Comparing Occupant Satisfaction in Green Versus Conventional Residential Real Estate in South Africa

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Abstract

This study compares occupant satisfaction in green versus conventional residential real estate in South Africa. It investigates the benefits and satisfaction levels related to green developments, particularly in terms of energy savings and socio-economic impacts. The research aimed to determine if there is a significant difference in occupant satisfaction between green and conventional residential developments. A quantitative approach was employed, utilizing stratified random sampling to survey 160 occupants from two developments: Crossberry Central (green) and Little Manhattan (conventional). Data was analysed using the Mann-Whitney U and Wilcoxon W tests due to non-normal data distribution. The findings indicate that occupants of green developments report significantly higher satisfaction levels. Key areas of satisfaction include air quality, utility savings, and environmental benefits. Green developments demonstrate higher levels of satisfaction regarding reduced utility bills, improved indoor air quality, and contributions to environmental conservation. The study concludes that green residential developments significantly enhance occupant satisfaction compared to conventional housing. This suggests a socio-cultural shift towards valuing sustainable living environments, emphasising the importance of promoting green building practices to improve both environmental and occupant well-being.

Keywords: Green buildings, occupant satisfaction, residential developments, South Africa.

1. Introduction

1.1 Green developments in African housing

Khoshbakht et al., (2018) highlighted that Africa is experiencing significant strain in providing clean water, electricity, sanitation, refuse collection, and basic service delivery, a situation exacerbated by climate change (Bobbins et al., 2023; Sewchurran and Davidson, 2021; Will Ingram and Patrick Thomson, 2022). Increasing the number of green developments can create a safer environment for future generations (Weaich et al., 2024). Khoshbakht et al., (2018) define green buildings as a practice in the building industry that prioritizes environmental responsibility and resource efficiency throughout the entire building life cycle.

Over the past five years, South Africa has faced an energy crisis, with utility costs increasing by an average of 15% annually, reducing the disposable income of the average South African resident (Statista, 2023; Wentink, 2023). Green developments, however, are demonstrating an average of 20% savings on utility bills, as reported by (Habitat for Humanity, 2024).

1.2 Awareness and benefits of green initiatives

Both Smit and Du Toit, (2015) and Weaich et al., (2023) note that South Africa has a high level of awareness about green initiatives and green technology as solutions to current and future environmental challenges. The extent of the benefits to users of these developments, however, remains a topic that requires continuous exploration (Nhamo et al., 2024). Similarly, the importance of new developments in adapting to the evolving needs of both humans and the environment continues to be explored and investigated (Mpofu et al., 2024; Ndiweni, 2020; Simbanegavi, 2019; Weaich et al., 2024; Yang et al., 2018).

The residential real estate market in South Africa is highly competitive, prompting many property companies to invest in green initiatives to gain competitive advantage, considering that housing can be considered a safe investment capable of outpacing inflation (Mpofu et al., 2024; Simbanegavi, 2019; Wang et al., 2020; Zhao et al., 2021). This competition underscores the need to investigate occupant satisfaction with these green products.

1.3 Occupant satisfaction with green developments

Given this, there is a concern about occupant satisfaction regarding greening efforts, particularly in terms of energy savings, natural sources of energy, and clean water sources (Laiche et al., 2021). The main question is: to what extent are these efforts benefiting the current inhabitants of the developments, and is there an appreciation of the financial and socio-economic benefits?

This paper aims to determine whether there is a difference in occupant satisfaction between green residential developments and conventional residential developments in South Africa. Specifically, it seeks to answer three questions:

- What is the extent of occupant satisfaction with green residential developments compared to non-green residential developments?
- What is the extent of occupant satisfaction with utility bills in green residential developments compared to non-green residential developments?
- Are occupants of green developments satisfied with the socio-economic benefits that accompany green developments compared to non-green developments?

1.4 Objectives and hypotheses

This paper aims to achieve three primary objectives, each accompanied by corresponding hypotheses.

Objective (i): Investigating the extent of occupant satisfaction with green residential developments compared to non-green residential developments.

$\boldsymbol{H_0}$: Most occupants are not satisfied with green residential developments compared to non-green developments, as they perceive no benefits in terms of air quality, reduced window-to-wall ratio, aluminium window frames, solid dense concrete blocks for internal and external walls, and ceramic tiles for flooring.

$\boldsymbol{H_1}$: Most occupants are satisfied with green developments compared to non-green developments due to the improved air quality, reduced window-to-wall ratio, aluminium window frames, solid dense concrete blocks for internal and external walls, and ceramic tiles for flooring.

Objective (ii): Investigating occupant satisfaction with utility bills in green residential developments compared to non-green residential developments

$\boldsymbol{H_0}$: Most occupants in green developments are not satisfied with their utility consumption bills, as they do not observe a reduction in utility bills compared to non-green developments.

$\boldsymbol{H_1}$: Most occupants in green developments are satisfied with their reduced utility consumption bills compared to occupants of non-green developments, due to greening initiatives such as low-flow showerheads, low-flow faucets for kitchen sinks and washbasins, dual flush water closets, LED lighting, and solar-heated geysers.

Objective (iii): Investigating if occupants of green developments are satisfied with the socio-economic benefits that come with green developments compared to non-green developments.

$\boldsymbol{H_0}$: Most occupants are not satisfied that green developments contribute to saving the planet compared to non-green developments.

$\boldsymbol{H_1}$: Most occupants are satisfied that green developments contribute to saving the planet due to the use of conservative materials in construction and renewable sources of energy, compared to non-green developments.

2. Literature Review

2.1 Greening of real estate developments to reduce global warming

Khoshbakht et al., (2018) assert that globally, there is at an extremely elevated risk of global warming, and if necessary, interventions are ignored, there may not be an Earth for future generations. A critical measure to help manage global warming and climate change is the encouragement of green real estate developments (Simbanegavi et al., 2020). The popularity and acceptance of green developments are heavily influenced by how current beneficiaries and end-users perceive them (Gurmu et al., 2022; Shooshtarian et al., 2021; Weaich et al., 2023). Khoshbakht et al., (2018) demonstrated in their study that green developments enhance user experience and reduce energy and resource consumption.

2.2 History and motivators of green initiatives

Onuoha and Okeahialam, (2018) noted that green development initiatives began in 2007 in South Africa with the establishment of the Green Building Council of South Africa (GBCSA). The GBCSA pioneered and championed green initiatives, encouraging both public and private sectors to develop policies that lead to the building and construction sectors delivering developments that reduce environmental carbon footprints, lower energy use, and promote sustainable living (Simpeh and Smallwood, 2024). Akreim and Suzer, (2018) stated that for policies regarding green developments to be adopted and followed, specific motivators are necessary. They defined motivators as catalysts that drive people to act in a particular manner, which are crucial for promoting decision-making towards transitioning to green developments. Some identified motivators include improved indoor air quality, lower annual energy costs, contribution to controlling climate change, increased building value, and enhanced water quality.

2.3 Happiness as a measure of satisfaction vs costs in green developments

Wu and Lo, (2018) conducted a study in Taiwan, highlighting that occupant of green developments reported higher levels of ‘happiness’ compared to those in conventional developments. However, the costs of green developments were deemed inconclusive, as another sector of society perceives green developments as expensive.

3. Methodology

3.1 Occupant satisfaction in housing developments

Quantitative methods were employed to compare occupant satisfaction between two of International Housing Solutions’ housing developments (International Housing Solutions, 2023; Saunders et al., 2023). One is a green residential development called Crossberry Central, EDGE-rated by the Green Building Council of South Africa, and the other is a non-green residential building called Little Manhattan. The chosen population for this study was occupants of Crossberry Central (green building) and Little Manhattan Lower East (non-green building) (Treiman, 2009). Both developments are in Gauteng Province.

3.2 Stratified sampling

The sampling design used was stratified random sampling (Castiglione et al., 2024). This method was chosen due to the nature of the study, which aimed to select equal sub-groups from the two groups—Crossberry Central and Little Manhattan Lower East—at random. The sample size was 160, with eighty people from each development. Surveys were used for data collection (Brace, 2018).

3.3 Non-normal data analysis techniques

To test data normality, the Shapiro-Wilk test was conducted (Verzani, 2014). The data analysis methods used in this study were the Mann-Whitney U and Wilcoxon W tests, as the data were non-normally distributed (Corder and Foreman, 2009).

4. Results

4.1 Data characteristics

Participants in this study came from diverse backgrounds, with varying gender, income levels, and education levels. The study was conducted in 2022.

4.1.1 Gender

Out of 160 respondents, 47.5% were male, and 52.2% were female. The data highlighted that more females were staying in green developments than males, with females making up over 50% of the occupants in green developments.

4.1.2 Income

The data (Figure 1) depicts that occupants of green developments generally have slightly higher monthly incomes compared to those in non-green developments. Among non-green development respondents, 13.8% earned below R10,000 per month, compared to only 5% of green development respondents earning below this amount. Both groups shared a 67.5% proportion in the income range of R10,001 to R50,000. In the higher income group of R50,001 to R100,000, green developments had a higher percentage of respondents at 26.3%, compared to 18.8% in non-green developments. The data further indicates that many occupants of green developments are satisfied with their living conditions. The dominant income groups in green developments range from R10,000 to R100,000, suggesting a preference for green developments among those who can manage the significant initial costs, despite the long-term savings associated with these developments.

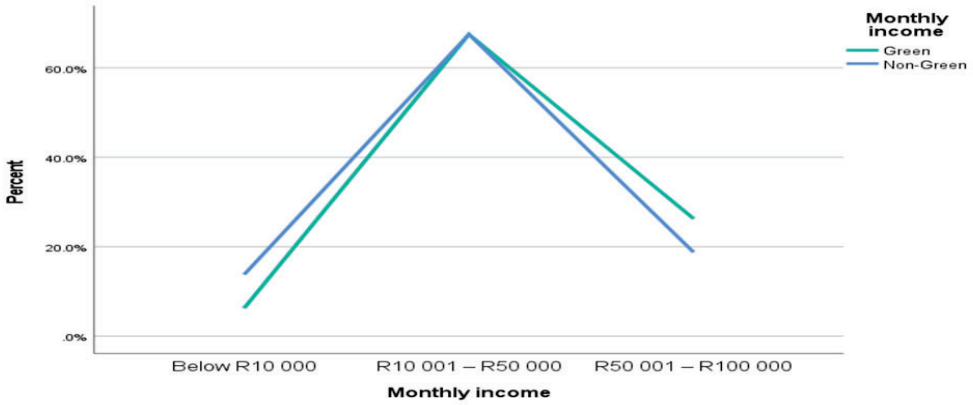

Figure 1: Monthly income
Source: Authors Dataset, 2022

4.1.3 Education

The results (Figure 2) indicate that green developments have a lower percentage of respondents with less than a matric certificate, amounting to 15%, compared to 18.8% in non-green developments. Green developments have the highest number of respondents with a bachelor's degree as their highest qualification, quantified at 31.3%, compared to 11.3% in non-green developments. For master's degrees, green developments also have a higher percentage of respondents, with 8.8% holding a master's degree compared to 3.8% in non-green developments.

The data also highlights that the most dominant age groups in non-green buildings are 18-24 years and 25-34 years. This is attributed to new entrants into the workforce coming from colleges and universities. Additionally, the data depicts that over 66% of respondents in non-green developments hold a National Diploma.

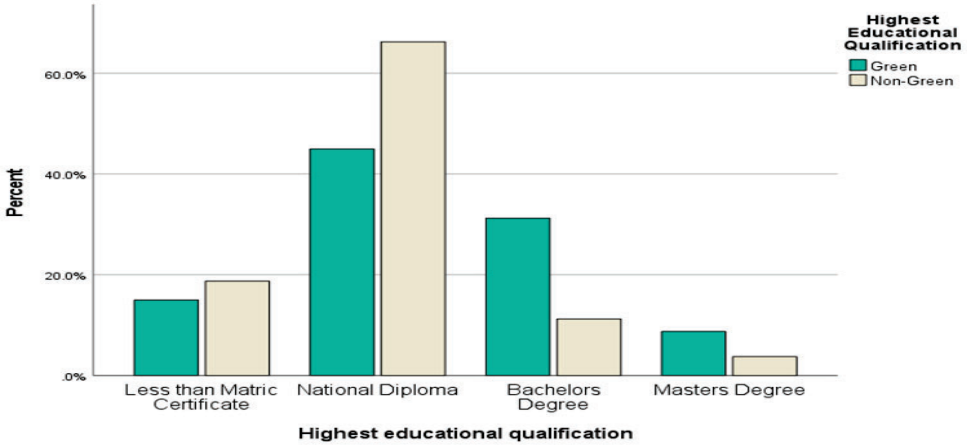

Figure 2: Highest Educational Qualification
Source: Authors Dataset, 2022

4.2 Data normality test

The data normality test for this study was conducted using the Shapiro-Wilk test (Table 1). Das and Imon (2016) highlighted that the Shapiro-Wilk test is a useful tool for assessing normality, as it is based on the correlation between given observations and associated normal scores. The hypotheses used to analyse if the gathered data were normally distributed are:

$\boldsymbol{H_0}$: The data gathered for the study are normally distributed.

$\boldsymbol{H_1}$: The data gathered for the study are not normally distributed.

Table 1: Data Normality Test

	Tests of Normality			
		Shapiro-Wilk		
		Statistic	df	Sig.
Q6	I am satisfied with the air quality of the apartment.	.905	160	<,001
Q7	I am satisfied with the aluminium window frames.	.886	160	<,001
Q8	I am satisfied with staying in a green building compared to staying in a non-green building.	.891	160	<,001
Q9	I am satisfied with the green component of solar heated geysers in assisting to save energy and costs	.867	160	<,001
Q10	I satisfied that the energy saving lights are assisting in saving energy and costs	.878	160	<,001
Q11	I am satisfied that the low flow faucet in my kitchen sink assists in saving water and costs	.875	160	<,001
Q12	I am satisfied that the low flow showerhead in my bathroom assists in saving water and costs	.872	160	<,001
Q13	I am satisfied with less energy usage in my apartment.	.874	160	<,001
Q14	I am satisfied with my utility bills.	.861	160	<,001
Q15	I am satisfied that my apartment was built in a manner that allows for saving the environment.	.891	160	<,001
Q16	I am satisfied with staying in my apartment as I contribute to conserving water.	.870	160	<,001
Q17	I am satisfied with overall savings from my reduced utility bills.	.841	160	<,001
Q18	I am satisfied with the reduced window to wall ratio	.909	160	<,001

Source: Authors Dataset, 2022

The p-values of the attributes utilised in the data collection tool (survey) indicate that they are all less than 0.05 ($p < 0.05$). This result leads to the rejection of the H_0 hypothesis, concluding that the data are non-normally distributed (Corder and Foreman, 2009; Hansen-Schirra et al., 2017). Consequently, the Mann-Whitney U test and Wilcoxon W tests were used as the default models for data analysis (Corder and Foreman, 2009).

5. Discussion

The results are presented according to the three specified objectives. The study finds higher occupant satisfaction in green housing developments compared to non-green housing developments. Occupant satisfaction is notably higher in green housing due to savings on utility bills. Additionally, there is greater satisfaction in green housing related to saving the planet using green materials and renewable energy sources.

5.1 Higher occupant satisfaction in green developments

The study findings highlight a significantly higher level of occupant satisfaction in green housing developments compared to non-green housing developments. Specifically, 72.5% of respondents in green developments reported high satisfaction with air quality. Regarding the window-to-wall ratio, 67.6% expressed satisfaction, and 70% were satisfied with the overall indoor environment. An emphatic 77.6% of respondents indicated overall satisfaction with living in green developments compared to non-green ones.

A Mann-Whitney U test and a Wilcoxon W test were conducted to assess the extent of occupant satisfaction between green and non-green residential developments. The data analysis yielded a p-value of <0.001, which is below the significance level of 0.05. This provides sufficient evidence to reject the null hypothesis and accept the alternative hypothesis that most occupants are happier staying in green developments compared to non-green developments (Corder and Foreman, 2009).

The results affirm occupant experiences regarding satisfaction and comfort in green buildings, aligning with findings from other studies such as Khoshbakht et al. (2022) and Gou et al., (2013), however, the findings in this study provide contradictory arguments. Historical literature on green building satisfaction, including studies by Gou et al. (2013), Menadue et al. (2012), and Gou et al. (2012), depicted lower satisfaction and comfort levels due to green building design choices, creating a link between lower satisfaction levels and selected green building design choices whilst a more recent study, Khoshbakht et al. (2022) found no significant differences in satisfaction and comfort between green and non-green buildings, presenting a conflicting argument for this study's findings.

Table 1: Mann-Whitney U test – Satisfaction & Green Building

Test Statistics[a]				
	I am satisfied with the air quality of the apartment.	I am satisfied with the reduced window to wall ration.	I am satisfied with the aluminum window frames.	I am satisfied with staying in green building compared to staying in a non-green building.
Mann-Whitney U	564.500	602.500	386.000	337.500
Wilcoxon W	3804.500	3842.500	3626.000	3577.500
Z	-9.274	-9.099	-9.809	-10.031
Asymp.Sig. (2 -tailed)	<, 001	<, 001	<, 001	<, 001
a. Grouping Variable: Indicate if your building is a green or non-green				

Source: Authors Dataset, 2022

These results affirm that green buildings now provide higher levels of satisfaction, indicating a socio-cultural temporal shift in satisfaction levels over time, which Deuble and De Dear (2012), argue that this is due to climate change awareness, whilst Tashiro and Kotsubo (2022), depicts that the COVID-19 pandemic has had a psychological effect on occupants in relation to building air quality. This variation underscores the importance of considering specific user needs and preferences in the design and operation of green buildings, highlighting the necessity for tailored approaches to maximise occupant satisfaction.

5.2. Occupant satisfaction with utility bills in green vs. non-green housing

The study posed six questions to respondents to assess satisfaction levels in green developments compared to non-green developments regarding solar-heated geysers, energy-saving lights (LED), low-flow faucets in kitchens, low-flow showerheads in bathrooms, utility usage, and utility bills. In green developments, 76% of respondents reported overall satisfaction across these six attributes. In stark contrast, non-green residential developments had an overall average satisfaction of just 14%, clearly indicating lower satisfaction levels, particularly concerning utility bills.

Data analysis revealed that 85.1% of respondents in green developments were satisfied with the savings they are earning by staying in such developments. Conversely, there was 0% satisfaction with utility bill savings in non-green developments, as conventional buildings offer little to no savings, leading to increased frustration due to rising utility costs. This finding underscores that more savings from utilities translate to more disposable income, thereby enhancing occupant satisfaction. This corroborates the findings of Wu and Zhou, (2022), who noted that financial savings are a critical factor in occupant satisfaction in green buildings.

Additionally, 82.6% of respondents in green developments expressed satisfaction with staying in an apartment that contributes to water conservation. In contrast, non-green developments exhibited a general dissatisfaction rate of 92.6% regarding water conservation. This significant disparity indicates a strong need for conventional developments to be upgraded to meet modern greening standards to conserve water and increase occupant satisfaction. These findings align with Altomonte et al., (2017) and Altomonte et al., (2019), emphasizing the role of sustainable practices in enhancing occupant satisfaction.

The Mann-Whitney U test and Wilcoxon W test were conducted to evaluate occupant satisfaction with utility bills in green residential developments compared to non-green residential developments (Corder and Foreman, 2009). The data analysis yielded a p-value of <0.001, which is below the significance level of 0.05 (Weisberg, 2014). This result leads to the rejection of the null hypothesis, confirming that most occupants in green developments are satisfied with their reduced utility consumption bills compared to those in non-green residential developments.

These findings highlight the critical role of green building practices in reducing utility costs and enhancing occupant satisfaction. They suggest that upgrading conventional buildings to incorporate green technologies can significantly improve financial and environmental outcomes for occupants. This study thus supports the growing body of evidence that green developments not only contribute to environmental sustainability but also offer tangible financial benefits to their occupants, reinforcing the need for broader adoption of green building practices.

Table 2: Mann-Whitney U test – Satisfaction with Overall Utility Bills

Test Statistics[a]						
	I am satisfied with the green component of solar heated geysers to save energy and costs.	I am satisfied that the energy saving lights are assisting in saving energy and costs.	I am satisfied that the low flow faucet in my kitchen sink assists in saving water and costs.	I am satisfied that the low flow showerhead in my bathroom assists in saving water and costs	I am satisfied with less energy usage in my apartment	I am satisfied with my utility bills
Mann-Whitney U	250.00	136.500	461.000	464.000	8323.000	444.55
Wilcoxon W	3490.000	3376.500	3701.000	3704.000	3563.000	3684.500
Z	-10.347	-10.692	-9.581	-9.551	-10.054	-9.624
Asymp.Sig. (2 - tailed)	<, 001	<, 001	<, 001	<, 001	<, 001	<, 001
a. Grouping Variable: Indicate if your building is a green or non-green						

Source: Authors Dataset, 2022

5.3 Utility savings and satisfaction in green developments

Most occupants in green developments are satisfied with their reduced utility consumption bills compared to those in non-green developments. This satisfaction is attributed to greening initiatives such as low-flow showerheads, low-flow faucets for kitchen sinks and washbasins, dual flush water closets, LED lighting, and solar-heated geysers.

The findings contrast with those of Khoshbakht et al. (2022), whose data were inconclusive regarding the energy efficiency benefits of green developments compared to conventional developments. However, this study aligns with Shabrin and Kashem (2017), who found that green developments exhibit greater electricity savings, a crucial benefit given the financial strain on households due to rising utility costs (Bohlmann and Inglesi-Lotz, 2021). Furthermore, the results support the conclusions of Simbanegavi et al. (2020) and Kim et al. (2017), which indicates that occupants of green housing developments save approximately 20% on utilities.

5.4 Socio-economic benefits and environmental impact of green developments

The findings of this study indicate that 78.7% of respondents in green developments were satisfied with their living conditions, compared to only 13.8% in non-green developments. This stark contrast underscores the growing importance of environmental considerations in residential satisfaction. The issue of environmental conservation is paramount in global discussions, with increasing emphasis on measures that can help save the planet. Our findings suggest that most respondents are happier with green developments because they are constructed with materials and practices designed to protect the environment.

To rigorously assess occupant satisfaction with the socio-economic benefits of green developments compared to non-green developments, the Mann-Whitney U test and the Wilcoxon W test were conducted. The tests focused on the use of conservative construction materials and renewable energy sources. The data analysis revealed a p-value of <0.001, which is below the significance level of 0.05. This result led to the rejection of the null hypothesis, indicating that most occupants

are satisfied with the contributions of green developments to environmental conservation due to the use of sustainable materials and renewable energy.

These results align with the findings of Shabrin and Kashem (2017), who reported that green developments offer significant electricity savings, thereby reducing the financial strain on households. Similarly, Simbanegavi et al. (2020) and Kim et al. (2017) found that occupants of green housing developments save approximately 20% on utilities, further supporting the socio-economic benefits highlighted in our study.

However, these findings contradict the study by Khoshbakht et al. (2022), which found inconclusive evidence regarding the energy efficiency benefits of green developments compared to conventional developments, this highlights and contradicts Khoshbakht et al. (2022), in saying that that green developments not only contribute to environmental sustainability but also enhance occupant satisfaction through socio-economic benefits. These include reduced utility bills and the positive impact of living in environmentally responsible buildings. The significant satisfaction levels among occupants of green developments underscore the importance of sustainable building practices and the use of renewable energy sources in residential construction.

The study affirms the positive relationship between green developments and occupant satisfaction, particularly regarding environmental and socio-economic benefits. These results emphasize the need for continued promotion and implementation of green building practices to meet the dual goals of enhancing occupant well-being and conserving the environment (Hu, 2013).

Table 3: Mann-Whitney U test on Conservative Construction Materials & Use of Renewable Sources

	I am satisfied that my apartment was built in a manner that allows for saving the environment.	I am satisfied with staying in my apartment as I contribute in conserving water.	I am satisfied with overall savings from my reduced utility bills.
Mann-Whitney U	197.500	115.500	161.500
Wilcoxon W	3437.500	3355.500	3401.500
Z	-10.515	-10.804	-10.645
Asymp. Sig. (2-tailed)	<,001	<,001	<,001

(Source: Authors Dataset, 2022)

6. Conclusion and Future Studies

The study concludes that occupants of green residential developments are more satisfied with good air quality, reduced window-to-wall ratios, aluminum window frames, solid dense concrete blocks for internal and external walls, and ceramic tiles for flooring. The savings from reduced utility consumption bills in green residential developments, compared to non-green developments, provide an additional benefit to occupants. Occupants are increasingly conscious of environmental conservation, making green housing developments a highly sought-after asset.

The implication of this study is that satisfied occupants are likely to commit to longer occupational leases in green housing compared to non-green housing. This can reduce operational costs associated with shorter leases that require recurring marketing efforts. The study recommends green-retrofitting conventional residential real estate with green technologies to improve

satisfaction levels to retain occupants. Further research into the link between green residential developments and a fund manager's profitability could be valuable to the industry.

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