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Willingness of End Users in Embracing Sustainable Housing in South Africa

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Abstract

Purpose: This study examines South African end-users' willingness to adopt sustainable housing, identifying preferred materials and investment levels. It aims to inform sustainable material adoption to reduce construction-sector carbon emissions.

Approach: A quantitative survey collected data on attitudes, knowledge, and willingness to pay for sustainable housing. SPSS was used for data analysis, focusing on socio-economic status, willingness to adopt sustainable homes, and cost comparisons with traditional materials.

Findings: Middle and high-income earners are more willing to adopt sustainable housing, despite higher costs. South Africans prefer materials that reduce energy grid dependence and are willing to pay for its full conversion. Regression analysis identified preferred sustainable options across income levels. Based on its findings, the study challenges the notion that affordability is the sole driver for low adoption levels of sustainable living in South Africa, emphasising individual values and the need for inclusivity in sustainable housing.

Limitations: The study's small sample size of 88 participants limits its scope. Future research should include longitudinal studies and deeper exploration of sustainable housing stakeholders and explore interventions, through end-user perceptions at a more in-depth level to form a theory of adoption pertaining to sustainable housing practices phenomena.

Practical implications: The study establishes a market demand for sustainable housing in South Africa, advocating for government and industry collaboration to boost awareness and adoption.

Value of paper: The paper informs policy, guides industry sustainable housing practices, and aids in the development of targeted strategies to promote sustainable housing and reduce its carbon footprint.

Keywords: Construction industry, End-user willingness, Green building certification, Sustainable development, Sustainable housing.

Introduction

The construction sector contributes significantly to global greenhouse gas emissions, with residential construction being a major culprit (Li & Chen, 2017; Larsen et al., 2022). Sustainable housing, defined as resource-efficient and environmentally responsible residential buildings, offers a potential solution (Oyebanji, Liyanage & Akintoye, 2017; Simbanegavi & Ijasan, 2017, 2022). Despite its benefits, such as energy efficiency, reduced lifetime costs, health benefits, increased comfort, and well-being of the building occupants, adoption rates remain low (Darko & Chan, 2018; Aigbavboa & Thwala, 2019; Simbanegavi & Ijasan, 2022). This is partly due to end-users' lack of awareness and misconceptions about sustainable technologies (Mlecnik et al., 2012; Hayles & Dean, 2015; Martek et al., 2019; Shooshtarian et al., 2021). In South Africa, the sustainable housing market is underdeveloped and still in its infancy stage (Aghimien et al., 2020). Developers claim that end-users' lack of awareness hinders the production of affordable, sustainable homes (Ganiyu, Fapohunda & Haldenwang, 2017; Nigama et al., 2018). This study posited that there is a gap in research concerning South African end-users'

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willingness to invest in sustainable housing that it aimed to fulfil. This study fills this gap by examining the factors influencing end-users' investment decisions in the South African context. The research will provide insights for policymakers and developers, contributing to the growth of the sustainable residential market in South Africa. In light of the above, and to explore the testing of this phenomenon, this study posits that sustainable housing refers to residential buildings that are designed and constructed using environmentally responsible and resource-efficient methods (Shiers, 2000). From design, construction, operation, maintenance, renovation, and deconstruction, all of which is conducted in a sustainable way (Hamid et al., 2010; Hauge, Thomsen & Löfström, 2013; He et al., 2018; Murtagh, Owen & Simpson, 2021; Švajlenka & Kozlovská, 2021; Li et al., 2023). The definition of which, coincides with South Africa's Green Star rating system and how the Green Building Council of South Africa classifies a building as sustainable (Hoffman et al., 2020). These Green Star rated sustainable homes seek to reduce their environmental impact and enhance the well-being of their occupants through energy efficiency, water conservation, and construction through the use of sustainably sourced or recycled materials (Dosumu & Aigbavboa, 2018; Shaikh, 2018; Aigbavboa & Thwala, 2019; Suh et al., 2019; Hoffman et al., 2020).

This study addresses its primary research question through two testable sub-questions, aiming to assess participants' willingness to invest in sustainable housing. It meets its objectives (**O1, O2**) and builds on established assumptions (**A1, A2**) to validate hypotheses (**H1, H2**) using quantitative methods like regression and Pearson's correlation analyses **MRQ**: What influences end-users' willingness to invest in sustainable housing materials in South Africa, and how do these correlates with market rates and material characteristics? **SQ1**: What sustainable housing characteristics are most desired by end-users? **SQ2**: How do market rates affect willingness to invest to lower construction CO_2 production? **O1**: To analyse for desired sustainable characteristics using survey data. **O2**: To assess willingness to invest at various market rates through regression analysis identifying decarbonising potential materials. **A1**: The survey data reliably represents end-users' preferences and investment willingness. **A2**: Market rates allow for meaningful regression analysis. **H1**: Sustainable characteristics like energy efficiency may increase investment likelihood due to South Africa's sociocultural and socioeconomic climate. **H2**: Market rates positively correlate with willingness to invest thereby potentially lowering housing construction carbonisation levels through the identification of them for guiding policy and practice.

Literature Review

Socio-Cultural Landscape, Cost of Progress, Policy Navigation, Collaboration Issues, and the End-Users Voice

Socio-cultural factors significantly influence sustainable housing adoption (Adabre, Chan & Darko, 2022). Traditional methods often overshadow sustainable alternatives due to cultural significance (Dosumu & Aigbavboa, 2018, 2020). Existing literature identifies this limitation but lacks a comprehensive exploration of these barriers, especially in South Africa. Economic feasibility is crucial for sustainable housing adoption. High initial costs and lack of government incentives are significant barriers (Adabre & Chan, 2019; Adabre, Chan & Darko, 2022). These concepts require further research on financing options and return on investment in South Africa. Government policies shape the housing sector significantly (Estevez & Janowski, 2013; Mey, Diesendorf & MacGill, 2016; Culwick Fatti, 2022). Literature informs that financial incentives can promote sustainable housing, but their effectiveness varies by context and by region. The literature provides an international perspective on the role of government but lacks in locale specifics. Stakeholder collaboration is critical but underexplored, especially in a South African end-user' perspective on what they are willing to invest in (Martek et al., 2019). Conflicting priorities among stakeholders seem to hinder sustainable housing adoption, as expert make educated guesses, rather than informed decisions about their end-users (Darko et al., 2017, 2018; Chan et al., 2018). The literature needs a comprehensive analysis of stakeholder roles in different contexts, guided by the end-user's perspective. End-users are crucial for sustainable housing adoption but are often overlooked (Adeyeye, Osmani & Brown, 2007; Shi et al., 2013). Theory relating to the specifics of South Africa's adoption phenomenon is not evident in the current body of knowledge. The lack of end-user engagement in decision-making can hinder the formation of a theory pertaining to this observed phenomenon. Existing literature needs further research on how to improve end-user engagement.

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Research Methodology, Approach, and Scope

This study followed a Positivism philosophy and employed a deductive, quantitative approach. Data was collected from end-users in Durban, Johannesburg, and Cape Town, and analysed data using SPSS. The study initially received 94 survey responses, which were narrowed down to 88 to maintain data integrity. The assess South African end-users' willingness to invest in sustainable housing and identify preferred sustainable materials. A quantitative approach was chosen for its ability to provide generalisable, statistically robust conclusions. The study revealed significant interest in sustainable housing among South Africa's middle class. The quantitative methodology facilitated the estimation of the potential future green building market and the monetary benefits of green buildings. The study focused on the willingness of South Africans to adopt and pay for sustainable housing, with an emphasis on methods that reduce construction-related greenhouse gas emissions. The research contributes to the existing body of knowledge on sustainable housing in South Africa (Flynn, 2003; Turner, 2003; Weeks, 2010; Singh & Masuku, 2014; Saunders et al., 2019). A survey focused on twelve key building materials as per the Standard System of Measurement South Africa 7th edition, comparing costs of traditional and sustainable options. These quantitative analysis techniques examined the willingness to pursue green star certification, adopt sustainable materials, and the extra cost end-users are willing to pay for sustainability. The study considered twelve sustainable building materials (SMBs) for further study, **Solar Geysers (SBM1),** water heating systems that utilise solar energy, reducing electricity consumption and lowering carbon footprint. **Solar Roof Tiles (SBM2),** photovoltaic tiles integrated into the roof to generate electricity from sunlight, offering an aesthetically pleasing alternative to traditional solar panels. **Recycled Steel (SBM3),** steel made from recycled materials, reducing the energy and resources needed for production. **Sheep Wool (SBM4), a** natural insulator that is renewable and biodegradable during the deconstruction process, used in thermal and acoustic insulation. **Recycled Wood (SBM5),** wood sourced from demolished structures or waste, reducing the need for new timber and the associated environmental impact. **Cork (SBM6),** harvested from the bark of cork oak trees without harming the tree, used for flooring and insulation due to its renewable and recyclable nature. **Recycled Plastic (SBM7),** plastic materials that have been processed and remanufactured, used in various construction applications like decking and insulation. **Hempcrete (SBM8),** a material made from the inner fibres of the hemp plant mixed with lime and water, used as a material for construction that is lighter than traditional concrete and acts as a natural insulator. **Enviroboard (SBM9),** a type of fibreboard made from recycled agricultural waste, used in interior and exterior walls. **Mycelium (SBM10),** the root system of fungi, used as a natural building material as an additive to concrete that and can be grown into various forms. **Recycled Clay Brick (SBM11), b**ricks made from recycled clay or made through a more energy-efficient process, reducing waste and energy use. **Sensor LED Lights (SBM12),** energy-efficient lighting that uses sensors to adjust brightness or turn on/off, reducing electricity usage.

Research Results

Four coefficients in a probit regression indicate a higher likelihood of adopting solar roof tiles (0.884), sheep's wool (0.016), hempcrete (0.410), and solar LED lights (0.393) among those willing to consider solar geysers. Conversely, eight coefficients show a lower probability of adopting materials like recycled steel (-0.0950), recycled wood (-0.0723), using cork as a resilient flooring material, (-0.0163), recycling plastic (-0,0457), Enviroboard (-0.0813), using mycelium (-0.0223) and recycled clay brick (-0.0935) among those willing to consider solar geysers.

Table 1 Generalised Linear Models: Probit Regression.

	B	Std. Error	WCI		HTWCS
			Lower	Upper	
(Intercept)	.620	.5404	-.439	1.679	1.317
SBM1:	.355	.7023	-1.022	1.731	.255
SBM2:	.884	.5797	-.252	2.020	2.326
SBM3:	-.950	.7339	-2.388	.489	1.675
SBM4:	.016	.7130	-1.382	1.413	.000
SBM5:	-.723	.7292	-2.152	.706	.984
SBM6:	-.163	.7101	-1.555	1.229	.053
SBM7:	-.457	.5489	-1.532	.619	.692
SBM8:	.410	.7176	-.996	1.817	.327
SBM9:	-.813	.8324	-2.445	.818	.954

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SBM10:	-.223	.5652	-1.331	.884	.156
SBM11:	-.935	.6626	-2.234	.364	1.991
SBM12:	0.393	0.6507	-0.882	1.668	0.365

Hypothesis Test Wald Chi-Square (HTWCS). 95% Wald Confidence Interval (WCI)

Independent Variable: Willingness to Adopt Green Star Rating (Sustainable Home).

Model: (Intercept), Willingness to consider a solar geyser, Willingness to consider solar roof tiles, Willingness to consider recycled steel, Willingness to consider sheep's wool, Willingness to consider recycled wood, Willingness to consider cork as a resilient flooring material, Willingness to consider recycled plastic, Willingness to consider hempcrete, Willingness to consider Enviroboard, Willingness to consider mycelium, Willingness to consider recycled clay brick, Willingness to consider sensor LED lights. a. Fixed at the displayed value.

A strong positive correlation (0.884) exists between willingness to consider solar geysers and solar roof tiles. Those open to solar geysers are also likely to consider other sustainable materials like sheep's wool, hempcrete, and solar LED lights. Conversely, those unwilling to consider solar geysers are less likely to adopt materials like recycled steel and recycled clay brick, which have the strongest negative correlations (-0.0950 and -0.0935). This suggests that attitudes toward solar geysers could serve as an indicator for general openness to other sustainable practices and materials. Pearson Correlation analysis revealed unique relationships between end-users' preferences for sustainable materials and their willingness to pay. About 67% of respondents showed a high likelihood of adopting a green star rating, indicating a potential market for sustainable housing in South Africa. Solar geysers were the most favoured, both in adoption interest and willingness to pay. However, a green star rating had a low influence on adopting or paying more for solar geysers (12% probability). In contrast, 45% of respondents with a green star preference had a high likelihood of adopting recycled clay bricks, and 43% were willing to pay a premium for them. A green star rating significantly influenced these choices. Most respondents were middle-class, with less than 10% in the upper-class income bracket.

Table 2 Pearsons Correlation for Solar Geysers.

Solar Geysers		WTGSR	WTCSG	WTPSG
WTGSR	(r)	1	.119	.117
	**Sig.		.271	.276
	N	88	88	88
WTCSG	(r)	.119	1	.439**
	**Sig.	.271		<.001
	N	88	88	88
WTPSG	(r)	.117	.439**	1
	**Sig.	.276	<.001	
	N	88	88	88

** Correlation is significant at the 0.01 level (2-tailed). Pearson Correlation (r). Independent Variable: Willingness to Adopt Green Star Rating (WTGSR). Model: (Intercept), Willingness to consider a solar geyser (WTCSG), Willingness to pay for a solar geyser (WTPSG)

Table 3 Pearsons Correlation for Recycled Clay Brick.

Recycled Clay Bricks		WTGSR	WTCB	WTPRCB
WTGSR	(r)	1	.451**	.443**
	**Sig.		<.001	<.001
	SSCP	19.443	7.114	7.847
	CoV	.223	.082	.090
	N	88	88	88
WTCB	(r)	.451**	1	.579**
	**Sig.	<.001		<.001
	SSCP	7.114	12.773	8.307
	CoV	.082	.147	.095
	N	88	88	88
WTPRCB	(r)	.443**	.579**	1
	**Sig.	<.001	<.001	
	SSCP	7.847	8.307	16.111
	CoV	.090	.095	.185
	N	88	88	88

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** Correlation is significant at the 0.01 level (2-tailed). Pearson Correlation (r). Sum of Squares and Cross-products (SSCP). Covariance (CoV). Independent Variable: Willingness to consider recycled clay brick (WTCB). Model: (Intercept), Willingness to Adopt Green Star Rating (WTGSR), Willingness to pay for recycled clay brick (WTPRCB)

The study observed that end-users aspiring to achieve a green star rating showed a strong inclination to adopt and pay a higher cost for sustainable materials like recycled clay bricks for structural and general building facade. Pearson's Correlation indicated a significant willingness among respondents to invest in recycled clay bricks over conventional ones. This suggests that promoting the benefits of achieving a green star rating through the use of recycled clay bricks could effectively drive consumer interest in this sustainable resource, particularly among the influential South African middle-class market segment. The data suggests that attitudes towards green star ratings may serve as a useful indicator of acceptance towards other sustainable practices and materials. The study found that end-users interested in a green star rating are more likely to adopt and pay extra for sustainable materials like recycled clay bricks. Pearson's Correlation supports this, particularly among South Africa's middle-class. Attitudes toward green star ratings can indicate broader acceptance of sustainable practices. Socioeconomic data shows that higher income levels are more willing to invest in sustainability, confirming a market demand among wealthier South Africans. The study also reveals that sustainability is not just about affordability; even lower-income participants aim for a greener future but at a lower cost. This aligns with Maslow's Hierarchy, emphasising that affordability is a key factor in home-buying decisions across income levels. The findings suggest that making sustainable housing more affordable could significantly boost demand and reduce construction-related carbon emissions.

Table 4 Extra Over (EO) Traditional Cost: Mean Willingness to Pay.

EO	N	Mean	SD	Variance	Unit	Amount (R)
SBM1:	88	2.091	0.748	0.560	no	5 500.00
SBM2:	88	2.034	0.947	0.897	m^2	1 818.99
SBM3:	88	1.784	0.818	0.669	m^2	7 006.37
SBM4:	88	1.864	0.814	0.663	m^2	643.90
SBM5:	88	1.932	0.837	0.700	m	440.00
SBM6:	88	1.898	0.812	0.660	m^2	526.95
SBM7:	88	1.955	0.811	0.657	m^2	166.28
SBM8:	88	1.818	0.791	0.626	m^3	522.50
SBM9:	88	1.955	0.796	0.634	m^2	102.33
SBM10:	88	1.670	0.822	0.675	m^3	2 394.56
SBM11:	88	2.034	0.859	0.737	m^2	196.65
SBM12:	88	2.273	0.836	0.698	no	176.00

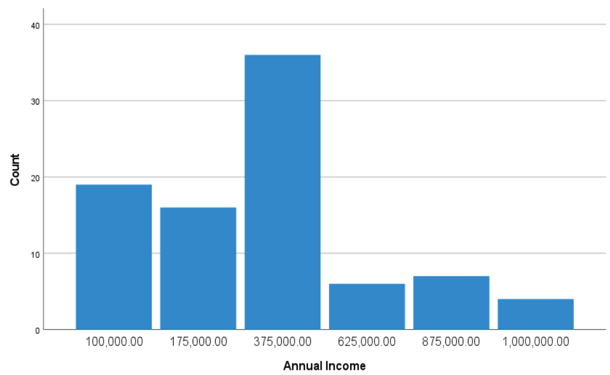

Figure 1 Average Annual Income of Participants Socioeconomic classes within South Africa's metropolitan population cross-sectionally (2022) in Rands.

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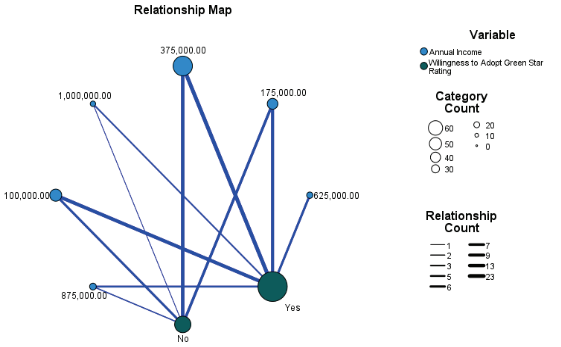

Figure 2 Relationship Between Annual Income and Willingness to Adopt a Green Star Rating.

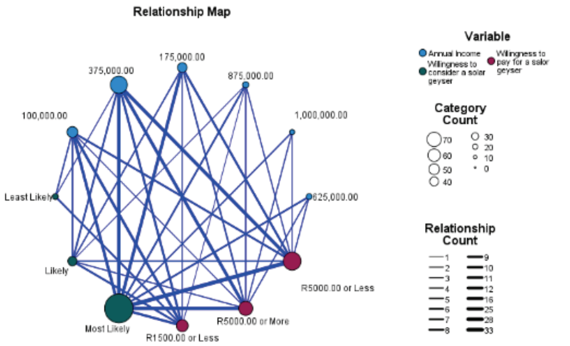

Figure 3 Relationship Between Annual Income, Willingness to Adopt a Solar Geyser and Willingness to Pay for a Solar Geyser.

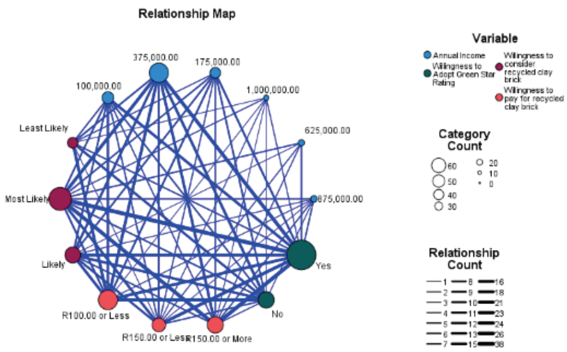

Figure 4 Relationship Between Annual Income, Willingness to Adopt a Green Star, Willingness to Consider Recycled Clay Bricks and Willingness to Pay for Recycled Clay Bricks.

Discussion

This study examines South African end-users' willingness to adopt sustainable housing, focusing on affordability, awareness, and perceived benefits. It reveals a significant interest in energy-efficient technologies like LED sensor lights and solar geysers. Despite this interest, barriers like high upfront costs and limited financing options persist. The study also identifies a market gap for sustainable materials, contrasting with previous literature. The unique socio-economic and sociocultural aspect could be a driver of acceptance when considering the context of South Africa and may explain this discrepancy from literature, suggesting a need for further research. This study confirms that South African end-users are aware of sustainability, regardless of socioeconomic status. The study reveals a series of phenomena at play affecting the sustainable housing market and future research must conceptualise a solution should South Africa's end-users remain outside of the majority of global adopters of sustainable housing practices.

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Conclusion

The study finds that middle-class and wealthier South Africans lead the push for sustainable housing. While low-income groups recognise the benefits, they face affordability challenges despite a considerable willingness to live in a sustainable home. The study identifies preferred sustainable materials across income groups and their willingness to pay, revealing a market gap, especially among middle-income earners and the identification that the market is still not where it needs to be in terms of its manufacturing supply chains to meet the costs required to provide sustainable homes for lower income end-users. It underscores the need for inclusivity in sustainable housing development and this study's findings has practical implications for policymakers and the construction industry.

Recommendations

Policy analysis on government support for sustainable housing is needed. Raising awareness through collaborative efforts among government, industry, and non-profits is recommended. Future research should focus on overcoming barriers to adoption, including socioeconomic and sociocultural factors, by investigating the impact of government policies, tax incentives for manufacturers to innovate more affordable solutions for sustainable housing adoption to meet its inclusivity targets. Given the study's small sample size, longitudinal studies are suggested for future research.

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