

An Exploratory Evaluation of the Factors impacting the Adoption of Innovative Sustainable Building Materials in Housing Construction Across Socio-Economic Contexts

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Abstract

This research examines the adoption patterns and key factors influencing the adoption of innovative sustainable building materials in housing construction across socio-economic contexts in Cape Town, South Africa. In South Africa, the adoption of sustainable building practices is hindered by socio-economic constraints, technological limitations, economic barriers, and a lack of awareness. Despite notable advancements in sustainable building practices, several factors contribute to uneven adoption patterns, hindering the widespread implementation of these practices. A mixed-methods approach was used to collect data, employing semi-structured interviews and a survey questionnaire randomly distributed to Cape Town residents and purposively selected professionals working on housing construction projects. Furthermore, the data collected were analysed using descriptive, thematic, and inferential statistical techniques. The study found that most respondents from both classes were aware of sustainable building technology and materials, and perceived that environmentally friendly building materials help mitigate the environmental impact of construction. They also indicate that, compared to middle- to high-class respondents, most low-class respondents lack access to resources such as government assistance and financial support, and both groups often utilise recycled materials. The study found no significant difference in the main variables influencing respondents' choices regarding sustainable building materials across middle-high-class and lower-class groups. In conclusion, this study advances the understanding of how socio-economic circumstances influence the use of sustainable building materials and technologies in housing construction at various levels. The study recommends that governments and financial institutions establish initiatives through training and financial incentives to equip stakeholders with the necessary information, thereby improving the likelihood of adopting sustainable practices.

Keywords: Environmental Impact, Housing, Income Level, South Africa, Sustainable building materials

1. Introduction

The adoption patterns of sustainable building materials in housing construction vary significantly across different socio-economic contexts and are influenced by many factors (Eze *et al.*, 2021). This research uses the terms "sustainable building practices" and "sustainable building materials" interchangeably. Economic and socio-cultural contexts are particularly pivotal in shaping the acceptance of sustainable housing technologies (Okitasari *et al.*, 2022). These socio-economic contexts encompass various social and economic factors that influence housing construction, including cost considerations, access to information and education, regulatory environment, cultural factors, infrastructure and resources, and the impacts of climate change.

Housing construction is fundamental to societal development; however, conventional practices often lead to environmental degradation and social inequities (Kennedy *et al.*, 2009). Historical perspectives reveal a trajectory of resource-intensive construction methods that have led to ecological harm and economic disparities (Kennedy *et al.*, 2009). Wang *et al.* (2018)

and AlSanad (2015) stated that the building and construction industries consume a significant amount of global resources and have a substantial impact on the environment, contributing to high energy consumption and greenhouse gas emissions (GHG). In the same line of thought, Kennedy *et al.* (2009) confirmed that the housing industry produces approximately a third of GHG and uses up to 40% of total energy consumption across several phases, including raw material extraction, processing, manufacture, transportation, construction, and building operation.

In many countries, the adoption of sustainable building practices is hindered by socio-economic constraints, technological limitations, economic barriers, and inadequate awareness (Marsh *et al.*, 2020). While some regions readily adopt sustainable alternatives, others continue to rely on traditional, resource-intensive construction methods. This imbalance is particularly evident in South Africa and other regions, where disparities exist in the knowledge and affordability of sustainable building materials (Marsh *et al.*, 2020). For instance, developers in countries such as Malaysia face obstacles in meeting the growing demand for housing while upholding social and ecological responsibility

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(Abidin, 2010). Nigeria faces barriers to adopting sustainable construction practices (Osuzugbo *et al.*, 2020). Despite significant progress in researching the uptake of green buildings in developing countries, recent studies reveal a continued gap in understanding the theoretical and contextual factors influencing the adoption of innovative building materials in Africa (Mushi *et al.*, 2023).

Therefore, it is imperative to understand the adoption patterns of innovative sustainable materials in housing construction across diverse socio-economic contexts. This research examines the key factors influencing adoption rates, assesses barriers to implementation, and proposes targeted interventions to promote sustainable practices.

2. Literature Review

The increase in human population and urbanisation causes the demand for infrastructure, buildings, and facilities to outweigh the supply, resulting in the need to build more infrastructure, buildings, and facilities to meet the needs of the current and future generations (Mehmood & Ishak, 2024; Ngoy *et al.*, 2023). The construction sector is a significant contributor to global carbon dioxide emissions, primarily due to the use of conventional building methods and materials. The industry's impact on environmental degradation highlights the need to adopt a circular economy approach in construction to mitigate adverse effects (Saha *et al.*, 2021). Addressing environmental challenges and climate change issues in the construction sector is crucial, as buildings account for a significant portion of global energy consumption and greenhouse gas emissions.

Huang *et al.* (2018) highlighted that the construction industry is the most significant contributor to carbon dioxide emissions globally, primarily due to the materials and methods used in traditional building practices. This sector is a significant factor in environmental degradation, posing risks to future generations. Estimates suggest that construction activities contribute to 25% of global deforestation, with additional emissions from industrialised nations accounting for 10%. Emissions include 39% carbon dioxide, 49% sulfur dioxide, and 25% nitrous oxide, with 40% attributed to raw material extraction (Eze *et al.*, 2023).

2.1. Key Principles of Sustainable Construction

Sustainable construction seeks to create comfortable and healthy indoor environments while minimising the environmental impact of buildings and their operational structures. By examining documents from the International Union for Conservation of Nature (IUCN), Purvis *et al.* (2019) sought to trace the origins of the three key pillars of sustainability: environmental, economic, and social. They found that these three

pillars are deeply connected to sustainable development.

2.2. Sustainable Building Materials

The construction industry is adopting sustainable building materials and technology to reduce environmental impact and improve long-term viability (Javaid *et al.*, 2022). Sustainable methods currently transforming South Africa include using innovative materials like bamboo, precast concrete, cross-laminated timber, and straw bales and incorporating technologies like BIM and 3D printing.

2.3. Socio-Economic Context and Adoption of Sustainable Building Materials in South Africa

2.3.1. Low-Income Households in South Africa

According to Swilling *et al.* (2016), South Africa is the most unequal society in the world. Most people from low-income housing in South Africa live in low-cost RDP housing areas, and poor black South Africans mostly occupy them. These townships consist of a mix of old and new housing occupied chiefly by poor, black South Africans, as Shackleton *et al.* (2018) stated. As a result of poverty, they settle on vacant land on the outskirts of towns or unused land within the city and construct houses from low-cost or scavenged materials (Shackleton *et al.*, 2018). Similarly, new migrants to a town in South Africa usually occupy unused land, forming informal housing areas (Pauw *et al.*, 2022). They do this, hoping to be allocated an RDP house (Makole *et al.*, 2022). This suggests that high initial costs significantly impact the adoption rates of sustainable materials for low-income housing, as most households rely on government grants to cover their living expenses.

2.3.2. Middle-income Households in South Africa

According to Wright *et al.* (2019), middle-income households in the country have substantially better access to health, education, and other services than their low-income counterparts. They also live in urban areas with easy access to various services and private establishments (Alabi & Fapohunda, 2021). Compared to the low-income class, the middle class has higher educational attainment and puts a high value on human capital development (Albert *et al.*, 2018). Middle-income households in rural areas and certain regions have low access to social services (McKenzie & Hanass-Hancock, 2017). The government needs to reexamine its social protection policies and recognise that while the poor are mostly vulnerable to future poverty, even the middle class is vulnerable and needs to establish RDP houses and social housing for the middle class (Temidayo *et al.*, 2018).

2.3.3. High-Income Households in South Africa

Shackleton *et al.* (2018) found that suburbs ranging from middle to high-income areas are occupied mostly by white South Africans, but now there is an increasing presence of other racial groups. Ward and Shackleton

(2016) state that wealthier urban households tend to have high-income-earning jobs, measured mainly by the number of assets and electricity spending. They are also associated with high education levels, and these households are primarily located in the CBD and town areas of South Africa. According to Tetteh and Amponsah (2020), smart homes contribute to sustainable development. This implies that homeowners who choose innovative housing are typically high-income earners who can afford the associated expenses. They have the resources to fall back on alternative energy sources, such as generators and solar energy, during load shedding, which people with low incomes cannot afford (Williams *et al.*, 2020). This means that high-income households have sufficient monetary resources and knowledge to adopt sustainable materials at a high rate.

3. Research Methodology

This study employs a mixed-methods research approach to collect data from low-, middle-, and high-income populations regarding their experiences and perceptions of the factors influencing the adoption of sustainable building materials. The mixed methods approach encourages further refinement of the data beyond the results obtained by either qualitative or quantitative data. It leads to a deeper understanding of the research problem that would not be achieved if a single method were used in isolation. Residents of the

Cape Town metropolitan area, Western Cape, South Africa, from various socio-economic backgrounds were randomly surveyed to draw statistical inferences from the data (Andrews *et al.*, 2007), while professionals working on housing construction projects were conveniently selected and interviewed. The rationale for using the mixed method approach was to mitigate bias and ensure data reliability. The data collected was analysed using inferential, thematic, NVivo software, and descriptive analysis.

4. Findings and Discussion

4.1. Participant demographics

Table 1 presents the demographic characteristics of respondents, including their education level, employment status, income levels, and home ownership status. Table 1 reveals that the more educated the household, the greater the probability of being proactive in seeking sustainable building solutions. In contrast, the less educated the household, the less access to knowledge they have, and they may prioritise immediate financial requirements over long-term environmental advantages. This was confirmed by Wang *et al.* (2014), indicating that education plays a significant role in determining the development of behavioural intention, environmental knowledge, environmental sensitivity, environmental value, perceived behavioural control, and response efficacy. It is based on the fact that education not only helps people

Table 1: Participant demographic characteristics

Race	Low-class Respondent	Middle to high class Respondents
Black	89,66%	56,41%
White	3,45%	25,64%
Colored	6,90%	17,95%
Education Level	low-class Respondent	Middle to high class Respondents
High School	75,86%	15,38%
Bachelors	10,34%	61,54%
Master's Degree	3,45%	2,56%
Others	10,34%	20,51%
Employment Status	low-class Respondent	Middle to high class Respondents
Employed Full-Time	44,83%	87,18%
Employed Part-Time (Retired*)	24,14%	61,54%
Unemployed	17,24%	2,56%*
Students	13,79%	5,13%
Income Level	low-class Respondent	Middle to high class Respondents
R0 to R54 344	31,03%	0%
R151 727 to R363 930	68,97%	33,33%
R363 931 to R631 120	-	35,90%
R631 121 to R863 906	-	17,95%
R863 907 to R1 392 844	-	12,82%
Home ownership status	low-class Respondent	Middle to high class Respondents
Built my Own House	32,14%	35,90%
Bought an Existing Home	7,14%	35,90%
Rent	46,43%	20,51%
Other	14,29%	7,69%

better understand environmental issues, but it also helps people realise their environmental responsibility.

4.2. Location of respondents

Table 2 shows that 38.46% of respondents live in the township, 38.46% in a suburban neighbourhood, 12.82% in the urban city centre, and 10.26% in the outskirts.

Table 2: Location of Respondents

Outskirts	Township	Urban City Centre	Suburban Neighborhood
10,26%	38,46%	12,82%	38,46%

Housing inequality occurs within and between different Population groups. Low-income groups, predominantly minority ethnicities, and those with migrant backgrounds are more likely to encounter poor-quality housing and reside in rental tenures as a result of poor access to ownership. These affordability gaps are particularly pronounced among low-income households, renters in the private sector, and youth (Kährik & Pastak, 2023), indicating that those in more permanent or higher-quality housing are often more flexible in implementing sustainable practices, as they are willing to invest in quality.

4.3. Nature of regulatory environment, Knowledge of sustainable building materials, and Effect of sustainable building materials on reducing environmental impact

According to Table 3, 23 out of 39 respondents in the middle-high class and 18 out of 29 respondents in the low-class categories indicated an informal regulatory environment. Overall, both the middle-class and upper-class groups have an informal regulatory environment regarding the use of sustainable building materials. Additionally, it demonstrates that 22 of the 29 respondents from the lower socio-economic classes

were aware of sustainable building materials. Of the 39 middle and high school respondents, 34 were aware of sustainable building materials. Most responders from both classes/groups were aware of sustainable building technology and materials. Lastly, the title reveals that 14 low-income respondents strongly agreed, 11 agreed, two were neutral, and two disputed that using sustainable building materials helps reduce environmental impact. Most respondents from both

groups think that environmentally friendly building materials can lessen their impact.

Results indicate that government policies are directly proportional to some extent to the awareness of sustainable building materials, together with incentives. Saha et al. (2021) found that regulatory frameworks on sustainable materials are still lacking in developing countries and need to be fostered. The study conducted by Luthra et al. (2015), which focused more on sustainable technology, states that the lack of public interest litigation is one of the barriers identified for promoting sustainable technologies. This shortfall in legal advocacy results in decreased motivation and lower public awareness. To address this, the government should increase its efforts to clearly label the energy usage of appliances and machinery, along with providing certification to verify their energy-saving efficiency.

4.4. Use of Sustainable building materials and Frequency of using sustainable materials

Table 4 shows that 22 out of 39 respondents in the middle-high class and 16 out of 29 respondents in the low class have never utilised solar panels. The findings indicate that although a sizable portion of both groups

Table 3: Nature of regulatory environment, Knowledge of sustainable building materials, and Effect of sustainable building materials on reducing environmental impact

Regulatory Environment	Low-class Respondent	Middle to high class Respondents
Informal	18	23
Formal	11	16
Knowledge of Sustainability	Low-class Respondent	Middle to high class Respondents
No	7	5
Yes	22	34
Effect on Reducing Environmental Impact	low-class Respondent	Middle to high class Respondents
Strongly Disagree	0	0
Disagree	2	0
Neutral	2	5
Agree	11	13
Strongly Agree	14	19

have used solar panels, most have not. Additionally, it reveals that whereas 31 out of 39 respondents from the middle-class and upper-class groups have not used green roofs, 24 out of 29 respondents from the lower-class group have not. They equally indicate that both respondent groups use green roofs reasonably infrequently. Regarding recycled materials, 22 out of 39 respondents in the middle-high class and 17 out of 29 respondents in the low class had used them. Both groups utilise recycled materials more often than they do not. Finally, it reveals that although 23 out of 39 respondents from the middle-high class have used rainwater gathering systems, 17 out of 29 respondents from the low-class group have done so. This demonstrates that more people in both groups utilise rainwater harvesting systems than those who do not.

Sustainable materials can significantly influence how buildings are designed and constructed, offering a future where both the planet and its inhabitants benefit (Raji *et al.*, 2015). Each alternative considered sets new standards for eco-friendly construction, offering access to buildings that are better for the environment, affordable, and meet the growing demand for sustainable living (Korhonen *et al.*, 2018). Thus shaping a more sustainable world.

These materials are cost-effective, durable, and have a low environmental impact. Their versatility makes them excellent choices for a wide range of projects, from residential homes to commercial buildings. South Africa's commitment to sustainable development is evident in its increasing use of these innovative materials. Despite

Table 4: Use of Sustainable building materials and Frequency of using sustainable materials

Sustainable Building Material	Response	Low-class Respondents	Middle to high class Respondents
Use of solar panels	Yes	13	17
	No	16	22
Use of recycled materials	Yes	12	22
	No	17	17
Use of green roofs	Yes	5	8
	No	24	31
Use of rainwater harvesting	Yes	12	23
	No	17	16
Frequency of using sustainable materials			
Always		2	2
Frequently		6	8
Occasionally		11	16
Rarely		7	10
Never		3	3
Affordability of sustainable building materials			
Very Affordable		4	5
Affordable		10	8
Neither Expensive nor Affordable		3	5
Expensive		11	18
Very Expensive		1	3

Regarding the affordability of sustainable building materials, over half of middle-class respondents considered the materials expensive or extremely expensive, and a similar proportion of respondents from lower socio-economic classes shared the same view. Both categories believe sustainable building materials are more costly than conventional ones.

The results reflect the shift in the South African construction industry as more people become aware of environmental issues and seek greener building methods (Windapo, 2014). With problems such as limited resources and climate change, the focus has shifted to materials that can benefit the country's environment and economy (Korhonen *et al.*, 2018).

barriers to adoption, they help reduce harmful emissions and promote a greener future.

4.5. Factors influencing the adoption of Sustainable Materials

To identify the main variables influencing respondents' choices of sustainable building materials, the RII scores for the factors are displayed in Tables 5 and 6 for middle-class and low-income individuals, respectively. The three most important aspects of the low-cost option were initial cost, environmental impact, and long-term cost savings. The three variables that the middle class considered were initial cost, environmental effect, and long-term cost savings, revealing that the variables influencing adoption in the middle-class and lower-class groups were the same.

Table 5: Influencing factors - low-class

Rank	Influencing factors	RII
1	Cost savings in the long run	0,7
1	Environmental impact	0,7
2	Initial cost	0,6
2	Availability	0,6
2	Awareness and knowledge	0,6
2	Complying with building codes	0,6
2	Aesthetic appeal	0,6
2	Influence of media and adverts	0,6
2	Maintenance and ease of use	0,6
3	Government incentives	0,5

Table 6: Influencing Factors Middle-High class

Ranking	Influencing factors	RII
1	Cost savings in the long run	0,7
1	Initial cost	0,7
1	Environmental impact	0,7
1	Awareness and knowledge	0,7
1	Maintenance and ease of use	0,7
2	Availability	0,6
2	Complying with building codes	0,6
2	Aesthetic appeal	0,6
3	Government incentives	0,5
3	Influence of media and adverts	0,5

The study found that it sometimes costs more to embark on green building projects because green materials are mostly more expensive than their conventional counterparts. A comparison of construction costs between 'green' and conventional office buildings reveals that soft green building costs are higher than those of conventional projects, primarily due to incremental costs associated with achieving a green building rating (Chan *et al.*, 2017). This involves application costs and additional consulting required under the various rating tools. It is therefore necessary to provide financing options to encourage sustainable construction practices. Oguntona *et al.* (2019) corroborate the findings of this investigation, indicating that more financing alternatives, such as government incentives, can improve the implementation of green technologies.

The results of this investigation also prove that environmental factors significantly influence the Adoption of sustainable building materials. Ahn *et al.* (2016) and Ngoy et al. (2023) argue that one of the primary environmental factors driving the adoption of sustainable practices is the need to mitigate climate change, as building construction and operation contribute significantly to global greenhouse gas emissions.

5. Conclusion

This research examines the factors influencing the adoption of innovative sustainable building materials in housing construction across two socio-economic contexts. Key factors impacting adoption patterns include economic incentives, awareness and education, government policies, cultural values, and the availability of resources. The research highlighted significant differences in these factors based on socio-economic status, underscoring the need for targeted strategies to address the unique challenges different communities face. In conclusion, this study contributes to understanding how socio-economic contexts influence the adoption of sustainable building materials in housing construction. The insights gained can guide stakeholders such as policymakers, industry professionals, and community organisations in fostering more sustainable practices in the construction sector.

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References

- Andrews, D., Nonnecke, B. and Preece, J. (2007). Conducting research on the internet: Online survey design, development and implementation guidelines.
- Albert, J.R.G., Santos, A.G.F. and Vizmanos, J.F.V. (2018). Defining and profiling the middle class. *Philippine Institute for Development Studies*. <https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidspn1818.Pdf>.
- Alabi, B. and Fapohunda, J. (2021). Effects of increase in the cost of building materials on the delivery of affordable housing in South Africa. *Sustainability*, 13(4), 1772.
- Chan, A.P.C., Darko, A., Ameyaw, E.E. and Owusu-Manu, D.-G. (2017). Barriers Affecting the Adoption of Green Building Technologies. *Journal of Management in Engineering*, 33(3).
- Eze, E.C., Sofolahan, O. and Omoboye, O.G. (2023). Assessment of barriers to the adoption of sustainable building materials (SBM) in the construction industry of a developing country. *Frontiers in Engineering and Built Environment*, 3(3), 153–166.
- Khalid Mehmood Sadar, D. and Ishak, M.S. (2024). Sustainable Building Construction Materials in the United Arab Emirates: A Review. *Sustainability*, 16(15), 6565.
- Kährik, A. and Pastak, I. (2023). Access to homeownership in decline—rising housing inequalities for young people in the neoliberal housing market of Tallinn. *Frontiers in Sustainable Cities*, 5, 1149087.
- Javaid, M., Haleem, A., Singh, R.P., Suman, R. and Gonzalez, E.S. (2022). Understanding the adoption of Industry 4.0 technologies in improving environmental sustainability. *Sustainable Operations and Computers*, 3, 203–217.
- Innocent Chigozie, O., Aina, O.O. and Onokwai, A.O. (2023). Roles of clients in buildability improvement in Nigeria: an exploratory factor analysis. *Built Environment Project and Asset Management*, 13(6), 862–879.
- Huang, W.-H. (2015). The determinants of household electricity consumption in Taiwan: Evidence from quantile regression. *Energy*, 87, 120–133.
- Korhonen, J., Honkasalo, A. and Seppälä, J. (2018). Circular economy: the concept and its limitations. *Ecological economics*, 143, 37–46.
- McKenzie, T. and Hanass-Hancock, J. (2017). People with disabilities and income-related social protection measures in South Africa: Where is the gap? *African Journal of Disability*, 6(1), 1–11.
- Makole, K.R., Ntshangase, B.A., Maringa, M.S. and Msosa, S.K. (2022). Can a basic income grant improve the quality of life for the poor in South Africa: An analytical review. *Business Ethics and Leadership*, 6(3), 57–67.
- Ngoy, K.S., Chisumbe, S., Petere, G., Mwiya, B., & Mwanaumo, E. (2023). Factors influencing professional indemnity insurance use in construction risk management. *Baltic Journal of Real Estate Economics and Construction Management*, 11(1), 199–220. <https://doi.org/10.2478/bjreecm-2023-0013>
- Ngoy, K.S., N’Gandu, V.B. and Mwanaumo, E. (2023). 'Exploratory Analysis of Securities and Contractors' All Risk Insurance Implementation in the Construction Industry of Zambia', *Baltic Journal of Real Estate Economics and Construction Management*, 11(1), pp. 289–304. Available at: <https://doi.org/10.2478/bjreecm-2023-0018>
- Luthra, S., Kumar, S., Garg, D. and Haleem, A. (2015). Barriers to renewable/sustainable energy technologies adoption: Indian perspective. *Renewable and sustainable energy reviews*, 41, 762–776.
- Oguntona, O.A., Akinradewo, O.I., Ramorwalo, D.L., Aigbavboa, C.O. and Thwala, W.D. (2019). Benefits and Drivers of Implementing Green Building Projects in South Africa. *Journal of Physics: Conference Series*, 1378(3).
- Purvis, B., Mao, Y. and Robinson, D. (2019). Three pillars of sustainability: in search of conceptual origins. *Sustainability Science*, 14, 681–695.
- Pauw, C.J., Montagu Murray, H. and Howard, M.A. (2022). The use of dirty fuels by low-income households on the South African Highveld. *Clean Air Journal*, 32(1), 1–17.
- Shackleton, C., Blair, A., De Lacy, P., Kaoma, H., Mugwagwa, N., Dalu, M. and Walton, W. (2018). How important is green infrastructure in small and medium-sized towns? Lessons from South Africa. *Landscape and Urban Planning*, 180, 273–281.
- Saha, S., Hiremath, R.B., Prasad, S. and Kumar, B. (2021). Barriers to Adoption of Commercial Green Buildings in India: A Review. *Journal of Infrastructure Development*, 13(2), 107–128.

- Raji, B., Tenpierik, M.J. and Van Den Dobbelsteen, A. (2015). The impact of greening systems on building energy performance: A literature review. *Renewable and Sustainable Energy Reviews*, 45, 610-623.
- Tetteh, N. and Amponsah, O. (2020). Sustainable adoption of smart homes from the Sub-Saharan African perspective. *Sustainable Cities and Society*, 63, 102434.
- Temidayo, O., Aigbavboa, C., Oke, A. and Ohiomah, I. (2018). Construction 4.0: Towards delivering sustainable houses in South Africa. In, *Creative Construction Conference 2018*, 147–156.
- Swilling, M., Musango, J. and Wakeford, J. (2016). Developmental states and sustainability transitions: prospects of a just transition in South Africa. *Journal of Environmental Policy & Planning*, 18(5), 650–672.
- Ward, C.D. and Shackleton, C.M. (2016). Natural resource use, incomes, and poverty along the rural–urban continuum of two medium-sized, South African towns. *World Development*, 78, 80–93.
- Wang, P., Liu, Q. and Qi, Y. (2014). Factors influencing sustainable consumption behaviors: a survey of the rural residents in China. *Journal of Cleaner Production*, 63, 152–165.
- Williams, S.P., Thondhlana, G. and Kua, H.W. (2020). Electricity use behaviour in a high-income neighbourhood in Johannesburg, South Africa. *Sustainability*, 12(11), 4571.
- Wright, C.Y., Godfrey, L., Armiento, G., Haywood, L.K., Inglesi-Lotz, R., Lyne, K. and Schwerdtle, P.N. (2019). Circular economy and environmental health in low-and middle-income countries. *Globalisation and Health*, 15, 1-5.
- Windapo, A.O. (2014). Examination of green building drivers in the South African construction industry: Economics versus ecology. *Sustainability*, 6(9), 6088–6106.