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ADDRESSING THE NIGERIAN HOUSING AFFORDABILITY CHALLENGE THROUGH SMART CITY SOLUTIONS

Onyinye Vivian Keke[1], Stephen Chibuike Ugwuejim[2], Olayinka Clement Oloke[3]

[1]Department of Estate Management, Nnamdi Azikiwe University, Anambra State, Nigeria.
[2]Department of Estate Management, Babcock University, Ilishan-Remo, Ogun State, Nigeria.
[3]Department of Estate Management, Covenant University, Ota, Ogun State, Nigeria.

Corresponding authors email: ugwuejims@babcock.edu.ng, ov.keke@unizik.edu.ng

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Abstract

The twin challenges of deficit housing and the unaffordability of the available ones have been an issue contended with by Nigeria's growing population. While there have been deliberate efforts to mitigate this issue via government interventions and public-private partnerships, it has not effectively catered to those it was specifically created for, as most high-income and mid-income earners benefit more from such interventions. This problem has been alluded to the state of land governance and accessibility in Nigeria, which is still in need of development. This study was aimed at examining smart city solutions that can be applied to Nigeria's developing state of housing affordability. The study adopted a survey research design, with primary and secondary data sources consulted. The respondents were sampled purposively, and a Likert-scaled questionnaire and weighted averages were used to analyze the collected data. The study identified that the integration of technology in modular construction and its adoption in public-private partnerships towards the regulation of efficient land use can tackle housing affordability issues if implemented at Nigeria's current level of development. High cost and lack of government support were identified as potential barriers to its successful implementation, while the challenge of unequal access to technology and the likelihood of technological malfunctions were identified as concerns upon successful implementation. The paper suggests that the development of affordable housing through technology-enabled modular construction can be explored, especially the integration of local materials in the development of houses.

Keywords: *Housing Affordability, Smart City, Smart City Strategy, and Smart Technologies.*

1.0 Introduction

With 70% of the world population projected to be urbanized by the 2050s (Ibrahim et al, 2016), Nigeria, like other rapidly urbanized economies, has, over time been faced with the challenge of housing deficit or inadequacy in the supply of affordable housing (Bredenoord et al, 2014). Housing is perceived as an essential need of man, which is fundamental for his survival and integration with his environment (Dumreicher and kelb, 2008). Therefore, it is concerning that Nigeria's homeownership rate and housing shortage are recorded at 20% and 20 million units, respectively (Ezennia, 2022). The importance tied to affordable housing has scaled up to developments that are sustainable and align with sustainable development goals, as housing affordability is now rated on the basis of accessibility, adequacy, and amenity (Ezennia and Hoskara, 2018; Gomez, 2018). The demand for affordable housing has in part been sustained due to the government's incapacity to fund such development projects and while this has created an opportunity for public-private partnerships in facilitating social housing supply in certain parts of the country (Nigeria), it is still not enough (Alli, 2024; Akinyode, 2016; Adegoke, 2011; Ibem, 2011).

The concept of affordable housing is often viewed as an offshoot of social intervention programmes by governments to alleviate the poor and low-income groups in their regions. Interestingly, studies by Ackley et al (2018) and Barka and Kumar (2020) showed that affordable housing was occupied by high to mid-income groups in Nigeria and Ethiopia, respectively. Concerning high-density populated areas, which is a common feature in economic cities in Nigeria, the process of filtering should ideally create affordable housing for the renters, but instead, the prices have been maintained or increased due to increased demand and limited supply. In part, supply has been limited due to the difficulties experienced by potential investors seeking real estate investment creation, either by titling or development permission challenges. There are also the challenges of an unstable economy, exorbitant prices of building materials, skilled labour shortage, poverty, increased rural-urban migration, and inefficient transport facilities that have contributed to the moribund state of affordable housing in Nigeria today (Muazu and Oktay, 2011; Mukhtar, Amirudin, and Mohamad, 2016). Unlike developed economies where the housing markets are much mature and manage the housing demand of their population efficiently, developing economies risk the development of dead capital when their government fails to take action on its overburdened housing demand. A prominent feature of the absence of strategies to curb increased housing demand or a poor supply of housing facilities in developing economies is the rise of slum penetration (Amegah, 2021; World Bank, 2008).

The subject of housing affordability might drag on longer in the Nigerian context, as its large and growing population will gradually demand housing. With its large landmass, the challenge of housing should be catered for in terms of horizontal development, howbeit with the growing desire by most to migrate to urban areas or the rate of urbanization developing in some cities, vertical development becomes a more logical option in addressing housing needs. Unfortunately, the gap between socio-economic groups keeps getting wider in the context of the

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Nigerian economy and frustrates the capacities of low-income earners to comfortably afford housing. In the realization of the inefficiency of land resources, rising demand and limited supply of housing and infrastructural facilities, urban planners and governments are searching for innovative ways to address these challenges and inject the needed development that improves citizen welfare, its economy, and preserves its existing natural resources. One of such innovative ways is smart city strategies, and academics, governments, and international bodies have begun to explore the potential in this concept.

The concept of smart cities lacks a universal definition, but its perception as an essential element needed to solve urban challenges like mobility, energy, healthcare, modern governance, amongst others, is shared by most urban and institutional actors (Ahad et al, 2020; Trencher, 2019; Hollands, 2008). The rise in demand for smart cities has also signaled a rise in ambition by transitioning or developing cities to achieve it in some measure (Noori et al, 2020).

Therefore, a city might retain its conventional features but with an injection of digital advancement, technologies and management policies directed at improving quality of life in the city (Sun, 2019). Dahmane, Ouchani and Bovarfa (2024) noted that the process of smart city development must rely on at least one pf the following development keys: Modern Technologies, Internet of Things, Management Strategies and Cyber-physical Systems.

Thus, it is the objective of this study to examine the solutions that can be applied to Nigeria's moribund state of affordable housing supply, upon the adoption of the smart city concept. There is a lack of studies highlighting on the instrument of smart cities as a potential solution to the Nigerian affordable housing challenge. Within this work, the state of affordable housing in Nigeria will be examined, and the critical areas and solutions of smart cities will be relied on, as guidelines to addressing Nigeria's housing issues. In fulfilling this objective, an extensive literature review will be relied on in identifying the component areas within the smart city concept and recommendations directed at enhancing housing affordability will be made.

2.0 Literature Review

2.1 *Rating the housing affordability situation in Nigeria*

In a study of housing provision strategies engaged by private developers in Lagos, the author observed that the various effects of the government via housing programmes and policies have been inadequate in addressing housing deficit and affordability at various levels within the African continent (Shiyanbola and Olaleye, 2019). The twin issue of urbanization and population increase continues to plague the housing provision efforts of most governments in urban areas, hence the partnership with private developers is steered more towards the provision of housing units, but not necessarily affordable housing since most housing prices are usually above 30% of housing income (Cai and Lu, 2015). This is concerning, especially when it is considered that between 65%-90% of housing units provided in urban areas in Nigeria are generated by the intervention of private developers (Ogunbayo et al, 2016; Enisan and Ogundiran, 2013).

Yahaya and Ibrahim (2019) observed that both the public and private sectors within Africa have adopted inefficient housing delivery systems in the past, which have further worsened the housing deficit situation. While observing the critical success factors for the public-private partnership strategy in delivering housing projects, it was discovered that the strategy is mostly biased in its delivery, as it is addressing the needs of high-income earners while marginalizing the needs for affordable housing by low-income earners.

In an evaluation of the strategy of public-private partnerships in housing provision in Lagos, Nigeria, it was discovered that the adoption of the strategy is still very much limited to federal and a few state governments (Alli and Lawal, 2019). Also, its framework and organization were in much need of fine-tuning, as it was either inefficient or poor in performance.

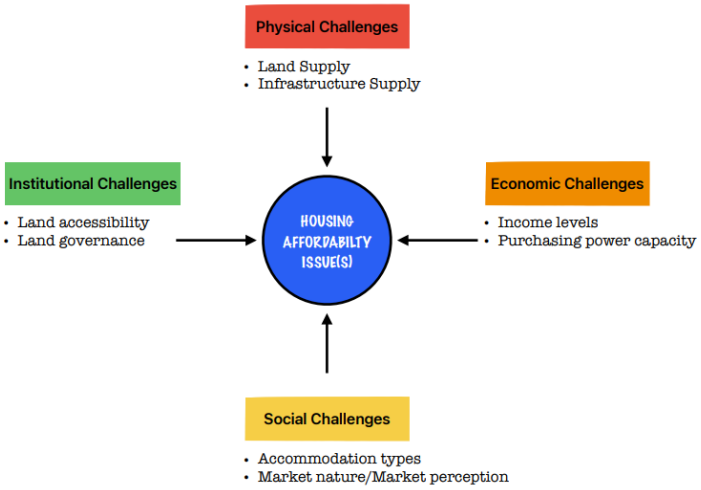


Fig. I Illustration of factors contributing to the issue(s) of housing affordability

The issue of housing affordability is one that operates as a merger of interrelated issues like land accessibility, income levels, purchasing power capacity, land supply, infrastructure supply, land governance, among others. For this study, we have classified these related issues via the illustration below;

These challenges and their contributions are discussed as follows;

1. *Physical challenges*: The issue of housing affordability could be tied to the physical challenges of land and infrastructure supply. With land being a scarce resource by virtue of its limited supply, it naturally creates a deficit in housing supply, as the available land resource is managed so as to ensure preservation and judicious use. In such situations, lands

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currently in use will naturally profit from their resource scarcity and appreciate both in value and rent price for the use and enjoyment of their resources. The same applies to infrastructure supply (physical infrastructure), which can be perceived as a facelift of the natural environment features, to support the use and enjoyment of one's occupation of such a location. Although it has been mostly adjudged as a responsibility of the government to make its provision, so as to improve citizen welfare, it is often politicized in the African climes and relied on as a factor cost by investors willing to make provisions for it. These challenges in their various forms and degrees contribute to the housing affordability issue.

2. *Economic challenges*: In this segment, the issues of housing affordability are supplemented by the factors of income levels and the purchasing power capacity of the region's trading currency. Lower income levels rationally create a risk of not affording increasing rental prices of homes, and this is further worsened by the increased rates of unemployment or underemployment in developing economies with rapidly growing populations. Another area of concern is the purchasing power of the trading currency. Where the capacity of the purchasing power of the local currency is strong or sustains a reasonable level of command over goods and services, or fares better compared to other trading currencies, the greater chances of residents being able to afford prices of goods and services (rent) as advertised and vice versa.

3. *Social challenges*: This looks at the accommodation types and the nature or perception of the market, as social factors that contribute to the housing affordability issue. Rationally, the number of rooms or house type influences rental pricing, be it in formal or informal real estate markets. Therefore, high-end property types are tagged as less affordable than those with simpler features or fewer bedrooms. The factor of accommodation type is also heavily influenced by real estate market type, as similar accommodations can trade for varying prices due to their market perception. Therefore, the nature, stage of development, or perception held by dwellers or visitors of a real estate market can influence the state of affordability in that locality or region.

4. *Institutional challenges*: These are factors generated by the actions and inactions of the authorities in power over a locality or region. The factor of ease in accessing land or its governance can influence housing affordability in an area. Where the means or processes of accessing land for property development are difficult in a locality/region, it frustrates the delivery of social housing projects or reinforces the objective of high profits from deluxe property developments by investors as a means of compensating for unplanned costs (due to project delay or additional cost requirements). The efficiency of land governance is also important to be considered as the administration of land and land management via supervision, policy enforcement, etc., can encourage or deter the propensity for housing developments in an area. Factors identified as reasons for sustained dead capital in developing economies have been linked to complicated or bureaucratic

processes associated with formalization processes of land titles, construction permits, limited access to finance, amongst others (Owotemu, 2019, PWC, 2018; De Soto, 2001).

2.2 *Smart Cities: Definition, Components, and Case Study Analyses*

As earlier stated under introduction, there is no universal agreement on the definition of smart cities, as it is a concept that has undertaken many evolutions, beginning with the idea of a digital cities, informative city or sustainable cities (Halegoua, 2020; Jenks and Jones, 2009, Hepworth, 1990)). However, Yang and Zhen (2024) observed that irrespective of varying definitions of the concept of smart cities, six (6) fundamental components should function in a smart city; they include: smart living, smart people, smart governance, smart economy, smart mobility, and smart environment. Each of these parts as well as their application to the Nigerian situation, are discussed below:

a. Smart Environment

Salleh et al (2022) noted that the components of a smart environment are critical to the fulfillment of a smart city. These components include environmental protection, environmental cleanliness, sustainable management of resources, a standby risk management strategy, and a quality living experience in housing zones. In other words, a smart environment accepts the innovation and development of digital technologies via modifications to its environmental form, while still ensuring sustainable use and management of land resources (Gupta, Mustafa, and Kumar, 2017). The limitations of a smart environment are aided by the adoption or integration of the smart system in that location. However, things must be in place to ensure the 'smartness' of the city plays out. A framework or structure for environmental cleanliness, protection, and preservation should be in place. The impact of human factors cannot be ruled out in a smart environment, as the environment itself is a reflection of human perception and interaction with it. Therefore, the better the living conditions, the better the chances of the environmental regulations recording compliance with environmental guidelines and policies, vice versa.

In the Nigerian context, the realization of a smart environment is attained when planning is devoted to the preservation of our natural environment and the reduction of carbon footprint. Where policies targeted at natural environment growth and sustainability, in line with sustainable development goals, are implemented, supervised, and enforced across the sectors in the economy, it becomes feasible to attain a smart environment. Another critical area is pollution, waste management, and recycling, of which Africa's largest population is still poor due to the absence of an efficient waste management or pollution control system (Damania, et al, 2023). Efforts must be directed towards ensuring a formal waste management system that can effectively cater to all neighborhood types on the basis of socio-economic equity rather than profits alone.

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b. Smart People

Godwin et al (2023) noted that the component of smart people is targeted at citizens', people or residents' behavioural development, which aligns with progressive artificial intelligence and internet of things knowledge. In other words, smart people are actors in a space that has aligned and allowed the integration of the systems and infrastructure of progressive technologies in their lives, so as to support innovative and creative impact around them.

Every smart city needs smart people to support and engage the system, so that it can perform and deliver better. Smart people possess traits that show alignment with the aim and objectives of a smart city. In other words, they are knowledgeable of digital advancements via artificial intelligence or machine learning, and they can adapt, learn, function, and develop within such a system. Mun Chye et al (2022) noted that experience, professional knowledge, and training exhibited by skilled manpower are critical for a developed economy. The traits of smart people are defined via team spirit, a healthy degree of sociability/networking, emotional soundness, diligence, and flexibility (Gupta, Mustafa, and Kumar, 2017).

Since the Global System for Mobile Communications (GSM) made its way to Nigeria in May 2001, Nigeria has recorded progress in its familiarity with smart devices and equipment. Still, a large percentage of Nigerians resort to conventional lifestyle choices, which are accentuated by culture, location, or degree of development in such areas. Even with the web and internet access becoming fully functional in Nigeria in 1996 and 1998, respectively (Adomi, 2005), Nigeria shows signs of infancy in harmonizing its network systems and Information, Communication Technology (ICT).

c. Smart Living

Gupta, Mustafa, and Kumar (2017) noted that smart living relates to the adaptation of smart equipment and devices to the everyday lifestyle of individuals, irrespective of culture, religion, gender, or race. In other words, smart living hinges on the ability of Artificial Intelligence (AI) and Machine Learning (ML) to assist and provide individuals with quality living experiences. The European Commission (2014) observed smart living as phased developments that grant people the opportunity to benefit from newer, efficient, productive, economic, and sustainable ways of living. In the Nigerian context, smart living should be easily adaptable when there are efficient institutions in place, to ensure law, order, and sustainability in the enjoyment of one's human right to live and interact with the environment. By ensuring that institutions are efficiently run, they can, in turn, hold the citizens accountable to law and order in all facets of human living and interaction. The advancements in technology can easily be adapted to a system that is efficient already, i.e., the building sector, health sector, food sector, market and trading sector, amongst others. Smart living would also need to be supported by sensitization/education on the use of technological devices to access goods and services, as most low-income neighborhoods still operate in conventional ways and means of living.

d. Smart Governance

Smart governance is marked by accessibility, transparency, and knowledge sharing, and it is facilitated by intelligent technology. Smart governance advances beyond conventional governance in the sense that it scales up the coverage of the government in terms of its reach, responsibility, and awareness towards its citizens. It is targeted at enhancing administrative services, improving urban areas, heightening transparency, and importantly addressing social welfare and equitable distribution of resources (Jiang, 2021; Liang et al, 2023; Kaiser, 2024). Therefore, smart governance is simply the integration of intelligent technology into government processes, so as to aid their delivery, coverage, and accessibility.

From the Nigerian perspective, governance institutions are marked by high levels of bureaucracy and inefficiencies in their administrative duties, such that public sector reforms are needed. The attachment to the conventional systems of database access and management via paperwork is still practiced in most governmental agencies. For smart governance to be truly rooted in Nigeria, the public sector would need to be revamped in its areas of operation, data sharing, and database management.

e. Smart Economy

Smart economy is simply the integration of technology tools, systems, and processes in the economic life of an area or region. By integrating technology into the systems and processes of economic activity in an area, it nurtures flexibility, widens coverage and accessibility in trading activities, as well as scales up productivity and market diversification (Pajitani et al., 2022). A smart economy not only fosters creativity, it stimulates competition in the labor market and drives research and development in production.

From a Nigerian context, while there have been some manifestations of technology integration in the nation's economic activities via e-commerce, the areas of productivity, innovation, and full assimilation of ICT in economic activities are still in their infancy.

f. Smart Mobility

Smart mobility has to do with the integration of technological advancements in a city's transportation system. This transport system comprises means and modes of transportation, and by integrating ICT into its operation, city-wide connectivity and intelligent accessibility can be achieved (Gupta, Mustafa, and Kumar, 2017).

In the Nigerian context, the absence of a sound public transportation policy and an integrated and functional transport system already cripples the prospects of integrating technology into transportation in Nigeria (Adanikin and Oyedepo, 2017). A transportation policy is a standard set in place to achieve an efficient transport system(s). With Nigeria lacking a sound public transport policy, it becomes challenging to adopt the possibility of a smart transportation system.

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Parappallil, Matthew, and Bangwal (2024) observed that studies on smart city development have focused more on innovation and technology than the stakeholders' (people) view within it, and this negatively affects the quality of life. The study was aimed at assessing the people-centered governance model's effectiveness in life quality improvement within the smart city. The study employed a thematic literature review method in discovering findings. It was discovered that within Oman, limited studies on an industry basis that are targeted at smart city execution have been performed. This is also related to people's involvement in the development of the smart city in Oman. It was also discovered that even with advancements in technology, there are study limitations on people-centered smart governance. The people-centered governance model approach has not been able to integrate smart governance, smart environment, and smart people. While analysis-based modelling was developed for smart cities, the people-centered governance model approach has not been able to integrate smart city development with smart people. The poor priority assigned to people-centered governance has negatively impacted the quality of life in work-in-progress smart cities. Research studies have stressed innovation and technology, much to the detriment of the perceptions of the end users in the local community. The authors recommended that smart city models should be developed and tested on a sustainability basis and that people-centered welfare and natural preservation should be prioritized and integrated in urban planning. The administration of data should be supported by a robust security architecture, and identify barriers to smart city execution via comprehensive studies. Lastly, stakeholders should be engaged in the production of plans for the networking of smart cities.

De Jong, Joss and Taeihagh (2024) asserted that the issues of citizen's data protection and privacy; tendency for small shadow groups to be negatively sidelined by smart projects in a top-down development fashion and the requirement of finance and planning authorities by smart projects initiated from grass root levels, upwards have raised concerns in the engagement or implementation of smart city developments. The study was aimed at assessing the concept of smart city and its various characteristics in the 21st century, that reflects developments in capitalism. Utilizing the desk study method, it was discovered that contemporary capitalism is reflected in the following characteristics: increased capital accumulation, complicated arrangements by the government on matters of capital conversion and resource extraction, and wide coverage data extraction and monitoring. The authors also identified six spatial representations of the smart city as: science parks and smart campuses, innovation districts, smart neighborhoods, urban platforms, alternative smart city spaces, and city-wide, metropolitan, and city-regional interventions. The evaluation of smart cities also grants it the capacity to receive large flows of various capital forms i.e., financial, human, physical, natural, and social. Financial capital is rated as the best benchmark for all other capital forms in smart technology production. In summarizing smart cities as a reflection of capitalism in the 21st century, the authors noted that the consequences of socio-economic inequality and planetary destruction are products of smart cities' business model of harnessing information to advertise general consumption, at the expense of natural resources, human relations, and capabilities. The result is an ecological overshoot and socio-economic undershoot. This prompted recommendations by the authors on further research on theory

development and policy recommendations with respect to types of 21st-century capitalism, spatial manifestations, and means of moderating the unyielding capital accumulation process.

Kong, Hwang, and Kim (2025) asserted that inadequate knowledge exists in discerning the impact of adapting technology in cities. The study was aimed at assessing strategies on smart city development and their fitting into urban development plans in Siheung-si and Neocity areas of South Korea and Florida, United States, respectively. Utilizing an exploratory case study approach, the extant literature review, in-depth interviews, and the adaptation of Damen's framework were consulted in data collection and analysis. It was discovered that considerations specific to an area's socio-economy should be made before implementing decisions or policies on technology, land, people, infrastructure, and governance. Partnerships between governments aid the process of knowledge sharing in a smart city network. The authors recommended that smart city development strategies should accommodate sustainable land use, stakeholder and citizens' partnership, whilst leveraging digital developments. Such collaboration creates adaptive and resilient cities.

Hashim (2024) observed that doubts mostly surround smart city projects due to the issues of security that feature in their environment(s), as digital gadgets often pose as security flaws. The study was aimed at examining the factors of smart cities that influence e-governance in Saudi Arabia. Utilizing the media-synthesis technique in collating and analyzing data, the author elucidated on the role of e-governance in smart cities and how Saudi Arabia has made progress from independent running systems to an integrated network of information supplied to aid the government in the operation of smart city. It was also observed that upon the implementation of the smart city project in e-governance, there was an impact created in inflation due to increased energy costs. Challenges in the adaptation of ICT today can be solved when the government makes available the opportunity for affordable and equal access to internet services. The reception of e-governance can also be facilitated by an atmosphere that promotes partnership among businesses, stakeholders, and the government. The issues of infrastructure, data management and integration, network administration and surveillance, and legal obstacles are the challenges that smart cities in e-governance face. The author recommended that provisions be made to cater to the lack of funding for digital program implementation, digital infrastructure, and low confidence levels, which most governments face. Government should also build trust with its citizens by collaborative participation, fostering partnerships and developments aimed at their well-being, amongst others.

3.0 Materials and Methods

This study adopted a survey research design, where survey responses were relied on in generating proposed strategies for the adoption of the smart city concept in addressing the affordable housing situation in Nigeria. The data used in this study were obtained from primary sources via a structured questionnaire, administered purposively to fifty (60) construction/real estate industry professionals in Nigeria cutting across 3 major cities (Abuja, Lagos, and Awka) representing the

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major ethnic regions of the country. The structured questionnaires employed the use of Likert scales in gauging the views of the respondents.

Survey design is a process that utilizes the collection of information from a targeted sample of respondents via structured questions. The process involves question generation, selection of a response format, sampling strategy, data collection, and data analysis.

Table I: Administration of Questionnaire

	Number of Questionnaires Administered	Number of Questionnaires Retrieved	Percentage (%)	Number of Questionnaires Used for Analysis	Response Rate (%)
	60	50	90.00	50	100.00

Data collected were analyzed using statistical tools such as Frequency and Percentage Distribution tables and Weighted Average (mean). Charts are mostly relied in illustrating data collected from respondents.

The Weighted Average is a type of average calculation that assigns different degrees of importance to the options (numbers) in a particular data set (Ganti, 2024). Each option (data point) is multiplied by its assigned weight, summed, and divided by the total of the options (data points). The assigned weight already predetermines the relative importance of the options to be selected by the respondents. It is denoted as follows;

$$\text{Weighted Average} = \frac{Sum\ of\ weighted\ terms}{Total\ number\ of\ terms} = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}$$

Where:

W_i = Weight of each value

X_i = Individual value in the dataset (product)

$\sum$ = Summation of products and weights

The use of Likert scales is also justified in the analysis of data using weighted averages (mean) for questions about the level of positive impact of smart city strategies on housing affordability in Nigeria and the barriers to implementing smart city strategies. The 4-point Likert scale for the two questions was used as weights in ascertaining the sentiments of the respondents. The length of the

period used is 0.75(3/4), where the four-point Likert scale has three distances between four points. Table 2 below shows the analysis of the weighted means for the Likert scales

Table II: Analysis of weighted means for Likert scale.

Question Number	Weight (Likert Scale)	Weighted mean	Descriptive Equivalent
1	1	1.00-1.75	No Positive Impact
	2	1.76-2.50	Low Positive Impact
	3	2.51-3.25	Medium Positive Impact
	4	3.26-4.00	High Positive Impact
2	1	1.00-1.75	Major Barrier
	2	1.76-2.50	Medium Barrier
	3	2.51-3.25	Minor Barrier
	4	3.26-4.00	No Barrier

4.0 Results and Discussion

4.1 Results

Table III: Housing Affordability Segment

What measure best describes housing affordability in your city?	Frequency	%
Ability to access a housing loan	4	8.00
Ability to spend less than 30% of your annual income on housing	27	54.00
Access to land	19	38.00
Total	50	100
What do you believe are the main factors contributing to housing unaffordability in Nigeria?		
Low income levels	7	16.6
High building costs	5	11.90
Poor economy	7	16.6
Poor access to land	5	11.90

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All of the above	18	43
Total	42	100

Table III shows that 54% of the respondents are of the opinion that the ability to spend less than 30% of your annual income on housing is a proper measure of housing affordability. Also, 43% believe that a mix of low-income levels, high building costs, poor economy, and poor access to land has contributed to the poor state of housing affordability in Nigeria today.

Table IV: Smart city concept awareness

Familiarity with smart technologies or strategies in improving urban living conditions	Frequency	%
Internet of Things	10	20.41
Green Energy	15	30.61
Machine Learning	3	6.12
Artificial Learning	8	16.33
Data Analytics	5	10.20
All of the above	8	16.33
Total	49	100
Perception of the role of technology in solving urban housing challenges		
Very positive	15	53.57
Somewhat positive	8	28.57
Neutral	5	17.86
Somewhat negative	0	0
Very negative	0	0
Total	28	100

Table IV shows that all the respondents are familiar with the various smart strategies in improving urban living conditions, with 30.61% constituting the most familiar with Green Energy. On the perception of the role of technology in solving urban housing challenges, about 54% are very positive about the instrumentality of technology in solving urban housing challenges that are unique to the Nigerian situation.

Table V: Choice of smart city solutions for tackling housing affordability

Rate the importance of the use of data in optimizing housing policy and resource allocation.	Frequency	%
Very important	17	58.62
Important	9	31.03
Neutral	1	3.45
Not important	1	3.45
Unsure	1	3.45
Total	29	100
How could smart city data improve access to affordable housing for low-income households?		
Misallocation of affordable housing resources could be stopped	17	32.69
It could improve neighborhood governance	11	21.15
It could improve the government's emergency response to disaster management	9	17.31
It could improve data sharing between housing administrative institutions	15	28.85
Total	52	100

Table V above shows that 58.62% recognize the importance of data in making efficient housing policy and resource allocation, while 32.69% are of the opinion that smart city data could improve access to affordable housing for low-income households by stopping the misallocation of available and affordable housing resources.

Table VI: Smart city strategy implementation challenges

Identify the stakeholders to be responsible for the implementation of smart city strategies in improving housing affordability	**Frequency**	**%**
Local Government	8	17.02
Private Developers	10	21.28
NGOs	0	0
Technology Companies	11	23.40
Community members	4	8.51
All of the above	14	29.79

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Total	**47**	**100**
Concerns about the implementation of smart city technologies in solving housing affordability issues		
Loss of privacy	1	2.27
Increased gentrification	8	18.18
Unequal access to technology	17	38.64
Technological malfunctions or failures	18	40.91
Total	**44**	**100**

Table VI reveals that 29.79% of the respondents are mostly of the opinion that the local government, private developers, NGOs, technology companies, and community members are responsible for the implementation of smart city strategies targeted at improving housing affordability. Technological malfunctions or failures (40.91%) is the largest selection by the respondents as the major concern about the implementation of smart city technologies in solving housing affordability issues. This is justified by the poor maintenance culture that is associated with facility management, as highlighted by Abiodun, Olayemi, and Joseph (2016).

Table VII: Recommendations on Smart city strategies

Policy changes deemed necessary for integrating smart city solutions into housing development	Frequency	%
Collaboration amongst stakeholders	15	20.83
Citizen engagement in city planning	17	23.61
Improved debt funding strategies	10	13.90
Technological capacity building	15	20.83
Sensitization on smart city service integration	15	20.83
Total	72	100
How can the government and private sector work together to make housing affordable through smart city strategies?		
Policy formulation aimed at supporting housing development	16	22.86
Creation of development funding to support affordable housing projects	21	30
Support for local construction materials development	17	24.28

The government's role of making access to land easy	16	22.86
Total	70	100
What long-term benefits do you foresee from the integration of smart city technologies into urban housing?		
Low carbon emissions	16	25.81
Increased access and leverage on housing information	14	22.58
Development of the housing supply and the development sector	18	29.03
Quality life interventions for vulnerable groups	14	22.58
Total	62	100

In Table VII, citizen engagement in city planning (23.61%) is the largest selection of recommended policy changes needed to integrate smart city solutions into housing development. The creation of development funding to support an affordable housing project (30%) is the largest selection under the suggested collaborations for the government and private to undertake in providing affordable housing. Finally, the development of the housing supply and development sector (29.03%) is considered to be the major long-term benefit to arise from the integration of smart city technologies into urban housing.

Table VIII: Weighted Mean results on the impact level of smart city strategies and the challenges associated with its implementation.

Question 1: Rate for each smart city strategy, their level of positive impact on housing affordability in Nigeria	**RATING SCALE**				**OVERALL**	
OPTIONS	4	3	2	1	WM	DE
Digital platforms for improving tenant-landlord relationships	12 (48)	6 (18)	10 (20)	0 (0)	1.72	NPI
Data-driven urban planning (i.e., the use of AI in housing need prediction)	16 (64)	5 (15)	10 (20)	0 (0)	1.98	LPI

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Smart energy systems (e.g., energy-efficient buildings)	16 (64)	5 (15)	11 (22)	0 (0)	2.02	LPI
Public-private partnerships utilizing technology for efficient land use	18 (72)	5 (15)	14 (28)	0 (0)	2.30	LPI
Affordable housing development through tech-enabled modular construction	20 (80)	9 (27)	12 (24)	0 (0)	2.62	MPI
AVERAGE					2.33	
Question 2: What do you think are the biggest barriers to implementing smart city technologies for affordable housing?						
OPTIONS						
Privacy concerns	0 (0)	(0)	0 (0)	0 (0)	0.00	Nil
Lack of public awareness	13 (52)	5 (10)	6 (18)	0 (0)	1.60	NB
Political challenges	15 (60)	8 (16)	4 (12)	0 (0)	1.76	MDB
Others	12 (48)	10 (20)	5 (15)	0 (0)	1.66	NB
Technical limitations	21 (84)	10 (20)	0 (0)	0 (0)	2.08	MDB
Lack of government support	24 (96)	11 (22)	5 (15)	0 (0)	2.66	MDB
High costs	29 (116)	10 (30)	8 (24)	0 (0)	3.4	MJB
AVERAGE					1.88	

Note: **WM**: Weighted Mean (per option)

DE: Descriptive Equivalent

Concerning Table II and Table VIII above, we see that in question 1, affordable housing development through tech-enabled modular construction is rated as a Medium Positive Impact (MPI), which is the highest among the options selected with a WM of 2.62. High costs with a WM of 3.4 are the only Major Barrier (MJB) identified in implementing smart city technologies for affordable housing (as seen in question 2).

5.0 Recommendations and Conclusion

From the tables presented, we can see that Nigeria has some ways to go with respect to addressing its housing affordability issue via smart city strategies, as the process of property development is still deeply rooted in conventional methods with high rates of carbon emissions. To attain the smart city status, Nigeria will have to work on reducing its carbon emissions, particularly from its construction sector. By ensuring that buildings have their utilities optimized, energy consumption can be reduced, which in turn reduces carbon emissions. The concept of green building is still novel to most parts of Nigeria and needs support in terms of public sensitization and from the government via policy guidelines, incentives, etc., for it to find bearing in Nigeria.

From a Nigerian context, if the objective of smart city adoption is aimed at addressing the issue of housing affordability, the following recommendations should be considered;

1. Formalization of developments in informal areas or zones, or the integration of informal settlements into an originally planned urban layout
2. Phased infrastructural developments of informal settlements upon their integration into originally planned layouts.
3. Development of affordable or low-cost housing, integrating low-grade carbon materials in its construction, i.e., green concrete, green tiles, fine glass powder, and recyclables.
4. Enforce rental vertical development purposes for newer constructions in densely populated areas.
5. Institution of an efficient system to facilitate the equitable disposal of affordable housing units upon completion.

Drawing from this, the development of affordable housing through tech-enabled modular construction can be explored, especially the integration of local materials in the development of houses. This should have a reasonable level of impact in addressing the affordability challenge of housing development faced by prospective homeowners.

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