Barriers to the Adoption of Smart Housing Concept in African Smart City Projects: Case of Akwa Millennium City

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Abstract

In as much as there is a wealth of research on smart housing, there is limited literature based on empirical findings from Africa. The aim of this paper is to examine barriers to the adoption of smart housing concept in Africa using a case study of Akwa Millennium City Project in Nigeria. The case study was chosen because is a premium multi-nucleic smart city project that is slated to redefine the concept of urban living in Nigeria and Africa at large. Structured questionnaires were purposively administered to all the staff of Akwa Millennium City project while all retrieved questionnaires were found suitable for analysis. Descriptive statistics was employed to analyse the data collected from the respondents. Findings depicted that the major barriers could be classified as socio-economic, technical and policy hindrances. It is noteworthy that smart housing concept could be unaffordable due to the most perceived barriers (such as limited consumer demand, retrofitting of existing homes and buildings, lack of financial and financing incentives, high cost of development, and smart technology as divisive, exclusive or irrelevant). This study therefore recommends that developers should focus on socio-economic attributes in the adoption of smart housing concept to achieve an effective planning of smart city projects in Nigeria and Africa at large.

Keyword: Akwa Millennium City, Africa, Social Housing, Smart Housing, Smart City, SDGs11

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1.0 Introduction

A city can be termed smart when it is able to effectively apply ICT and other smart technologies in achieving intelligent solutions technology to everyday challenges posed by the city. In view of this, smart housing concept leverage on smart technologies and data to solve housing problems. Smart city as a concept adopts the use of data, information and other smart technologies in achieving smart solutions to everyday challenges posed by the city (Dameri & Rosenthal-Sabroux, 2014). The concept has been generally adopted to be a solution to creating an enabling future environment that is technologically driven, resource efficient, and providing an affordable home through this process (Gobbo, Souza & Gobbo, 2016). In view of this, smart housing leverage on data, information and smart technologies to solve housing problems in smart city projects.

Smart cities create collaboration opportunities between public and private sectors which include the circular economy, smart governance, social cohesion, public management, smart transportation, smart environment and smart logistic among others. Most literatures focus on the technological aspect of the smart city and data sharing (Emmanuel, 2014; Gosden, 2014; Greenough, 2015; Gobbo, Souza & Gobbo, 2016; RICS, 2019). Few studies emphasised on the opportunities the smart technologies can create in the urban environment while projecting ICT as a means of making a city smart (Aliyu & Amadu, 2017; Odefadehan, 2021). The claim is that smart housing can come up with the smart technologies and technical know-how of facilities that makes for a smart city project.

In smart housing concept, smart cities are conceptualized as metropolitan areas housing smart urban dwellers with a high level of education can easily adopt smart technologies in the developmental activities of the cities. This assertion is that the highly educated urban dwellers are the major drivers of technology innovations in smart city. In view of this, the problem lies with the numerous hindrances on techniques to the adoption of smart housing solutions. These problems include privacy and data security, lack of understanding user needs, irrelevant of some smart technology, and regulatory barriers in smart city development projects (Odefadehan, 2021).

The initiative of Nigeria Smart City Initiative (NSCI) is to transform Nigerian major urban centres from traditional dysfunctional cities to modern, efficient, responsive ones capable of satisfying the housing needs of present and future generation of Nigerians. The modalities of smart housing

concept could provide a better solution to the housing and urbanization in Nigerian cities. For instance, cities like Lagos, Abuja, Kano, Kaduna, Akwa are experiencing challenges as regards housing, inadequacy of infrastructural facilities. Housing has been a major issue in Nigerian cities as there is an exponential increase in population growth in urban areas and the available housing in cities is not affordable to the middle-and low-income earners. Using Akwa Millennium City project in Nigeria, it is therefore pertinent for this study to examine the barriers to the adoption of smart housing concept in African smart city projects.

2.0 Literature Review

Currently, the world is witnessing an unprecedented increase of urbanisation (Opoko & Oluwatayo, 2014; Pugalis, Giddings & Anyigor, 2014; Bodo, 2019). In Africa, policy makers are overwhelmed with a mammoth task of arresting urbanisation which is spreading like veld fire (Opoko & Oluwatayo, 2014; Pugalis, Giddings & Anyigor, 2014). A plethora of environmental and socio-economic challenges including but not limited to pollution, unemployment and poverty are attributed to high levels of urbanisation (Babanyara & Saleh, 2010; Chourabi, Nam, Walker, Gil-Garcia, Mellouli, Nahon, Pardo and Scholl, 2012; Bodo, 2019; Kolandaisami, 2020; Chigara, 2020). Opoko and Oluwatayo (2014), Bodo (2019) as well as Babanyara and Saleh (2010) singled out Nigeria as one African country with is experiencing a proliferation of urbanisation and its associated challenges.

The growth of technology especially the technology of things incubated the idea of smart cities (Albany, Alsahafi, Alruwili & Elkhediri, 2022). Proponents of the smart cities postulate that smart cities are the much-needed cure of most ills of urbanisation (Chourabi, et al, 2012) as well as a vaccination to against climate change (Balta-Ozkan, Boteler, and Amerighi, 2014). Of late recognition the introduction of smart cities concept has gained momentum (Oke, Aghimien, Aigbavboa and Akinradewo, 2020) as shown by an increase in policy paradigms and debates on the subject across the world. In as much as the smart cities concept is widely used by academics and practitioners, the concept is misunderstood and under-researched (Jiogap and Abdryashitova, 2020; Oke, et al, 2020).

A smart city is a broad concept which include aspects such as smart transport, Balta-Ozkan, Boteler, and Amerighi (2014) defined a smart house as the one that allows its occupants to:

"…*control and manage their energy use more efficiently whilst increasing their comfort and convenience for a variety of household activities*."

According to Tetteh and Amponsah (2020):

"… smart homes enhance the comfort of the dwellers, ensure the diversification of energy sources and use, promote inclusiveness in the provision of housing and present an avenue for environmental cleanliness."

In view of the foregoing discussion, one's take-home point is that the smart housing concept emanated from the smart cities concept, and it entails the use of technology in housing development, management and use. In this case, the technology of things can be viewed as a catalyst which enhances a reduction in pollution through recovery, recycling and reuse for example (empty paint cans and/or pallets) during housing construction and maintenance, reducing energy consumption (by using smart water meter) as well as improving water and energy efficiency. However, Balta-Ozkan, Boteler and Amerighi (2014) warned that if not properly planned, smart houses might not be affordable to the urban poor, in that case it will benefit just a selected few.

Drivers and barriers to the adoption of smart cities are influenced by the local environment (Kolandaisami, 2020). Jiogap and Abdryashitova (2020) emphasises the importance of the use of locally available technology in the construction of a smart house that reduces the cost of running the house. They gave an example of adoption of solar technology when constructing housing especially in Africa where solar is abundant.

According to Tomal (2020), the smart housing concept is not limited to a housing unit or a neighbourhood, but it can also be applied to the entire property market including the use of technology in following areas:

"…*rental housing market; innovative digital platforms in the traditional housing market; innovative policies and housing models; and the ability to forecast demand on the housing market*…"

The delivery of smart housing concepts and technologies in smart city projects can be hindered by several factors. According to Gobbo, Souza and Gobbo (2016) informal settlement of urban sprawl and the need for affordable homes makes the adoption of smart housing concepts in cities difficult.

Mosha, Sungirirai, Dick and Paradza (2022) noted a dilemma faced with African city fathers in their quest to attain sustainability when their environments are infested with informality. They went on to argue that informality seems to be a permanent feature of African cities and whatever form of sustainability these cities seek to achieve must embrace and not seek to eliminate informal environments. If one is to go by this argument, then a model African smart city and smart house must recognise not just informal settlements but also embrace indigenous technology.

Barriers of smart housing concepts have been outlined in various studies (Greenough, 2015; Gobbo, Souza & Gobbo, 2016; Aliyu & Amadu, 2017; Odefadehan, 2021). The study of Edwards and Grinter (2001) highlighted the barriers of smart housing concepts as interoperability, devices, appliances and systems from different vendors to operate together, administration, reliability, system intelligence and behaviour interference, and data security. Furthermore, the study of Ciesielska and Li (2011) outlined the lack of understanding of user needs, and infrastructure solutions as the major smart housing barriers. Due to the introduction of innovations and technologies applied in smart housing concept, recent studies outlined the major barriers in developing countries as follows (Emmanuel, 2014; Gosden, 2014; Greenough, 2015; Gobbo, Souza & Gobbo, 2016; Aliyu & Amadu, 2017; Odefadehan, 2021):

- Administration.
- High Costs of development.
- Limited consumer demand/ Unaffordability.
- Long replacement cycles.
- Ageing of electric infrastructure.
- Macroeconomic barriers.
- Lack of skilled and specialised workers.
- Incipient micro energy generation market.
- Regulatory barriers.
- Sharing infrastructure responsibilities and costs.
- Fragmented energy market structure.
- Tax system for energy micro generation.
- Lack of financial and financing incentives.
- Usability.
- Lack of understanding user needs.
- Loss of control and apathy.
- Smart technology as divisive, exclusive or irrelevant.
- Communication with consumers.

- Difficulty to change consumer behaviour.
- Theft and fraud in electricity distribution system.
- Interoperability.
- Reliability.
- Systems intelligence and behaviour inference.
- Privacy and data security.
- Retrofitting of existing homes and buildings.
- Complexity.
- Slow and precarious electrical system recovery from power interruptions.

However, the study of Gobbo, Souza & Gobbo (2016) classified these barriers under four major categories. These are social, economic, policy, and technical challenges. Alharbi, McAvoy and Woodworth (2019) classified the barriers into functional and psychological barriers as shown in Table 1.

Table 1: Types of barriers to innovation

Barriers		**Definition**
Functional Barriers	Usage barriers	Resistance towards a new invention due to its incompatibility with present routines, exercises, and plans.
	Value barriers	Resistance towards the usage of products or services when they do not fulfil the user's perception of performance-to-price value in contrast with other substitutes.
	Risk barriers	Uncertainty regarding the possible negative consequences of using a product or service.
Psychological Barriers	Tradition barriers	The cultural change created for the customer by the innovation.
	Image barriers	The degree to which an innovation is perceived as having an unfavourable image.

Source: Alharbi, McAvoy and Woodworth (2019:30)

In view of the foregoing review, it can be noted that the smart housing concept is believed to be a panacea of the ills of urbanisation is anchored by technology. The concept is broad and can be applied at different stages of housing ranging from development, marketing, management and use but the overall idea being to use technology to bring comfort and security to the user at the same time promoting inclusivity and environmental protection. There is vast literature on barriers of smart housing projects but the findings of most of the studies lack the empirical studies on its adoption in the smart city projects especially in the African context. This may be due to few or no empirical research that has been carried out on this subject area. This study therefore set to fill the gap in the literatures.

3.0 Methodology

Akwa Millennium City project in Nigeria was selected as the case study area while all the staff of Akwa Millennium City project was considered as the target population for this study. The sample size of this study consists of all the 25 staff of Akwa Millennium City project in Nigeria. Key informants from Akwa Millennium City project were chosen because of their experience in the subject under study. Personal interview and questionnaire administration were the primary data collection methods adopted for this study. Structured questionnaires were purposively administered to all the staff of Akwa Millennium City project while all retrieved questionnaires were found suitable for analysis. Secondary data collection sources include the review of relevant literature in the subject area. The data collected were analysed using descriptive statistics (i.e frequencies, weighted mean score, standard deviation and ranking order). Descriptive statistics was adopted to examine the perceived barriers to the delivery of smart housing concept in Akwa Millennium City project in Nigeria.

4.0 Result and Discussions

The discussions of results generated from the analysis are presented in this section. The socio-economic background of respondents in the case study area is shown in Table 2 below.

Table 2. Socio-economic background of respondents

Background	Frequency	Percentage (%)
Gender		
Male	19	76
Female	6	24
Total	**25**	**100**
Age of Respondents		
20-30years	4	16
31-40years	14	56
41years and above	7	28
Total	**25**	100
Staff Profile		
Contract/permanent Staff	21	84
Part-Time Staff	4	16
Total	**25**	**100**
Profession		
Architect	2	8
Quantity Surveyor	3	12
Engineer	15	60
Project Manager	4	16
Artisan	1	4
Total	**25**	100
Educational Background		
HND	1	4
B.Tech/B.Sc	6	24
Post Graduate	18	72
Total	**25**	**100**
Professional Qualification		
Graduate Member	5	20
Associate Member	17	68
Fellow member	3	12
Total	**25**	**100**
Years of Experience		
0 – 5 years	10	40
6 – 10 years	12	48
11 years and Above	3	12
Total	**25**	**100**

Source: Research Findings (2022)

Table 2 above indicates that majority of the respondents were male while 56% of the respondents are within the age bracket of 31 – 40 years. Majority of the staff are full-time employee while minority is part-time staff. The profession of the staff indicates that 8% were Architect, 12% were

Quantity Surveyor, 60% were Engineer while 16% were Project Manager and 4% were Artisan. This implies that most of the respondents were engineers (these include site engineer, civil engineer, structural engineers etc.) Furthermore, majority (72%) of the respondents had studied up to post graduate level (these include Master degree and PhD degree), 24% were Bachelor of Technology (B.Tech) or Bachelor of Science (B.Sc) and 4% were Higher National Diploma (HND) holders. This implies that majority of the respondent's qualification were masters and PhD degree holder.

Professional qualifications indicate that 68% of the respondents were associate members of their various professional bodies, 20% were graduate member while 12% were fellow members. It is noteworthy that majority of the respondents are professionally registered, affiliated and recognized by their respective professional bodies. Furthermore, all respondents had the adequate work experience; 48% had experience between 6 – 10 years, 40% had worked below 5 years while 12% had over 15 years.

From the profiles of key informants, it can be noted that most of them are within the middle age group and are educated hence it can be assumed that they are well versed with the subject under study. This assumption is also supported by the work experience of most of the key informants.

Table 3. Perceived barriers to the delivery of Smart Housing Concept in Akwa Millennium City project

Barriers	N	Mean	Std. Deviation	Rank
Limited Consumer Demand/Unaffordability.	25	4.20	.408	1st
Retrofitting of Existing Homes and Buildings.	25	3.96	.841	2nd
Lack of Financial and Financing Incentives.	25	3.92	.400	3rd
High Cost of Development.	25	3.92	.812	3rd
Smart Technology as Divisive, Exclusive or Irrelevant.	25	3.80	1.000	5th
Theft and Fraud in Electricity Distribution System.	25	3.72	.678	6th
Slow and Precarious Electrical System Recovery from Power interruptions.	25	3.68	.748	7th
Regulatory Barriers.	25	3.64	.810	8th
Ageing of Electric Infrastructure.	25	3.56	.507	9th
Long Replacement Cycles.	25	3.56	.507	10th
Reliability.	25	3.52	1.005	11th
Administration.	25	3.52	.872	11th
Difficulty to Change Consumer Behaviour.	25	3.48	.510	13th
Incipient Micro Energy Generation Market.	25	3.48	.510	13th
Complexity.	25	3.44	.712	15th
Loss of Control and Apathy.	25	3.36	.810	16th
Tax System for Energy Micro Generation.	25	3.20	.408	17th
Interoperability.	25	3.08	.640	18th
Fragmented Energy Market Structure.	25	2.80	.408	19th
Lack of Understanding User Needs.	25	2.52	.823	20th
Sharing Infrastructure Responsibilities and Costs.	25	2.48	.714	21st

Macroeconomic Barriers.	25	2.48	.872	21st
System Intelligence and Behaviour Inference.	25	2.40	.816	23rd
Privacy and Data Security.	25	2.28	.458	24th
Usability.	25	2.00	.000	25th
Communication with Consumers.	25	1.76	.436	26th
Lack of Skilled and Specialized Workers.	25	1.72	1.208	27th
Valid N (listwise)	**25**			

Source: Research Findings (2022)

Table 3 above shows the perceived barriers to the delivery of Smart Housing Concept in Akwa Millennium City project in Nigeria. Findings depicted that limited consumer demand (4.20), retrofitting of existing homes and buildings (3.96), lack of financial and financing incentives (3.92), high cost of development (3.92), and smart technology as divisive, exclusive or irrelevant (3.80) were the most rated barriers to the delivery of smart housing concept in smart city project in the case study area. This implies that smart housing may not be affordable due to the limited consumer demand which supports the views of Balta-Ozkan, Boteler and Amerighi (2014). However, these barriers could be classified as the socio-economic, policy, and technical challenges in the adoption of smart housing concept in African smart city projects which resonates well with the classification by Gobbo, Souza & Gobbo (2016). Furthermore, theft and fraud in electricity distribution system (3.72) ranked 6th, followed by slow and precarious electrical system recovery from power interruptions (3.68) ranked 7th while regulatory barriers (3.64) ranked 8th. These could be attributable to the technical and policy challenges in the delivery of smart housing in African smart city projects.

Other barriers (such as ageing of electric infrastructure, long replacement cycles, reliability, and administration) with lower mean scores were slightly rated as the challenges to the delivery of smart housing concepts in the case study area. Findings also indicated that macroeconomic barriers, system intelligence and behaviour inference, privacy and data security, usability, communication with consumers, lack of skilled and specialized workers with the lowest mean scores were the least rated barriers to the adoption of smart housing concept in the smart city

project. These barriers could as well be classified as psychological and functional hindrances in the delivery of smart housing in African Smart City projects in line with the classes of Alharbi, McAvoy and Woodworth (2019:30). The need for IT expert could help to facilitate the use of smart technologies (such as smart grid, Artificial Intelligence) in the delivery of smart housing concept in the project. These findings are in consistent with the study of Akinwamide & Hahn (2021) that the development of Eko Atlantic city has led to the application of smart city in Nigeria to upgrade its major cultural and innovative cities (such as Akwa Millennium City project in Anambra state).

5.0 Conclusion

This study has examined the barriers to the adoption of smart housing concept in African smart city projects using Akwa Millennium City project in Nigeria. It's noteworthy that smart housing concept could be unaffordable due to the most perceived barriers (such as limited consumer demand, retrofitting of existing homes and buildings, lack of financial and financing incentives, high cost of development, and smart technology as divisive, exclusive or irrelevant) in the development of African smart city projects. Furthermore, socio-economic hindrances (such as communication with consumers, macroeconomic barriers, usability, and lack of skilled and specialized workers) were the least barriers to the adoption of smart housing concept in Akwa Millennium City project. As African policy makers are faced with these barriers, it might be the right time to embrace indigenous technology and come up with a home-grown definition of an African smart city. It is therefore recommended that developers should focus on socio-economic attributes in the adoption of smart housing concept to achieve an effective planning of smart city projects in Nigeria and Africa at large. It is further recommended that more research should be done with the intention of defining a smart house/city from an African perspective taking into consideration the local environment, indigenous technology and availability of resources. The major limitation of this study is that it was limited to data from key informants whilst leaving out homeowners who might have lived experiences. Therefore, it is recommended that future studies must be focus on the views of home owners.

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