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A scoping study of barriers and drivers of sustainable design and construction in Nigeria

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Abstract:
Construction stakeholders have been under pressure to reduce the industry's environmental footprint by adopting new technologies. In a two-round Delphi survey, a panel of 12 experts were required to rate and rank the importance of 75 drivers and 21 barriers to sustainable design and construction. After the second round of the survey, 61 drivers and 15 barriers were rated with a high degree of group agreement (Kendall's W =.511; p.001). A high Spearman's rank correlation.value (rho = 0.923, p <.001) indicated a strong degree of convergence between rounds. Also, the result (Kendall's W = 0.76; p < 0.000) indicated a high panel consensus on ranked barriers items with lack of government policy, misconception of construction cost overrun, no reflection of recovery of long-term savings in service fee structure, conflicting public policy and/ or regulations, lack of awareness from clients (Owner/ Developer), a limited knowledge and understanding of sustainable issues by customers, deployment of resources to back technological changes, and lack of knowledge and understanding from design professionals were ranked low as barriers to sustainable design and construction. The findings from the study would provide information on regulatory and socio-economic factors that impact sustainable design and construction in Nigeria, and strengthen the implementation of sustainability in the construction industry.

Keywords:
Infrastructure, Sustainable construction, Sustainability, Urban development, Urban growth

Introduction

By 2050, approximately 68 percent of the global population will be living in cities, with new urban dwellers in India, China, and Nigeria accounting for about 35 percent of this (UN DESA, 2019). By 2030, it is expected that developing countries (mostly in Asia and Africa) will account for roughly 80% of those living in urban areas (UN-HABITAT, 2006). According to some estimates, about half of Nigeria's population will have moved to urban areas by 2020 (Bloch, Monroy, Fox, & Ojo, 2015). Rapid population growth has been related to urban growth and expansion (Sharifi & Hosseingholizadeh, 2019; Zhang & Xie, 2019), negatively impacting sustainable development (Ejaro, 2009). Therefore, fast-growing cities like Abuja will have pronounced growth, such that current space and facilities would be insufficient to accommodate the increasing population and expanding area. Indeed, rapid urbanisation has had a detrimental effect on the FCT's long-term growth (Ejaro & Abubakar, 2013). Serious and persistent construction sustainability challenges have been observed in FCT Abuja (Ekpetere, Faith, & Eziechi, 2019; Windapo & Rotimi, 2012). Using Abuja (the Federal Capital Territory) as a case study, this paper seeks to identify the primary drivers and barriers to sustainable design and construction in Nigeria's construction industry.

It uses Delphi techniques to study the views of a panel of expert and determine the major drivers and barriers of sustainable design and construction. Findings from the study would provide information on regulatory and socio-economic factors that impact sustainable design and construction in Nigeria.

Literature Review

The demand for affordable housing, transport systems, and other infrastructure increases with urban growth. However, this would have negative consequences. Indeed, it is well recognized that urbanisation and spatial changes have significant environmental, social, and economic implications for long-term sustainability (Keivani, 2010). Cities are responsible for a greater percentage of greenhouse gas (GHG) emissions (Hoornweg, Sugar, & Trejos Gómez, 2011). Efforts at mitigating these harmful emissions should be targeted at areas with higher socio-economic and health benefits (Urge-Vorsatz & Novikova, 2008). The construction industry should strive to balance the various aspects (social, economic, and environmental) of human activity, by encouraging the implementation of construction processes that incorporate basic sustainable development objectives of sustainable (Liu, Pypłacz, Ermakova, & Konev, 2020). These three dimensions of sustainable construction are discussed in detail, highlighting the key themes and principal issues (Akadiri, Chinyio, and Olomolaiye (2012).

Sev (2009) classifies sustainable construction into environmental, social and economic dimensions. Sustainable construction processes bring about a profitable and competitive industry capable of addressing changes in user requirements (Raynsford, 2000). This enables environmental responsibility, social awareness, and economic profitability, and provision of facilities for the wider community. There are observations that the focus of the construction industry is no longer limited to the minimization of energy consumption, but has extended to other functions of planning of sites, waste management, materials selection and design, which are critical to solving environmental crisis caused by the industry’s activities (Mir-Babayev, Gulaliyev, Shikhaliyeva, Azizova, & Ok, 2017). Kibert (1994) conceptualises sustainable construction as a tripartite interaction of stages or phases, required resources, and principles in the design and execution of construction projects.

Various factors that enhance or inhibit sustainable design and construction have been extensively studied and documented in earlier studies (Ahn, Pearce, Wang, & Wang, 2013; Augenbroe & Pearce, 2009; Hale, Legun, Campbell, & Carolan, 2019; Ifije & Aigbavboa, 2020; Lopez-Chao, Casares Gallego, Lopez-Chao, & Alvarellos, 2020; Mohammed & Abbakyari, 2016). It has been suggested that a major factor that drives the implementation or adoption of sustainable construction practices is a buy-in or concern by the management of an organisation (Shen, Tam, Tam, and Ji, 2010).

Research Methodology

1.7 Study Location

Abuja FCT occupies a land mass of about 8000km^2 in the Guinea-Savanna vegetation zone (Idoko & Bisong, 2010). It is situated between latitude 7°25′N and 9°20′N and longitude 5°45′E and 7°39′E (Enoguanbhor, Gollnow, Walker, Nielsen, & Lakes, 2020), and bounded by Kaduna State in the North, Nasarawa State in the East, Kogi State in the South, and Niger State in the West (Musa, Oguche, & Onyekwulu, 2020). Abuja, Nigeria's largest construction area, has been described as an unsustainable city (Obiadi, Onochie, & Uduak, 2019).

1.8 Delphi Panel and Consensus Criteria

Expert opinion was sorted through a two-round Delphi survey to identify and rank the importance of the key drivers and barriers of sustainable design and construction in the construction industry in Nigeria. Seventy-five drivers (grouped into four sustainable dimensions (Chao et al., 2020), and twenty-three barriers identified from the review of web of science and literature were presented to the panellists. Fifteen potential panel members were invited through email to participate in the study, twelve indicated interest to participate. The purposively sampled panel consisted of twelve (*n =12*) sustainable design and construction experts (two academics, one urban planner, four architects, and five construction professionals), seven of whom have experience ranging between 11-25years. The qualification of the panellist ranged from degree (5), Master's degree (4) and PhD (3).

A questionnaire with a total of ninety-eight questions related to drivers and barriers of sustainable design and construction was developed for the panel of experts. Experts were asked to rank the factors on a scale between 1 and 5 (1= Not at all important, 2=Somewhat unimportant, 3=Neither/not important, 4=Somewhat important, 5=Extremely important). In the first round, the experts were asked to rate the relevance of the items in driving sustainable design and construction, while in the round 2, the experts were asked to rank in addition the barriers items to sustainable design and construction among construction industries. Consensus was reached on a questionnaire item based on 75% of respondents rate of an agreement on individual items on 5-point Likert scale. Kendall's coefficient of concordance (Kendall's W) ($\geq .5$; $p > .05$) and Spearman rho ($\geq .9$; $p > .05$) was employed to compute level of consensus among individual experts in a round; and stability or convergence of expert response between Delphi rounds respectively. Delphi method is a suitable technique used to reach a consensus on a complex research problem in which there is no precise information available (Linstone & Turoff, 2011)

Findings and Discussion

The results of the rounds of the Delphi expert rating of drivers of sustainable design and construction in Nigeria are presented on Tables 1 to 4. In the first round, 12 experts out of 15 contacted participated. The expert panel has an understanding of sustainable design and construction practices, with experiences and interest in the green construction market. The result of the first round revealed a good agreement (≥75 % of agreement) in 63 of the 75 items across the four dimensions. However, the level of consensus among the experts was low (Kendall's W = .369; $p < .00$). This indicates that the experts had strong agreement on selected items. However, no consensus was achieved among panel in the first round. Delphi process is iterative and incremental; thus, second around is required to review panel judgement. In the second round, the 12 experts were asked to reassess their responses, taking into account the results in the first round. In this round, the result revealed a good agreement (≥75 % of agreement) in 63 of the 75 items across the four dimensions. However, the level of consensus among the experts was high with an increase in Kendall's coefficient of concordance (W = .511; p<.00). In the second around, under the environmental sustainability criteria, the experts maintained their position on 'Waste reduction and management - reuse and recycle '(item 7), renewable energy, (item 9) ‘preserve and enhance bio-diversity’(item 11), ‘creating a non-toxic environment – including high indoor air ’(item 12), ‘protect and enhance sensitive landscapes including scenic, cultural, historical and architectural’(item 16), and ‘balance between natural and the built environment’(item 21), which failed to gain consensus.

In the economic sustainability dimension, ‘recognition of commercial buildings as productivity assets’ (item 6), gain expert agreement in first round failed in the second round, while the 'using life cycle costing' (item 14) gained expert acceptance (≥75(75.0). The expert panel maintained their position on ‘support of local economies’, Whole/Integrated building design approach’, ‘decreased initial project costs’, and ‘New cost metrics based on economic and ecological value systems’, which failed to gain consensus. In the social sustainability dimension, 'improving human health and productivity' (item 8), and 'recruitment and retention' (item 20) failed to gain expert agreement in the second round along ‘diversity (cultural diversity) in development planning’ (item 16) and equality (item 21). In the governance dimension, the experts maintained a level of agreement of all items in both rounds. The difference in the level of agreement between rounds may be due to the different backgrounds of the panel group. Consensus was not reached on environmental factors (waste reduction and management – reuse, preservation and enhancement of bio-diversity, creation of a non-toxic environment, and protection and enhancement of sensitive landscapes, achieving a balance between natural and built environment); economic factors (whole/integrated building design approach); social factors (improvement in human health and condition, seeking intergenerational equity and reducing cost for future generations, recruitment and retention, as well as equality).

Table 15: Environmental Sustainability Drivers

	Variables	R1 Mean	R1 Consensus (%Agreement)	R2 Mean	R2 Consensus (%Agreement)
	Environmental Sustainability Criteria				
1	Energy conservation and efficiency	4.63	≥75(100)	4.58	≥75(100)
2	Water conservation and efficiency	4.88	≥75(100)	4.67	≥75(100)
3	Environmental /resource conservation	4.50	≥75(75)	4.17	≥75(75)
4	Indoor environmental quality	3.87	≥75(91.6)	4.42	≥75(100)
5	Land use regulations and urban planning policies	4.63	≥75(100)	4.75	≥75(100)
6	Plans and design (urban structure, open spaces and green areas	5.00	≥75(100)	4.83	≥75(100)
7	Waste reduction and management - reuse and recycle	3.62	**≥75(50.0)**	3.67	**≥75(58.3)**
8	Pollution minimization (Land, Water, Noise (and efficiency)	4.50	≥75(100)	4.42	≥75(100)
9	Renewable Energy	3.75	**≥75(50)**	3.25	**≥75(50)**
10	Resource conservation	4.23	≥75(75)	3.58	≥75(75)
11	Preserve and enhance bio-diversity	3.50	**≥75(66.7)**	3.17	**≥75(41.7)**
12	Creating a non-toxic environment – including high indoor air	4.13	**≥75(50.0)**	3.50	**≥75(68.0)**
13	Visual impact	3.75	≥75(75.0)	3.75	≥75(100)
14	Site and design (land use, conservation, reuse)	4.88	≥75(100)	4.83	≥75(100)
15	Transport – including provision of public transport	4.88	≥75(100)	4.83	≥75(100)
16	Protect and enhance sensitive landscapes including scenic, cultural, and historical	4.75	**≥75(50.0)**	4.17	**≥75(66.7)**
17	Creating a healthy, non-toxic environment – including high indoor air quality	4.50	≥75(100)	4.33	≥75(100)
18	Environmental Impact (process and product)	4.50	≥75(100)	4.58	≥75(100)
19	Re-use existing built assets	4.38	≥75(88.8)	4.33	≥75(88.8)
20	Green building rating systems (LEED, Green Globes)	4.38	≥75(100)	4.25	≥75(100)
21	Balance between natural and the built environment	3.87	≥75**(66.7)**	3.67	≥75**(66.6)**
	Number(n)	12		12	
	Kendall's W[a]	0.333		0.465	
	Significance	.000		.000	

Table 26: Economic Sustainability Drivers

S/N	Variables	R1 Mean	R1 Consensus (%Agreement)	R2 Mean	R2 Consensus (%Agreement)
	Economic Sustainability Criteria				
1	Proactive role of materials manufacturers	3.88	≥75(100)	4.17	≥75(100)
2	Financial affordability for intended beneficiaries	4.63	≥75(100)	4.50	≥75(100)
3	Product and material innovation and/or certification	4.25	≥75(75.0)	3.50	≥75(75.0)
4	Support of local economies	4.00	≥75**(66.7)**	3.50	≥75**(50.0)**
5	Adoption of incentive programmes	4.50	≥75(75.0)	3.83	≥75(75.0)
6	Recognition of commercial buildings as productivity assets	4.50	≥75(75.0)	2.25	≥75**(41.7)**
7	Whole/Integrated building design approach	4.50	≥75**(50.0)**	4.00	≥75**(66.6)**
8	Decreased initial project costs	3.88	≥75**(66.6)**	3.92	≥75**(66.6)**
9	Viability	4.25	≥75(75.0)	4.33	≥75(91.7)
10	Client worries in profitability	5.00	≥75(100)	4.67	≥75(100)
11	Competitiveness	4.63	≥75(100)	4.42	≥75(100)
12	Productivity	4.88	≥75(100)	4.58	≥75(100)
13	Value for money	4.13	≥75(100)	4.17	≥75(100)
14	Using life cycle costing	4.75	≥75**(66.6)**	4.50	≥75(75.0)
15	Creating and maintaining high and stable levels of employment	4.13	≥75(100)	4.17	≥75(100)
16	Investment (green products and in the use of renewable resources	4.00	≥75(100)	4.08	≥75(100)
17	Use of Key Performance Indicators (KPIs)	4.63	≥75(91.6)	4.50	≥75(100)
18	Maintaining high and stable levels of economic growth	4.50	≥75(100)	4.67	≥75(100)
19	New cost metrics based on economic and ecological value systems	4.38	≥75**(50.0)**	3.33	≥75**(66.7)**
20	Encourage use of local resources	4.63	≥75(75.0)	3.75	≥75(100)
	Number(n)	12		12	
	Kendall's W[a]	0.179		0.383	
	Significance	.000		.000	

Table 37: Social Sustainability Drivers

	Variables	R1		R2	
		Mean	Consensus (%Agreement)	Mean	Consensus (%Agreement)
	Social Sustainability Criteria				
1	Education and training	4.00	≥75(100)	4.42	≥75(100)
2	New kinds of partnership and project stakeholders	4.50	≥75(100)	4.33	≥75(100)
3	Improving occupants' productivity	4.00	≥75(100)	4.00	≥75(100)
4	Improving indoor environmental quality	4.75	≥75(100)	4.50	≥75(100)
5	Increase of awareness from clients	4.38	≥75(100)	3.42	≥75(75.0)
6	Community and social benefits	4.63	≥75(100)	4.42	≥75(91.7)
7	Building strong communities	4.00	≥75(100)	4.08	≥75(100)
8	Improving human health and productivity	4.38	≥75(100)	3.67	≥75(**66.7**)
9	Protecting and promoting human health and wellbeing	4.38	≥75(91.7)	4.33	≥75(91.7)
10	Participation of stakeholders –including community involvement	4.75	≥75(91.7)	4.58	≥75(91.7)
11	Improving public space quality	4.38	≥75(100)	4.50	≥75(100)
12	Making provision for social self-determination/enhancement	4.75	≥75(100)	4.75	≥75(100)
13	Training and development (skills training and capacity enhancement)	4.13	≥75(100)	4.33	≥75(100)
14	Equitable distribution of the social costs and benefits of construction	4.00	≥75(100)	4.58	≥75(100)
15	Seeking intergenerational equity and reducing cost for future generations	4.13	≥75(100)	4.08	≥75(100)
16	Diversity (cultural diversity) in development planning	3.87	≥75(**50.0**)	4.27	≥75(**63.6**)
17	Social inclusion	4.88	≥75(100)	3.92	≥75(91.7)
18	Improving image/reputation	5.00	≥75(100)	4.92	≥75(100)
19	Employment –including equal employment opportunities	4.50	≥75(100)	4.08	≥75(75.0)
20	Recruitment and retention	4.75	≥75(75.0)	4.25	≥75(**66.6**)
21	Equality	3.38	≥75(**66.6**)	4.00	≥75(**66.6**)
22	Accessibility	4.88	≥75(100)	4.25	≥75(75.0)
23	Work in occupied premises	4.38	≥75(100)	4.25	≥75(100)
24	Working environment	4.50	≥75(100)	4.33	≥75(100)
25	Security (minimising crime)	4.63	≥75(100)	4.75	≥75(100)
26	Satisfaction (workforce and user satisfaction)	4.25	≥75(100)	4.75	≥75(100)
	Number(n) Kendall's W[a] Significance	12 0.207 .000		12 0.339 0.000	

NOTE: The items that did not gain consensus are in **bold** typeface on Tables 1 to 3; %Agreement**:** ≥75 expert's response on item ≥4 on 1-5 Likert Scale (1=Not at all important to 5 =Extremely important); a: Kendall's coefficient concordance

Table 48: Governance Sustainability Drivers

S/N	Variables	R1		R2	
		Mean	Consensus (%Agreement)	Mean	Consensus (%Agreement)
	Governance Criteria				
1	Incentive programmes	4.63	≥75(100)	4.42	≥75(100)
2	Performance-based standards	4.62	≥75(100)	4.50	≥75(100)
3	Re-engineering the design process	4.62	≥75(75.0)	4.50	≥75(100)
4	Sustainable construction materials	5.00	≥75(100)	4.75	≥75(100)
5	Re-engineering the design	4.25	≥75(100)	4.42	≥75(100)
6	City planning and innovation (Smart city policy and	5.00	≥75(100)	4.92	≥75(100)
7	development				
8	Integrating agenda 21into urban planning	4.13	≥75(91.6)	4.00	≥75(100)
	Transparency and open Government	5.00	≥75(100)	4.67	≥75(100)
	Number(n) Kendall's W[a] Significance	12 0.298 .000		12 0.383 .000	
	Overall: Number(n) Kendall's W[a] Significance	12 0.369 .000		12 0.511 .000	

In overall, the results from the second (and final) round revealed a high consensus (Kendall's W = .511; p <.001) reached on 63 drivers of sustainable design and construction. The spearman's rank correlation computed to determine the stability of the level of expert ratings between the Delphi rounds reveals strong and positive correlation value (rho = 0.923, p <.001), indicating high degree of convergence implying that the stoppage criteria is achieved.

The result of the rounds of the Delphi expert rating of the barriers to sustainable design and construction in FCT Nigeria is presented on Table 5. The result reveals Kendall's W = 0.76 ($p < 0.000$) indicating that the panel's consensus with each other on the items is high. The mean rank of the items indicated that the most rated barrier item among the construction industries in Abuja was the tendency to maintain current practices. Barriers such as Lack of government policy (9.67); Misconception of Construction cost overrun (8.67); Recovery of long-term savings not reflected in service fee structure (8.54); Conflict public policy and/ or regulations(8.46); Lack of awareness from clients (Owner/Developer)(7.50); Limited sustainable knowledge and understanding from customers(7.42); Deployment of resources to back technological changes(6.92); and Lack of knowledge and understanding from design professionals(3.42) were ranked low. However, Tendency to maintain current practices (17.63), Ignorance of life cycle cost (16.29) and Unfamiliarity of sustainable materials and products (15.04) were the highest-ranking barriers.

Table 5: Expert ranks on barriers to sustainable design and construction in Abuja

	Variables	*Mean Rank*
1	Tendency to maintain current practices	17.63
2	Lack of an integrated work environment among all stakeholders	16.29
3	High building cost	15.50
4	Ignorance of life cycle cost	15.50
5	Unfamiliarity of sustainable materials and products	15.04
6	No understanding of the benefits of sustainable construction	15.00
7	Limited sustainable knowledge and understanding from subcontractors	14.58
8	Limited supply of sustainable materials and products	14.33
9	Extension of project schedules	14.25
10	Lack of public awareness	13.67
11	First cost premium of sustainable design and construction	13.63
12	Delay in decision making	13.50
13	Requirement for long payback periods from implementing sustainable practices and technologies	12.71
14	Concerning warranties and risks on non-standard sustainable materials and methods	12.25
15	Initializing sustainability due to lack of building regulations	11.54
16	Lack of government policy	9.67
17	Misconception of Construction cost overrun	8.67
18	Recovery of long-term savings not reflected in service fee structure	8.54
19	Conflict public policy and/or regulations	8.46
20	Lack of awareness from clients (Owner/Developer)	7.50
21	Limited sustainable knowledge and understanding from contractors	7.42
22	Deployment of resources to back technological changes	6.92
23	Lack of knowledge and understanding from design professionals	3.42
	Number(n)	12
	Kendall's W[a]	0.762
	Significance	0.000

The last two factors were awareness-related factors and are consistent with the finding of Marsh, Brent, and de Kock (2020), who found that lack of knowledge is one of highest ranked barriers to implementing sustainable development in South Africa. Again, this finding aligns with the views expressed by Enshassi, Ayash and Sherif (2018) that insufficient capacity to implement sustainable practices is a major barrier. The findings also support earlier findings and conclusions by Daniel, Oshineye and Oshodi (2018) about critical barriers to sustainable construction practices in Nigeria. This suggests the need for context-based strategies that will focus on increasing or improving awareness in sustainable design and construction among stakeholders. Most importantly, the study's findings show the barriers and drivers to sustainable development that the respondents view as important. The study shows that the respondents agreed on many factors; however, this should not be misconstrued as being the correct answer or opinion of judgement rather as stimulation to debate on the issues and an avenue for structuring group discussions (Hasson, Keeney, & McKenna, 2000). However, the method has been criticised for having the potential to produce forced consensus.

Conclusion and Further Research

The study used a two-round Delphi method to identify a set of drivers and barriers that represent consensus-based factors for sustainable design and construction in Abuja. The factors are consistent with previous research. Academics, the government, and professional institutions are encouraged to develop localised strategies to improve stakeholder knowledge of sustainable design.

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