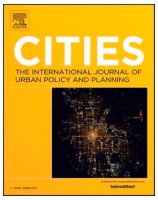
Cities 129 (2022) 103809

Contents lists available at ScienceDirect

Cities

journal homepage: www.elsevier.com/locate/cities



Is green good: Unveiling the latent benefits of sustainable housing delivery

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ARTICLE INFO

Keywords:
Benefits
Built environment
Green housing
Housing delivery
Sustainability

ABSTRACT

Sustainable green housing delivery has been advocated as the pathway to a balanced built environment. However, stakeholders have not fully embraced its adoption, particularly in developing nations. To encourage the widespread adoption of sustainable housing, a better understanding into sustainable green development's potentials are imperative. This research unveils sustainable green housing delivery benefits. The common beneficial themes from the literature were extracted for investigation using a structured questionnaire. The survey participants were private investors (housing developers) and academia. Data for the study were analysed using mean item score, factor analysis, and ranking agreement analysis. Findings indicated that all the identified 22 investigated benefits are essential. The factor analytical result grouped these variables into satisfaction, housing promotion, cost minimization, economic promotion, and environmental development-related benefits. The agreement analysis revealed a high level of consensus between housing developers and academia on housing promotion (73%), economic promotion (100%), and environmental development (100%) related benefits. This study's findings are a credible road map and prudent recommendation for housing providers to implement sustainable housing delivery to promote a balanced and sustainable environment. It will also assist the government, clients, policymakers, and practitioners in increasing the delivery and investment in sustainable housing.

1. Introduction

The traditional housing delivery system in developing nations has detrimental effects on the economy, society, and the environment. Apart from the fact that the housing supply does not meet the geometric rise in population, the delivery has been devoid of social ingredients (Maliene & Malys, 2009). Over the years, the traditional housing development system has contributed negatively to the environment globally. For example, the housing construction sector is believed to utilise 45% of energy in its operations, 40% of raw materials are eaten up, and about 40% of waste is generated. Furthermore, approximately 25% of carbon (iv) oxide is released, around 50% of fluorocarbon output is released, and landfill materials make up 40%. The traditional housing development also represents 40% of greenhouse gas emissions and utilise 15% of the world's usable water, thus eating up 32% of the fund and stock resources (Chan et al., 2018). Therefore, the traditional housing delivery system has not helped the nations (Berardi, 2013; Killip, 2006; Sherwin, 2000). Since housing is the heartbeat of a country, the negative effect posed by traditional housing developments prompted the need for sustainable development (Akinshipe et al., 2019; Kolawole & Anigbogu, 2005).

Sustainable development is the attainment of improved quality of life via careful use of resources while promoting the nation's social, economic, and environmental goals (Ibem & Aduwo, 2013). Oyebanji et al. (2017) view the development as one that enhances the needs of the living and preserves the unborn through efficient use of environmentally friendly, socially acceptable, and economically viable resources. Accordingly, it is a development that embodies different housing criteria (Olanrewaju et al., 2018). These criteria include but are not limited to affordability, durability, waste minimization, social impact, energy efficiency, indoor quality, and being user-friendly. It is always planned and designed with attention to social, environmental, and economic indicators (Gibberd, 2002). It is an 'energy-efficient' and 'healthy' building. Due to the inherent benefit, many nations aim to attain

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https://doi.org/10.1016/j.cities.2022.103809
Received 22 January 2021; Received in revised form 5 March 2022; Accepted 2 June 2022
Available online 17 June 2022

sustainable housing development.

Sustainable green housing delivery is advocated as the pathway to a balanced built environment. Hamid et al. (2014) noted that most nation efforts had been directed towards sustainability. However, it is surprising that most construction stakeholders, particularly in developing countries, are yet to tap into the intrinsic values and benefits that sustainability offers (Ibrahim et al., 2013; Olanrewaju et al., 2018). This has resulted in a lack of demand for and the implementation of sustainable housing. Hayles (2006) concluded that there would be no demand for such development without creating awareness and educating about it. Olanrewaju et al. (2018) affirmed that sustainable housing supply would rise when demand for it increases. This is also dependent on the awareness of sustainable development. Accordingly, Williams and Dair (2007b) submitted that certainty about its significance is imperative to promote a sustainable built environment. More certainty would spur clients to increase investment in sustainable housing, invariably pushing professionals to develop more. Promoting the wide adoption and delivery of sustainable housing in developing nations is tied to creating a better understanding of the drivers and benefits of sustainable housing delivery against the experiences over the years (Darko et al., 2017; Dodge Data & Analytics, 2017).

Presently only a fraction of housing development in developing countries utilise sustainability characteristics (Oluleye et al., 2020). The primary factor responsible for this could be attributable to the lack of clients' knowledge about sustainability and government awareness of the perceived benefits inherent in developing sustainable housing (Akinshipe et al., 2019; Chan et al., 2018). The client's lack of motivation could also be linked to undefined benefits inherent in sustainable housing delivery to the society, economy, and environment. Adetunji et al. (2003) posited that lack of clear understanding of sustainable housing benefits is one of the significant issues in various countries' housing sector. Sourani and Sohail (2005) submitted that developers and society are in the dark to understand the fundamental significance of sustainable housing delivery. Darko et al. (2017) reiterated that the main issue plaguing sustainable housing delivery in developing countries is the inability to clearly show the co-benefits inherent during and after the delivery system.

Any sustainable project success depends on the awareness and knowledge of its benefits. Therefore, awareness and knowledge of the benefits inherent in sustainable housing are the critical issues that need to be addressed to create sustainable housing delivery (Abidin, 2010). This study explored housing developers and academia's understanding of the built environment discipline regarding the benefits inherent in sustainable housing delivery. The rationale for assessing the view of both respondents stems from their role in the construction sector. The housing developers engage in the actual (practical) housing delivery, and those in academia are involved in the theoretical foundation of teachings on housing delivery. The results of this study would make an essential contribution to the research in sustainable housing and be an eye-opener that provides information to homebuyers, practitioners, clients, policymakers, and every stakeholder in the housing industry on the contribution that could help attain sustainable housing. This study's outcome would also provide a valuable basis for why the implementation and delivery of sustainable housing should be promoted.

1.1. Sustainability and housing: a conceptual framework

Over the last decades, there has been a significant decline in sustainable, affordable housing provision (Moghayedi et al., 2021). Also, urbanisation due to population upsurge and the demand for housing brought challenges to most urban areas. These forms of problems could be socio-economic, environmental, and governance (Belanche et al., 2016; Yigitcanlar et al., 2018). Monzon (2015) suggested that the challenges can be socio-economic, legal, financial, and technological. This is why, as the urban environment develops, new challenges crop up and add to the existing ones (Camero & Alba, 2019; Joshi et al., 2016). Therefore, a city that aims for sustainability should consider the rising challenges the stakeholders face in housing provision and its associated obstacles, barriers, and limitations.

Stakeholders involved in housing provisions and development have a key role in pivoting the environment towards sustainable, resilient, and regenerative development pathways (Hestad et al., 2021). Likewise, in promoting sustainability transformations, they must develop the capacity to adapt and transform. Therefore, enabling environments and an adaptive approach will help mitigate the unintended negative consequences. The concepts of sustainability and housing are believed to relate to each other in our everyday life (Vehbi et al., 2010). The main concern of sustainable housing is not just to meet the citizens' accommodation needs; but that the housing environment must be safeguarded from deteriorating to the extent that it weakens the ability of unborn generations to meet their housing needs. This means that sustainable housing should only be focused on meeting basic needs, but must also entail improving the liveability and quality of life enjoyed by the citizens. This should be in terms of economic, social, and cultural dimensions.

Sustainable housing should promote good climatic conditions, ensuring energy and efficiency of resources in the housing industry. The UN-HABITAT (2012) suggests that sustainable housing must enhance the protection of the ecosystem, promote sustainable and low carbon infrastructure in the cities, promote safe, decent location and green area, and achieve access to infrastructures. Similarly, the urban policy framework for neighbourhood sustainability put forward by UN-HABITAT (2012) includes resources affordability, green design, home adaption, and hazard elements prevention. For a city to be healthy, pollution must be reduced to the barest minimum. This is what the concept of greening entails. However, the greatest challenge when creating a healthy city is developing public awareness (McCay & Burszta, 2016). Denis et al. (2021) suggest that the urban environment design, inclusive of housing, should provide proper mental comfort to its inhabitants. For instance, a good city should provide access to jobs and create a platform for people to relate to each other in a space that provides access to green areas and recreation.

According to Vehbi et al. (2010), the relationship between sustainability and housing can be jointly viewed as two concepts. First, the need to incorporate sustainable principles into housing development, maintenance, and refurbishment. This will contribute to achieving sustainability objectives and provide important advances in housing developments' quality, durability, and cost-effectiveness. Second, there is a need for a change in culture concerning housing development. This helps in placing sustainability at the center stage of property development. In the recent past, cities have tried to boost innovation and provide favourable urban solutions by implementing technological advancements (Siokas et al., 2021). Researchers have also advocated that to meet sustainable development goals, there is the need to incorporate the development of green housing into the property sector. This is due to the benefits that green developments are believed to offer. Likewise, to promote sustainable housing developments, it can be argued that a framework for sustainable green housing should be conceived from three inter-related dimensions. These also include economic benefits, social benefits, and environmental benefits. This suggests that sustainability objectives in housing can only be met if considered at all stages of the project life cycle. That is, from the design process (initial construction) through the long-term use to the eventual disposal and recycling. There is a need to raise awareness for all those involved at all stages to achieve this. Accordingly, Ojo-Fafore et al. (2018) also argued that development according to environmentally sustainable urban policy is crucial to developing and promoting urban cities and sustainable development goals.

2. Sustainable green housing and its associated benefits

Sustainable housing and its origin could be traced to Brundtland

Report in 1987. Here, sustainable development was regarded as a veritable tool and a panacea for a better-built environment, making provision for the present by amalgamating environmental issues and social and economic issues to meet the needs that won't jeopardise the future. Ibem and Aduwo (2013) posited that sustainable housing is a secure shelter that uses affordable, safe, and healthy material and in a neighbourhood that makes provision for quality water, good sanitation and drainage system, health care facilities, transportation facilities, quality education, and development of the children without overlooking environmental pollution and hazard prevention. It is the housing that meets the social and cultural priorities of the people. UN-HABITAT (2012) submitted that sustainable dwelling embraces quality construction, affordability, and the use of renewable resources. From the foregoing, sustainable housing can be described as one that gives adequate attention to the social, economic, and environmental dimensions of sustainability in a holistic way.

Darko et al. (2018) noted that the perceived top benefits of sustainable housing in the literature include a decrease in lifecycle cost, energy efficiency, health and comfort enhancement, productivity enhancement, and environmental protection. In Malaysia, Olanrewaju et al. (2018) investigated housing providers' insights on sustainable, affordable housing benefits using a cross-sectional approach. The study submitted that sustainable housing delivery offers diverse benefits, among which are improvement in the comfort of homeowners, the enjoyment of natural ventilation, a reduction in water bills, and decrease in electricity bills, reduction in housing maintenance cost, improvement of quality of life, and improvement in housing values. Chua and Oh (2011) investigated green prospects and progress in Malaysia based on observation and an audit checklist and found that going sustainable in housing delivery significantly impacts the national economy's performance and minimizes the cost expended on housing maintenance.

Ojo-Fafore et al. (2018) examined the benefits of green buildings in Johannesburg. Data for the study were collected via a questionnaire administered to the construction professionals. The study found that sustainable housing would enhance the provision of better health for occupants, develop more energy-efficient products, comfort improvement, and lower environmental and emission costs. In Australia, Moore et al. (2017) researched the benefits and challenges of energy-efficient social housing. They discovered that low-income households are the significant beneficiaries of such housing. This is because they enjoy thermal comfort, cost of maintenance minimization, improved health, and well-being. The study also established that other benefits that could accrue from such dwellings include reducing the cost of living, enhancing the occupants' savings, and financial situations. Likewise, other benefits are reducing maintenance costs and enabling households to keep their dwellings better than non-sustainable housing.

Roshanfekr et al. (2016) investigated sustainable housing criteria and benefits via a literature review. The study found that most of the perceived benefits of sustainable housing include safety and security, maintenance cost reduction accessibility, affordability to low-income earners, durability, and long-lasting. The study also found that sustainable housing ensures minimal adverse effects on buildings, occupants, and the environment. Dahiru et al. (2014) examined the prospects of green building practices in Nigeria using data obtained via questionnaire administered to construction professionals in academics. The study found that the benefits derived from sustainable buildings include reducing capital cost, reduction in investment risk, market benefits, enhancement of occupants' health, and productivity gain.

Bordass (2000) investigated cost and value about time and fiction. The study described data collected from the respondents via questionnaire and found the significant importance of sustainable housing in terms of value through improved rental income from the property. The findings corroborate Edwards (2006) that sustainable housing often improves and enhances a property's rental income. Bersson et al. (2012) developed a framework for applying the system engineering process model to design high-performance buildings and observed that sustainable building and structure are significant in setting future housing design standards in any country. Heerwagen (2000), in a study of green buildings, organizational success, and occupant productivity, submitted that the benefits inherent in sustainable housing include promoting sustainable operations, countries' image and reputation, housing market promotion, fewer complaints from users, and reduction in bills payment. Ries et al. (2006), while investigating the economic benefits of green buildings in Pennsylvania, found that green and sustainable housing improves users' productivity.

Sustainable housing is important as it promotes sustainable operations, enhances the housing market, projects and promotes countries' image and reputation, and improves the housing aesthetics (Vanek & Vogel, 2007). Keeton (2010) projected that green and sustainable housing benefits are numerous if adequately implemented. For instance, while focusing on the United States, the author confirmed that the benefits include but are not limited to an improvement in air and water quality, conservation of natural resources, energy efficiency, neighbourhood stability, improvement in productivity, and reduction of operating cost. According to Williams and Dair (2007b), the benefits of sustainable housing include reducing housing waste and increasing its life span. Spiegel and Meadows (2010) also noted that sustainable housing development would reduce penalties and homeowners' fines.

Table 1 presents the summary of the benefits inherent in sustainable housing delivery. It should be pointed out that there exists a dearth of empirical studies on the potential benefits of delivering sustainable housing in developing nations. Subsequent sections of this study assess and investigate the survey participants' views on the latent benefits of providing and adopting sustainable housing.

3. Methodology

3.1. Study area

This study was conducted in Lagos, the former Federal Capital of Nigeria. Lagos State is popularly referred to as the economic headquarter of Nigeria and represents the former Federal Capital of Nigeria. It is the major commercial hub in Nigeria and remains the fastest-growing urban area in Africa (Oladokun et al., 2010). It is in the Southwestern part of Nigeria along the Gulf of Benin. It lies approximately on the Latitude 6.465422 and Longitude 3.406448, east of the Greenwich Meridian. The state covers an area of about 3474sq.km. This study area has attained a metropolitan and mega status. The location was chosen on the premise that there are housing shortages for its teeming population, and most of the available ones are deemed unsustainable (UN Habitat, 2010). The state also houses the highest number of housing developers in the country.

3.2. Data collection approach

A quantitative research design was adopted in this study through an extensive systematic literature review to identify the key benefits inherent in the delivery of sustainable housing. The benefits that are easy to understand, unambiguous, and appear more commonly in the literature were selected and adopted for investigation. The population for this study involves housing developers who are actively engaged in housing developments and academia in the built environment within the city of Lagos. This selection rests on the fact that they are well-versed and knowledgeable about issues in the built environment and urban cities at large, especially housing issues. Specifically, the selected housing developers are the Real Estate Developers Association of Nigeria (REDAN) members. The association is the principal agency and umbrella body of the organized private/public sector, responsible for housing development for both private and public housing in Nigeria. The Federal Government of Nigeria (FGN) officially recognized REDAN since November 2002 and has been increasing in membership to date.

The authors also conducted a pilot survey of the research instrument

Table 1
Selected benefits inherent in sustainable housing delivery.

Codes	Benefits	References
BEF 01	Enhance occupant's health and comfort	Dahiru et al. (2014); Ojo-Fafore et al. (2018); Darko et al. (2018)
BEF 02	Improve the quality of life	Ojo-Fafore et al. (2018); Olanrewaju et al. (2018)
BEF 03	Reduction in the cost of maintenance	Keeton (2010); Chua and Oh (2011); Dahiru et al. (2014); Roshanfekr et al. (2016); Moore et al. (2017); Olanrewaju et al. (2018)
BEF 04	Enhance environmental protection	Keeton (2010); Ojo-Fafore et al. (2018)
BEF 05	Setting standards for future design and construction	Bersson et al. (2012); Li et al. (2014)
BEF 06	Promote sustainable operations	Heerwagen (2000); Bordass (2000); Edwards (2006), Vanek and Vogel (2007); Dahiru et al. (2014)
BEF 07	Enhance housing marketability	Heerwagen (2000); Bordass (2000); Edwards (2006), Vanek and Vogel (2007); Dahiru et al. (2014)
BEF 08	Increase housing value	Burnett et al. (2008); Olanrewaju et al. (2018)
BEF 09	Improve rental housing income	Burnett et al. (2008); Olanrewaju et al. (2018)
BEF 10	Improve the performance of the national economy	Chua and Oh (2011); Darko et al. (2018)
BEF 11	Reduced life cycle cost	Keeton (2010); Darko et al. (2018)
BEF 12	Promote countries image and reputation	Heerwagen (2000); Bordass (2000); Edwards (2006), Vanek and Vogel (2007); Dahiru et al. (2014)
BEF 13	Reduced investment risk in housing	Dahiru et al. (2014); Olanrewaju et al. (2018)
BEF 14	Promote aesthetics appearance of the building	Heerwagen (2000); Bordass (2000); Edwards (2006), Vanek and Vogel (2007); Dahiru et al. (2014)
BEF 15	Enhance thermal comfort	Darko et al. (2018)
BEF 16	Reduce complaints from tenants	Heerwagen (2000); Bordass (2000); Edwards (2006),
BEF 17	Reduction in electricity and water bills	Heerwagen (2000); Bordass (2000)
BEF 18	Increase the life span of housing	Williams and Dair (2007b); Spiegel and Meadows (2010)
BEF 19	Reduction in construction waste	Williams and Dair (2007a); Spiegel and Meadows (2010)
BEF 20	Productivity improvement of users	Keeton (2010); Ries et al. (2006)
BEF 21	Reduce penalties and fines to homeowners	Spiegel and Meadows (2010); Darko et al. (2018)
BEF 22	Increase neighbourhood stability	Burnett et al. (2008); Keeton (2010)

within their domain in order to strengthen it. Afterward, the revised instrument was administered to the target respondents to understand their perceptions of the inherent benefits of green and sustainable housing delivery. In order to avoid sampling bias, the authors made the research anonymous. All the respondents had an equal chance of being selected. The systematic random sampling technique was used in selecting the registered and practicing housing developers, while a census sampling technique was adopted in selecting the academia in the built environment discipline. Out of the 132(100.00%) questionnaires administered to the housing developers, only 96(72.73%) were retrieved. During the cross-examination of the retrieved responses, only 74(77.08%) completed responses met the criteria for consideration for inclusion in the study. This was considered valid for further analysis. From the professionals in the built environment discipline, the staff members cut across different fields in the higher education institutions within the Lagos metropolis. In this group, 75(100.00%) questionnaires were distributed, 52(69.33%) were retrieved, with only 48(92.31%) found valid for the data analysis.

It is imperative to verify the dependability and soundness of the data collected through the respondents' demographic characteristics. Table 2 shows that the housing developers have the minimum required education for their opinion to be relied on. Similarly, most of the housing developers have a moderate year of practical professional experience in the housing sector; hence, their information can be relied upon. On the other hand, since those in academia cuts across major fields in the built environment, the data collected have no element of prejudice about profession. The largest percentage of academia has above 15 years of theoretical teaching of built environment sustainability. This means those in academia have practicable years of experience in the built environment sector. From the foregoing, the respondents' opinion is credible to be relied on.

3.3. Cronbach's alpha coefficient

This is otherwise known as the reliability test and is usually done before running a statistical analysis of the collected data. The items and the questionnaire's scale were assessed to ascertain the measured construct (Olatunji et al., 2017). This was used in establishing the scale of the questionnaire. Robinson et al. (1991) stated that if the alpha value is higher than 0.70, it implies that the questionnaire measured a good internal consistency and is well constructed. In this research, Cronbach's alpha analysis of the questionnaire construct gave a coefficient of 0.907, higher than the threshold of 0.70. Thus, it shows a higher internal consistency among the measured benefits.

3.4. Mean item score

This is a quantitative analysis technique used for prioritising the level of significance of the variables. This method has been widely used in construction research (see Adabre & Chan, 2019; Chan et al., 2018; Olawumi & Chan, 2019). The mean item score analysis was adopted in this study to determine the relative priorities that the respondents attributed to the benefits of sustainable green housing development.

3.5. Agreement analysis

Agreement analysis is relevant to determine the extent of consensus (if any) between the views of two or more groups on the same constructs or variables of measurements (Adabre et al., 2020). The agreement analysis was conducted in this study to determine the extent of agreement in the housing developers' and academic opinions. The analysis was run to ascertain (if any) group of benefit(s) are significant to encourage the promotion and implementation of green and sustainable housing. Zhang (2005) revealed that the rank agreement analysis is a quantitative approach that adopts the rank agreement factor (RAF). The RAF reveals the absolute average disparity in the factors ranking between the two groups. i.e., housing developers (group1) and academia (group 2). RAF, according to Zhang (2005), Adabre and Chan (2019), and Adabre et al. (2020), could be computed using the formulae:

$$\mathrm{R} = \frac{1}{n}\sum_{i=1}^{k}(Rij) \tag{i}$$

Rank Agreement Factor (RAF) is defined as:

$$\mathrm{RAF} = \frac{\sum_{i=1}^{N}\left|R_{i1} - R_{i2}\right|}{N} \tag{ii}$$

Maximum Rank Agreement Factor ($\mathrm{RAF_{max}}$) is given by

$$\mathrm{RAF_{max}} = \frac{\sum_{i=1}^{N}\left|R_{i1} - R_{j2}\right|}{N} \tag{iii}$$

Disagreement percentage (DP) is illustrated by:

Table 2
Profile of the respondents.

	Housing developers				Academia		
	Characteristics	Freq.	%		Characteristics	Freq.	%
Educational qualification	ND	9	12.16	Discipline in the built environment	Estate management	7	14.60
	HND	14	18.91		Civil engineering	6	12.50
	B.Sc/B.Tech	27	36.49		Building technology	9	18.80
	M.Sc/M.Tech	15	20.27		Construction management	7	14.60
	Ph.D	6	8.10		Architecture	9	18.80
	Others	3	4.05		Quantity surveying	10	20.80
	Total	***74***	***100.00***		***Total***	***48***	***100.00***
Years of practical experience	1–5 yrs	27	36.49	Years of theoretical experience	1–5 yrs	5	10.42
	6-10 yrs	31	41.89		6-10 yrs	10	20.83
	11-15 yrs	9	12.16		11-15 yrs	13	27.08
	>15 yrs	7	9.45		>15 yrs	20	41.67
	Total	***74***	***100.00***		***Total***	***48***	***100.00***

$$DP = \frac{\sum_{i=1}^{N} / R_{i1-R_{i2}} /}{\sum_{i=1}^{N} / R_{i1-R_{j2}} /} \times 100 \quad \text{(iv)}$$

$$\text{Agreement percentage (AP)} = 100 - DP \quad \text{(v)}$$

where:

R_{i1} and R_{i2} represent the rank of benefits within a component in group 1 and group 2, respectively.
R_{ij} stands for the sum of the ranks of a given benefit by the two peculiar groups.
R_{j2} denotes the mean value of the total ranks.
N represents the number of benefits in each component.
K represents the number of groups (k = 2).
(R_{i1}-R_{i2}) denotes the disparity in the ranks of benefits obtained from the two groups.
R_i of a benefit is the sum of the ranks of the benefits from the housing developers and academia.

3.6. Factor analysis (FA)

This is a statistical method otherwise known as the data reduction technique. It is used to identify a small number of groups that can denote relationships among interrelated variables (Adabre & Chan, 2019). The method is efficient for reducing/regrouping larger size factors into smaller sizes based on the responders' factor scores. Factor analysis was adopted in this study to unravel the underlying structure of the benefits inherent in sustainable and green housing delivery. The Kaiser-Meyer-Olkin (KMO) measure of sampling's adequacy was conducted to know the datasets appropriateness for FA. The minimum threshold for KMO is 0.50 (Norusis, 1993). The KMO tests result for this study shows a value of 0.8570, which implies an "excellent" degree of communal variance (Field, 2009). A KMO value close to 1 indicates a compact structure of the correlations. This suggests that the clusters generated during the FA are distinct and reliable (Chan & Choi, 2015). Bartlett's test of sphericity (BTS) is also extracted to determine the suitability of the principal component analysis (PCA) for factor extraction (Field, 2009). The test gave a chi-square value of 1093.317 with a *p*-value (significance) of 0.000, indicating that the correlation matrix is not an identity matrix (Chan & Choi, 2015). Given that pre-conditions for the analysis are met, the FA was carried out.

4. Results and discussions

Table 3 shows the mean item score of the benefits inherent in delivering sustainable housing as perceived by the respondents. The overall mean scores range from 3.16 to 4.25. The study revealed that the three topmost agreed benefits of sustainable housing delivery that are most significant include improving quality of life (with a mean score of 4.25 and standard deviation of 0.810), setting a standard for future design and construction (with a mean score of 4.11 and standard deviation of 0.923) and reduction in the cost of maintenance (with a mean score of 3.99 and standard deviation of 0.951). The findings agree with Moore et al. (2017) that sustainable housing can promote the welfare and quality of users' life and reduce housing maintenance costs. Bersson et al. (2012) also suggest that providing sustainable housing will help set a standard for future construction, which is consistent with this present study. The findings also corroborate Ojo-Fafore et al. (2018) that sustainable housing often enhances life quality by promoting better health and comfort for the occupants'. This is because whatever form of housing is developed, affordability plays a role, and this is a function of the income of the prospective users.

Table 3
Potential benefits inherent in delivering sustainable housing.

Benefits	Housing developers		Academia		Overall		
	Mean	Rank	Mean	Rank	Mean	Rank	SD
BEF 02	4.23	1st	4.27	1st	4.25	1st	0.810
BEF 05	4.09	3rd	4.15	2nd	4.12	2nd	0.923
BEF 03	4.19	2nd	3.79	11th	3.99	3rd	0.951
BEF 11	3.74	6th	4.06	4th	3.90	4th	0.869
BEF 04	3.91	4th	3.85	6th	3.88	5th	0.713
BEF 12	3.69	10th	4.08	3rd	3.88	6th	0.958
BEF 14	3.73	7th	3.92	5th	3.83	7th	1.173
BEF 09	3.61	11th	3.81	8th	3.71	8th	1.205
BEF 15	3.72	8th	3.67	12th	3.70	9th	1.132
BEF 06	3.70	9th	3.65	14th	3.68	10th	1.184
BEF 01	3.88	5th	3.46	19th	3.67	11th	1.190
BEF 07	3.51	12th	3.77	9th	3.64	12th	1.341
BEF 18	3.49	14th	3.75	10th	3.62	13th	1.302
BEF 10	3.30	17th	3.85	6th	3.58	14th	1.243
BEF 19	3.50	13th	3.65	13th	3.58	15th	1.363
BEF 13	3.42	15th	3.63	15th	3.53	16th	1.272
BEF 21	3.23	19th	3.60	16th	3.42	17th	1.412
BEF 20	3.35	16th	3.42	20th	3.39	18th	1.395
BEF 22	3.22	20th	3.52	17th	3.37	19th	1.571
BEF 08	3.27	18th	3.40	21st	3.34	20th	1.379
BEF 16	3.04	22nd	3.50	18th	3.27	21st	1.572
BEF 17	3.09	21st	3.23	22nd	3.16	22nd	1.591

In Table 4, the cluster of the inherent benefits in sustainable housing delivery was extracted using PCA and varimax with the Kaiser rotation method for its normalization. Chan and Hung (2015) affirm that the value of each variable's factor loading reflects the contribution of the variable to its underlying grouped factor. Olawumi and Chan (2019) avow that variables within a cluster with factor loading close to 1.0 have higher significance in the underlying group. The clustering of factors constituting the inherent benefits of sustainable housing delivery and implementation in Lagos falls within the five components and generated normalized cumulative sums of squared loading of 59.555%. This means

that the five components' cumulative effect explains 59.555% of the total variation in the benefits inherent in sustainable housing within Lagos state. The hidden benefits were unveiled with factor analysis. The resultant effect was grouped into five underlying groups: *satisfaction, housing promotion, cost minimization, economic promotion, and environmental development-related benefits*.

4.1. Group 1: satisfaction related benefits

Group 1 encompasses seven benefits: productivity improvement of users, enhanced thermal comfort, reduced penalties, and fines to homeowners, improved quality of life, enhanced occupants' health and comfort, decreased investment risk in housing, and reduced complaints from tenants. These are loaded into one component with factor loadings between 0.535 and 0.813. The extracted communalities also range between 0.605 and 0.782. This group explains 17.705% of the total variance compared to other groups. This suggests that satisfaction-related benefits are the most significant benefits inherent in sustainable housing delivery in Lagos, Nigeria. This cluster is concerned with the importance of sustainable housing in enhancing homeowners' and users' optimum satisfaction. Improvement in users' productivity is a crucial benefit of sustainable housing. For instance, Ries et al. (2006) observed that occupants' productivity in sustainable housing is 35% higher than non-sustainable ones. The finding agrees with the contribution of Heerwagen (2000), Edwards (2006), Bersson et al. (2012), and Dahiru et al. (2014) that sustainable housing would lead to productivity improvement.

Another vital benefit of sustainable housing is the enhancement of thermal comfort. With decent thermal comfort, users' satisfaction would be guaranteed. Therefore, investing in sustainable housing should help promote thermal comfort for users. This study's findings agree with Ojo-Fafore et al. (2018) that sustainable housing improves users' thermal comfort and satisfaction. Reducing penalties and fines on homeowners is another benefit of sustainable housing. With sustainable housing, unnecessary penalties and fees are eliminated on owners (Spiegel & Meadows, 2010). Sustainable housing offers benefits to improving the quality of life and enhancing occupants' health and comfort. With an improvement in the health and comfort of users, quality of life enhancement is guaranteed. This corroborates Dahiru et al. (2014) that sustainable housing enhances the quality of life and occupants' comfort. Reduced investment risk in housing and reduced complaints from tenants are other crucial benefits of sustainable housing. The statement supports Heerwagen (2000), Edwards (2006), and Dahiru et al. (2014) that sustainable housing reduces the risk of investment in real properties, and issues concerning tenancy complaints are minimised.

4.2. Group 2: housing promotion-related benefits

This group consists of six benefits: enhance housing marketability, reduce housing waste, promote housing aesthetic, increase housing values, improve rental income, and increase housing life span. These are loaded into one component with factor loadings between 0.566 and 0.727. The extracted communalities also range between 0.605 and 0.702. The benefits under this group collectively account for 16.440% of the total variance. The housing market will improve if social, economic, and environmentally friendly housing developments are implemented. Olanrewaju et al. (2018) argued that sustainable housing often has a better demand than conventional housing due to its characteristics. This study's submission agrees with Edwards (2006) and Dahiru et al. (2014) that sustainable housing promotes better housing supply and demand. Also, sustainable housing developments could lead to a reduction in construction waste. This construction method uses sustainable and environmentally friendly materials, often generating less waste than others (Williams & Dair, 2007a). This study's findings also support Dahiru et al. (2014) that sustainable housing reduces wastage. Aesthetic and housing appearance promotion is a crucial benefit inherent in sustainable green housing due to the construction material used in the delivery. This corroborates Edwards's (2006) opinion that sustainable housing has a better appearance. An increase in housing values and improved rental income are the beneficial contributions of sustainable housing delivery. This suggests why Burnett et al. (2008) avow that housing value and rental income will improve due to its intrinsic characteristics. An increase in housing life span is an essential benefit of sustainable housing delivery. The materials used for constructing the housing are environmentally friendly with durability assured. This is why Spiegel and Meadows (2010) claimed that sustainable housing would last longer than conventional housing.

4.3. Group 3: cost minimization related benefits

This group contains three benefits. They include reduction in maintenance costs, reduced life cycle cost, and electricity bills reduction. The variables are loaded into one component and ranges from 0.617 to 0.817. The extracted communalities range from 0.603 to 0.637. The

Table 4
Factor analysis of the benefits involved in the delivering sustainable housing.

Benefits	Cluster group	Commonalties	Factor loadings	Eigenvalue	Var. (%)
1: Satisfaction	BEF 20: improvement of users productivity	0.670	0.813	7.621	17.705
	BEF 15: enhance thermal comfort	0.605	0.535		
	BEF 21: reduce homeowners penalties and fines	0.713	0.695		
	BEF 02: improve the quality of life	0.667	0.586		
	BEF 01: enhance occupants health and comfort	0.661	0.669		
	BEF 13: decreased investment risk in housing	0.782	0.649		
	BEF 16: reduce tenants complaints	0.675	0.644		
2: Housing promotion	BEF 07: enhance housing marketability	0.650	0.727	1.681	16.440
	BEF 19: reduces construction waste	0.639	0.692		
	BEF 14: promotes building aesthetics	0.684	0.667		
	BEF 08: increases housing value	0.694	0.593		
	BEF 09: improved rental income on housing	0.702	0.566		
	BEF 18: increase the housing life span	0.605	0.593		
3: Cost minimization	BEF 03: reduces maintenance costs	0.617	0.817	1.439	8.884
	BEF 11: reduced life cycle cost	0.637	0.617		
	BEF 17: reduction in electricity and water bills	0.603	0.724		
4: Economic promotion	BEF 05: set standard for future design	0.643	0.683	1.287	8.866
	BEF 10: improve national economy performance	0.672	0.655		
	BEF 12: promote countries image and reputation	0.682	0.518		
5: Environmental development	BEF 04: enhance environmental protection	0.610	0.510	1.074	7.860
	BEF 06: promote sustainable operations	0.630	0.559		
	BEF 22: increase neighbourhood stability	0.665	0.552		
Total variance					59.555

three inherent benefits under this group collectively explain 8.884% of the total variance. Although the capital cost of sustainable housing construction is relatively high, operating or ownership costs such as maintenance cost, lifecycle cost, electricity, and water bills are lesser than conventional housing (Olanrewaju et al., 2018). It could be inferred from the above that sustainable housing would reduce various operational and maintenance costs. The high maintenance costs of buildings could be reduced through sustainable design and construction. The result of this study confirms Olanrewaju et al. (2018), where it was suggested that operational cost minimization is a crucial benefit of sustainable housing.

4.4. Group 4: economic promotion-related benefits

This group explained 8.742% of the total variance and consisted of three benefits. The variables are loaded into one component and range between 0.518 and 0.683, while the communalities range between 0.643 and 0.682. Under this group, the benefits include setting a standard for future design, improving the economy, and promoting countries' reputations. A significant benefit in this group is that sustainable housing benchmarks a standard for future housing design. It would enable developers to follow a sustainable design standard during housing delivery, positively affecting the development of the economy's national housing provision. This finding agrees with Bersson et al. (2012) that sustainable housing sets a standard for future designs. Improving the national economy and promoting countries' reputations are also the inherent benefits of sustainable housing implementation. Heerwagen (2000) and Edwards (2006) averred that the delivery of sustainable housing would promote the economy and give an excellent reputation to the country, which this current study discovered.

4.5. Group 5: environmental development

This group "environmental development" explained 7.860% of the total variance and comprised of three benefits. The benefits under this group are loaded into one component and range from 0.559 to 0.510, while the commonalities range from 0.610 to 0.665. The benefits of this group include enhancing environmental protection, promoting sustainable operations, and increasing neighbourhood stability. The need to promote sustainable housing has reduced housing operating costs by using environmentally friendly materials; this will invariably enhance environmental protection, promote sustainable operations, and increase neighbourhood stability (Olanrewaju et al., 2018). The submission of this study corroborates Keeton (2010) that the implementation of sustainable housing could reduce the negative environmental impacts of the construction industry.

Adopting the formula from Eqs. (i) to (v) and the figures obtained in Table 5, therefore:the rate of agreement and disagreement in **satisfaction-related benefits** is given as:

$$\mathrm{RAF} = \frac{12}{7} = 1.714$$

Table 5
Agreement analysis of the grouped inherent benefits of delivering sustainable and green housing.

Related benefits	Housing developers			Academics			Agreement analysis		
	Mean	SD	Rank (R_{i1})	Mean	SD	Rank (R_{i2})	R_i	(R_{i1}-R_{i2})	/(R_i - R_{j2})/
Group 1: satisfaction									
BEF 20: productivity improvement of users	3.35	1.103	5	3.42	1.029	7	12	2	4
BEF 15: enhance thermal comfort	3.72	1.190	3	3.67	1.226	2	5	1	3
BEF 21: reduce penalties and fines to homeowners	3.23	1.412	6	3.60	0.962	4	10	2	2
BEF 02: improve the quality of life	4.23	0.810	1	4.27	0.707	1	2	0	6
BEF 01: enhance occupants health and comfort	3.88	1.132	2	3.46	1.010	6	8	4	0
BEF 13: reduced housing investment risk	3.42	1.272	4	3.63	1.315	3	7	1	1
BEF 16: reduce complaints from tenants	3.04	1.572	7	3.50	1.384	5	12	2	4
							$R_{j2} = 8$	$\sum_{i=1}^{n}(Ri1 - Ri2) = 12$	$\sum_{i=1}^{n}(Ri - Rj2) = 20$
Group 2: housing promotion									
BEF 07: enhance marketability of housing	3.50	1.341	4	3.77	1.403	3	7	1	0
BEF 19: reduction in housing waste	3.51	1.363	3	3.65	1.101	5	8	2	1
BEF 14: promote aesthetics appearance of building	3.73	1.173	1	3.92	1.069	1	2	0	5
BEF 08: increase housing value	3.27	1.379	6	3.40	1.410	6	12	0	5
BEF 09: improve in housing rental income	3.61	1.205	2	3.81	1.142	2	5	0	2
BEF 18: increase housing life span	3.49	1.412	5	3.75	1.139	4	9	1	2
							$R_{j2} = 7$	$\sum_{i=1}^{n}(Ri1 - Ri2) = 4$	$\sum_{i=1}^{n}(Ri - Rj2) = 15$
Group 3: cost minimisation									
BEF 03: Reduction in the cost of maintenance	4.19	0.951	1	3.79	0.971	2	3	1	1
BEF 11: Reduced life cycle cost	3.74	1.169	2	4.06	1.040	1	3	1	1
BEF 17: Reduction in electricity and water bills	3.09	1.595	3	3.23	1.378	3	6	0	2
							$R_{j2} = 4$	$\sum_{i=1}^{n}(Ri1 - Ri2) = 2$	$\sum_{i=1}^{n}(Ri - Rj2) = 4$
Group 4: economic promotion									
BEF 05: set standard for future design and construction	4.09	1.009	1	4.15	0.945	1	2	0	2
BEF 10: improve performance of national economy	3.30	1.243	3	3.85	1.288	3	6	0	2
BEF 12: promote countries image and reputation	3.69	1.158	2	4.08	0.821	2	4	0	0
							$R_{j2} = 4$	$\sum_{i=1}^{n}(Ri1 - Ri2) = 0$	$\sum_{i=1}^{n}(Ri - Rj2) = 4$
Group 5: environmental development									
BEF 04: enhance environmental protection	3.91	1.073	1	3.85	1.052	1	2	0	2
BEF 06: promote sustainable operations	3.70	1.184	2	3.65	1.158	2	4	0	0
BEF 22: increase neighbourhood stability	3.22	1.571	3	3.52	0.714	3	6	0	2
							$R_{j2} = 4$	$\sum_{i=1}^{n}(Ri1 - Ri2) = 0$	$\sum_{i=1}^{n}(Ri - Rj2) = 4$

$$RAF_{max} = \frac{20}{7} = 2.86$$

$$DP = \frac{12}{20} \times 100 = 60\%$$

$$AP = 100 - DP$$

$$AP = 40\%$$

the rate of agreement and disagreement in **housing promotion-related benefits** is

$$RAF = \frac{4}{6} = 0.667$$

$$RAF_{max} = \frac{15}{6} = 2.50$$

$$DP = \frac{4}{15} \times 100 = 26.67\%$$

$$AP = 100 - DP$$

$$AP = 73\%$$

the rate of agreement and disagreement in **cost minimization-related benefits** is given as

$$RAF = \frac{2}{3} = 0.667$$

$$RAF_{max} = \frac{4}{3} = 1.333$$

$$DP = \frac{2}{4} \times 100 = 50\%$$

$$AP = 100 - DP$$

$$AP = 50\%$$

the agreement and disagreement percentage for **economic promotion-related benefits** is

$$RAF = \frac{0}{3} = 0.00$$

$$RAF_{max} = \frac{4}{3} = 1.333$$

$$DP = \frac{0}{4} \times 100 = 0\%$$

$$AP = 100\% - DP$$

$$AP = 100\%$$

the agreement and disagreement percentage for **environmental development related benefits** is given as

$$RAF = \frac{0}{3} = 0.00$$

$$RAF_{max} = \frac{4}{3} = 1.333$$

$$DP = \frac{0}{4} \times 100 = 0\%$$

$$AP = 100\% - DP$$

$$AP = 100\%$$

Table 5 shows the agreement analysis between the survey participants. Concerning "*satisfaction-related benefits*", the respondents agreed that the delivery of green and sustainable housing would improve the quality of life of its users. This is evidenced in this variable's rank position as it ranked 1st from the respondents' perception. There is a slight agreement on the ranked perception with two factors, "enhance thermal comfort and reduced housing investment risk" as they ranked within the respondents' 2nd and 3rd position. However, there is a divergent view on ranking the other factors within the group. Overall, the rank agreement analysis result showed an agreement percentage of 40% and RAF of 1.714 between the respondents. This indicates a somewhat divergent opinion in the survey participants' decision.

Regarding "*housing promotion-related benefits*", the survey participants rated that it promotes the building's aesthetics, improves housing rental income, and increases housing value equally as 1st, 2nd, and 6th. However, there is a slight rate of agreement between the other variables. Consequently, it could be inferred that there is a high degree of closeness in both groups' agreement analysis on "housing promotion-related benefits". This is with an agreement rate of 73% and RAF of 0.667. On "*cost minimisation related-benefits*", a reduction in the electricity and water bill cost was agreed upon and rated equally. Although, there is a close rating characteristic of the other two variables. The overall agreement rate depicts a 50% agreement analysis while the RAF was 0.667. The participants have a perfect degree of consensus regarding the "economic promotion-related benefits" and "environmental development-related benefits". Here, they rate the variable composition in both groups equally. The computation of the agreement analysis also results in a 100% rate with an RAF of 0.00.

5. Implications and policy recommendations for sustainable housing

In developing economies, limited studies on the latent benefits of sustainable housing delivery exist. Those in existence did not emphasize the need to promote and implement sustainable practices towards attaining a nation's developmental goals. This current study has not only empirically identified the benefits. It has structured these benefits using the perspectives of housing developers and academicians, which is an addition to sustainability literature. The findings could assist researchers and provide practitioners and government agencies in different countries with an insight into the need to promote and implement sustainable housing as a strategy to curb urban blight.

All the benefits inherent in sustainable housing delivery within the five groups were rated high (i.e. >3.0). Therefore, to achieve the United Nations Sustainable Development Goals (SDG) in housing, these groupings should be clear to local housing practitioners, particularly in developing countries. Other international countries that are yet to carve a niche for sustainable housing could also learn from this. The adoption would trigger more investment in sustainable housing delivery. To attain the satisfaction-related benefits inherent in sustainable housing delivery, the government must develop policies of inclusive support to educate housing users of the benefits that abound when they inhabit sustainable housing. These would increase users' demand for sustainable housing and prompt housing developers to supply more. However, to ensure compliance and widespread acceptance, the cost involved should be affordable and reasonable for the users.

Effective measures are needed to popularize the promotion and cost minimization benefits inherent in sustainable housing delivery among property investors. It is recommended that local and international investors who wish to invest must bear this in mind. This is expected to reinforce their motivation for sustainable housing investment. The government should implement policies to promote the incorporation of sustainable green development in the built environment curriculum. This will promote awareness of the benefits from the grassroots. While doing that, effective policies should be put in place for construction professionals to avoid unsustainable developmental practices. This

could be attained through regular mandatory seminars and workshops on the issues. This would nurture their mind towards a sustainable built environment.

Overall, the identified benefits may be used to either motivate or pressure stakeholders to be involved in promoting and implementing sustainable green housing. As a result, the benefits can be promoted in the society by encouraging the adoption of these practices. Promoting the benefits may thus be a powerful tool for guiding stakeholders towards more environmentally, socially, and economically sustainable behavior. However, based on the analysis, it is reasonable to assume that government laws and policies could play a great role in promoting these benefits. It is advisable that the government at both local and international levels develop and promote regular regulations and controls to ensure strict compliance by parties involved. Also, international nations that are yet to make sustainable green housing efforts are urged to learn and put sustainability attainment at the top of their government's agenda.

6. Conclusion

The study investigates the housing benefits of green building standards. This study unveils the latent benefits inherent in sustainable housing provision and delivery. Questionnaires were administered to private investors and academicians in the housing sector in Lagos State, Nigeria. The data collected were analysed using mean ranking, factor analytical, and rank agreement analysis. The findings of the study are relevant for policymakers and practitioners for sustainable housing delivery.

The research findings revealed that all the 22 benefits are relatively significant based on Kazaz et al. (2008) rating scale. However, the top three most significant benefits are improving quality of life, setting a standard for future design and construction, and reducing maintenance costs. Factor analysis of the potential integrated benefits from the perception of housing developers and academia was run using the PCA approach. This resulted in five grouping components: *satisfaction-related benefits*, *housing promotion-related benefits*, *cost minimization-related benefits*, *economic promotion-related benefits*, *and environmental development-related benefits*. Findings also show the rank agreement analysis of the benefits based on the various components in the group. There is a high degree of consensus on housing promotion-related benefits (73%), economic promotion-related benefits (100%), and environmental development-related benefits (100%).

This study's findings have filled the gap in knowledge regarding sustainable housing benefits in developing economies. Practically, this research finding has provided valuable road maps and basis to help government, clients, policymakers, and practitioners to understand the need to increase the delivery of and investment in sustainable housing. Therefore, it is recommended that stakeholders, government, and the construction industry encourage the promotion, implementation, and delivery of green and sustainable housing to ensure that the hidden but unveiled benefits are maximised in the built environment. Also, educating on this subject is crucial to glean the full potential of delivering sustainable housing and sustainability in the built environment.

6.1. Limitations

Despite the contributions of this work to theory and practice, this study is not without limitations. However, this does not affect the quality of the results of the study. Therefore, caution should be exercised in generalising the findings of this study. This is because of the type of respondents used and its limited sample size. However, the findings can be a point of reference for other nations. Also, this study did not consider property renters as stakeholders. However, future research can examine their perspectives to determine the implication of sustainable housing delivery on their investment since they are regarded as leaseholder investors. This study further recommends that future studies could adopt a considerable sample size to test the differences in the stakeholders' perspectives using other forms of data collection tools such as interviews and focus groups.

CRediT authorship contribution statement

Oyetunji Abiodun Kolawole: Conceptualization, Methodology, Data analysis and validation, Writing- reviewing and editing.

Oluleye Benjamin Ifeoluwa: Conceptualization, Methodology, Data analysis and validation, Writing- original draft preparation.

Olukolajo Michael Ayodele: Conceptualization, Writing- reviewing and editing.

Daniel W.M Chan: Proofreading and Supervision.

Declaration of competing interest

The authors declare that there is no conflict of interest whatsoever in the study. The manuscript has not been published, and neither is it under consideration for publication elsewhere. The author(s) received no financial support for the manuscript.

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