19.0	2.40	7
The absence of automation for building systems	4.8	14.3	23.8	38.1	14.3	4.8	1.70	8

Table 3: The extent to which eight factors influence IEQ and occupants' health in existing conventional buildings

Factor	U	Response (%)					MS	Rank
		Minor.....Major						
		1	2	3	4	5		
High humidity levels leading to dampness or mould inside the building interior.	0.0	4.8	4.8	4.8	33.3	52.4	4.24	1
Ventilation rate and air circulation of ventilation system installed.	0.0	4.8	4.8	9.5	33.3	47.6	4.14	2
Inconsistent indoor thermal comfort due to poor thermal control.	0.0	9.5	9.5	14.3	42.9	23.8	3.62	3
Ability of the building to provide and maintain adequate indoor lighting conditions.	0.0	14.3	4.8	28.6	23.8	28.6	3.48	4
The acoustic design (noise pollution control) of the building.	0.0	14.3	9.5	33.3	19.0	23.8	3.29	5
The lack of automated systems for monitoring and controlling indoor air quality.	0.0	14.3	19.0	14.3	33.3	19.0	3.24	6
Build-up of indoor dust and particles from poor filtration.	4.8	9.5	4.8	9.5	33.3	38.1	2.90	7
Use of interior finishes / material releasing harmful emissions (e.g. VOC's).	4.8	4.8	9.5	19.0	33.3	28.6	2.75	8

conventional buildings in terms of percentage responses to a scale of minor to major, and MSs ranging between 1.00 and 5.00. It is notable that 6 / 8 (75.0%) of the MSs are > 3.00 , which indicates in general the factors have a major as opposed to a minor influence on IEQ and occupant health. It is notable 1 / 8 (12.5%) MSs is $> 4.20 \leq 5.00$, indicating that high humidity levels leading to dampness has between a near major to a major / major influence. Then, 3 / 8 (37.5%) MSs are $> 3.40 \leq 4.20$, indicating between a moderate to a near major / near major influence - ventilation rate and air circulation ranked second, followed by inconsistent indoor thermal comfort, and provision of adequate lighting conditions. Furthermore, acoustic design ranked fifth, followed by lack of automated air quality monitoring, build-up of indoor dust, and use of interior finishes releasing harmful emissions all have MSs $> 2.60 \leq 3.40$, indicating they have between a near minor to a moderate / moderate influence on IEQ and occupant health. The findings are aligned with previous studies conducted by Valderrama-Ulloa *et al.* (2020), Emeteri *et al.* (2024), and Kurmanbekova *et al.* (2025). For instance, poor IEQ in conventional buildings may affect occupant health and productivity and may lead to SBS (Valderrama-Ulloa *et al.*, 2020; Emeteri *et al.*, 2024). Kurmanbekova *et al.* (2025) note that this situation is exacerbated due to reliance on outdated ventilation systems and materials with higher VOCs.

Table 4 indicates the extent to which nine factors contribute to the rapid deterioration of interior building materials and finishes in existing conventional

buildings in terms of percentage responses to a scale of not at all to a very large extent, and MSs ranging between 1.00 and 5.00. It is notable that 4 / 9 (44.4%) MSs are > 3.00 , indicating in general the factors contribute to a large as opposed to a limited extent to rapid interior material deterioration. It is notable 1 / 9 (11.1%) MSs is $> 4.20 \leq 5.00$, indicating the quality of workmanship during installation of the material contributes between a large to a very large / very large extent towards rapid deterioration of interior building materials. Conformance to standards ranked second, followed by resistance to moisture exposure, and frequency of maintenance have MSs $> 3.40 \leq 4.20$, which indicates they contribute between a moderate to a large / large extent. In addition, 4 / 9 (44.4%) MSs are $> 2.60 \leq 3.40$, indicating the factors contribute between a limited to a moderate / moderate extent - compatibility with indoor conditions ranked fifth, followed by time elapsed since installation, compatibility of protective coating, and resistance to chemical exposure. Resistance to mechanical stress has a MS $> 1.80 \leq 2.60$, indicating it contributes between not at all to a limited / limited extent.

In terms of the top ranked factors, the findings are similar to previous studies. Conventional materials commonly used in developing countries are vulnerable to environmental degradation. For this reason, material durability is a key determinant of lifecycle performance and maintenance costs (Phillipson, Emmanuel & Baker, 2016; Ferrara, La Noce & Sciuto, 2023). Hence, the quality of workmanship during installation of the

Table 4: The extent to which nine factors contribute to rapid deterioration of interior materials in existing conventional buildings.

Factor	U	Response (%)					MS	Rank
		Not.....Very						
		1	2	3	4	5		
The quality of workmanship during installation of the material.	0.0	4.8	0.0	14.3	28.6	52.4	4.24	1
The conformance to standards of the interior construction material.	0.0	4.8	0.0	19.0	47.6	28.6	3.95	2
The resistance of the interior construction material to moisture exposure.	0.0	4.8	9.5	19.0	42.9	23.8	3.71	3
The frequency of maintenance and repairs required for the material (e.g., concrete, timber, clay bricks).	0.0	4.8	23.8	23.8	19.0	28.6	3.43	4
The compatibility of the interior material with the indoor environmental conditions.	4.8	4.8	0.0	23.8	38.1	28.6	2.90	5
The time elapsed since the installation or replacement of the original interior construction material.	4.8	0.0	0.0	38.1	33.3	23.8	2.85	6
The compatibility of protective coating, sealants or treatment applied with the indoor environmental conditions.	4.8	9.5	0.0	23.8	28.6	33.3	2.80	7
The resistance of the interior construction material to chemical exposure.	4.8	4.8	9.5	28.6	28.6	23.8	2.60	8
The resistance of the interior construction material to mechanical stresses.	4.8	4.8	4.8	33.3	38.1	14.3	2.55	9

material and conformance to standards of building material are important aspects in reducing the cost of maintenance throughout the building life cycle

5 Conclusions and Recommendations

This study examined the performance limitations of existing conventional buildings in the NMBM to inform the adoption of non-demolition sustainable transformation practices. The findings confirm that continued reliance on conventional building approaches results in measurable economic, environmental, and health-related inefficiencies that undermine the long-term performance of buildings. The study determined that high operating costs are primarily driven by inefficient occupant behaviour, outdated HVAC systems, dependence on grid electricity, and the absence of automation. These factors collectively increase energy consumption and a building's lifecycle expenditure. From a market perspective, buildings with no sustainable features experience reduced resale and rental values, and financial performance emerges as the main element for competitiveness. Which places sustainable transformation of existing conventional buildings not only as an environmental consideration but as a strategic economic necessity to ensure building value retention.

The study further establishes a clear relationship between poor IEQ and increased likelihood of SBS symptoms. High humidity levels, inadequate ventilation, and inconsistent thermal comfort were identified as key contributors to occupant discomfort and potential health risks. In addition, rapid deterioration of interior building materials was found to be strongly associated with poor workmanship, non-compliance with South African National Standards (SANS), and exposure to moisture, leading to a shortened service life and increased maintenance demands. Overall, the findings confirm that non-demolition sustainable transformation practices are essential to improve energy efficiency, enhance market competitiveness, protect occupant health, and extend building longevity. The takeaway is that delaying sustainable transformation interventions preserves building inefficiency and loss of building value, whereas proactive transformation of the existing buildings can present a pathway toward improved performance, economic strength, and environmental sustainability within the NMBM.

5.1 Theoretical contributions, practical implications, and policy contributions

In terms of the theoretical contribution, the study adds to the body of knowledge regarding building performance and sustainability by providing empirical evidence associated with the multi-dimensional limitations of conventional buildings from four

perspectives, namely, economic, market, health, and material performance.

Concerning practical and industry implications, the findings of the study offer valuable insights for professionals within the construction and real estate sectors. First, it provides evidence of key economic inefficiencies associated with conventional buildings and demonstrates how poor IEQ and unhealthy building conditions can influence occupant well-being and productivity. Second, the study provides empirical evidence that highlights material performance deficiencies and how they influence the marketability of conventional buildings in terms of property attractiveness, occupancy rates, and asset values. Subsequently, these findings will enable stakeholders to make informed investment and design decisions.

Regarding policy contributions, the study provides evidence-based insights that can support policymakers, regulators, and professional bodies within the built environment by promoting sustainable development through strengthening building regulations and performance standards relating to energy efficiency, indoor environmental quality, material sustainability, and retrofitting of existing buildings.

5.2 Recommendations

Further research should focus on conducting detailed lifecycle cost analysis and post-occupancy evaluations to quantify the economic, environmental, and health benefits of sustainably transforming existing conventional buildings. Empirical measurement of energy saving, improvements in IEQ, and reductions in maintenance frequency would strengthen the business case for transformation. For stakeholders, including property owners, developers, and facility managers, immediate action is required to improve the performance of existing buildings. Priority should include conducting energy and IEQ audits to identify inefficiencies, integrate automation and monitoring technologies to manage resource consumption, and enforce strict compliance with construction materials SANS to enhance interior material durability. Provincial and municipal authorities can strengthen policy support mechanisms by introducing targeted incentives, technical guidelines, and monitoring frameworks that encourage sustainable transformation over continued conventional practices.

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