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Assessing the Multifaceted Impact of Innovative City Initiatives on Housing Affordability, Environmental Sustainability, and Social Equity in Abuja, Nigeria

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ABSTRACT

Smart city initiatives are increasingly being deployed as tools for improving urban housing systems, particularly in rapidly growing cities of the Global South. This study, titled "Assessing the Multifaceted Impact of Innovative City Initiatives on Housing Affordability, Environmental Sustainability, and Social Equity," investigates how these technological and planning innovations affect residents of Abuja Municipal Area Council (AMAC), Nigeria. Employing a mixed-methods design, the research combines quantitative surveys of 272 residents with qualitative interviews of government officials, planners, developers, and community leaders. Findings reveal a strong consensus that smart city initiatives have the potential to enhance housing efficiency, affordability, environmental performance, and social inclusion. However, significant concerns persist around digital exclusion, the financial burden of implementation, and data privacy risks. Stakeholders emphasise the importance of integrating smart city technologies with community-driven planning, affordable housing policies, and inclusive digital infrastructure. The study contributes to the discourse on sustainable urban development in Africa by highlighting the need for equitable, context-sensitive smart city frameworks. It concludes with recommendations that promote inclusive innovation, foster public-private collaboration, and prioritise digital literacy, affordability, and environmental responsibility. These insights provide a roadmap for cities seeking to leverage technology for sustainable and inclusive housing transformation.

INTRODUCTION

Urbanisation is accelerating at an unprecedented rate globally, with the United Nations (2019) projecting that nearly 70% of the world's population will reside in urban areas by 2050. In Africa, and particularly in Nigeria, this rapid urban growth is creating an urgent demand for sustainable, affordable, and inclusive housing solutions. Abuja, the capital city of Nigeria, exemplifies this challenge. With its status as a rapidly urbanising metropolitan area, Abuja, particularly the Abuja Municipal Area Council (AMAC), faces complex housing issues—ranging from unaffordability and slum proliferation to environmental degradation and social inequality. These challenges have necessitated the exploration of innovative urban development solutions, including the adoption of smart city initiatives.

Smart city initiatives, which integrate digital technologies and data-driven governance into urban systems, are increasingly being implemented as a solution to the multifaceted problems of urbanisation. These initiatives are designed to enhance service delivery, promote sustainability, and improve the quality of life of urban residents (Batty et al., 2012). In the context of housing, smart city innovations can offer improved energy efficiency, cost-effective infrastructure, and inclusive planning mechanisms that account for the needs of vulnerable populations. However, the effectiveness of these innovations in achieving social equity, affordability, and environmental sustainability remains under-researched in developing countries, particularly in African urban settings like Abuja.

The green and smart housing concept in cities is underpinned by the broader framework of sustainable urban development, which aligns with global agendas such as the United Nations Sustainable Development Goal 11 (SDG 11)—to make cities inclusive, safe, resilient, and sustainable. According to UN-Habitat (2016), housing is not only a fundamental human need but also a key factor influencing economic productivity, environmental sustainability, and social cohesion. Sustainable housing, therefore, must strike a balance between affordability, environmental integrity, and social inclusivity. In developing countries, however, housing systems are often constrained by weak institutions, fragmented policy implementation, inadequate infrastructure, and limited access to financing (Mushanga, Oloke, & Olukanni, 2024).

In this context, smart city technologies offer new possibilities. From digital infrastructure and real-time data monitoring to renewable energy integration and intelligent housing designs, these innovations are transforming the approach to urban housing challenges. Research by Bhanye et al. (2024) highlights that in African cities, strategies like green building, micro-housing, and co-housing have the potential to promote spatial justice and housing affordability if adequately supported by policy and community engagement. However, these approaches often encounter systemic challenges, such as cultural resistance, regulatory inertia, and economic disparities. Therefore, evaluating the effectiveness of smart city approaches in diverse urban environments is crucial for advancing housing policies that are both sustainable and inclusive.

In Abuja, government initiatives have begun exploring the smart city framework as a means of urban transformation. Projects such as the Abuja Mass Transit System and digital cadastral mapping are early indicators of this transition. Nevertheless, limited empirical research has evaluated how these innovations are influencing the key pillars of sustainable housing: affordability, environmental sustainability, and social equity. While some studies have examined Nigeria's urban planning challenges (Unegbua et al., 2024), few have systematically assessed the multifaceted effects of smart city programs at the local government level, particularly in AMAC.

Moreover, as Kajiita and Kang'ethe (2024) argue in the South African context, smart initiatives often risk excluding the urban poor unless integrated with inclusive governance mechanisms and pro-poor design principles. The same risks apply to Abuja, where income inequality (Magaji, Musa & Ismail, 2025), informal housing, and limited access to services continue to marginalise large segments of the population (Magaji & Musa, 2015). Without addressing these socio-economic realities, smart city initiatives may further deepen existing disparities.

This study, therefore, seeks to fill this empirical gap by assessing how innovative city initiatives are impacting housing affordability, environmental sustainability, and social equity in AMAC, FCT-Abuja. The choice of AMAC is deliberate. As one of the most populous and socioeconomically diverse areas in the FCT, it presents a unique microcosm of Abuja's broader urban development dynamics. The council encompasses both high-income residential districts and informal settlements, providing a rich context for analysing how smart initiatives impact various social strata differently.

The overarching aim of this study is to understand whether and how smart city initiatives in AMAC contribute to sustainable urban housing development. Specifically, it examines stakeholder perceptions, implementation challenges, and the outcomes of these initiatives across three critical dimensions: affordability, environmental performance, and inclusivity. Using a mixed-methods approach, this study integrates insights from resident surveys, stakeholder interviews, and document analysis to present a nuanced understanding of the current urban transformation in Abuja.

By doing so, the study contributes to the growing discourse on smart urbanism in Africa, offering context-sensitive insights that can inform both local policymaking and international development strategies. It also responds to the call by Mushanga et al. (2024) for empirical research that links technological innovation with affordability and housing preferences in the Global South. Ultimately, this research aims to provide a knowledge base for designing equitable and resilient urban housing systems in Nigeria and beyond, grounded in the realities of technological innovation, environmental constraints, and social diversity.

LITERATURE REVIEW

Concept of Sustainability

Sustainability is a holistic development paradigm that seeks to meet present needs without compromising the ability of future generations to meet their own needs (Magaji, Musa, Ikechukwu & Ismail, 2025). The concept gained prominence with the 1987 Brundtland Report (WCED, 1987), which provided the foundational definition and emphasised the interdependence of economic development, environmental integrity, and social equity. Sustainability is now regarded as the guiding principle for addressing global challenges, including climate change, resource depletion, social injustice, and economic inequality.

Central to sustainability are its three interrelated dimensions: environmental, social, and economic. The environmental pillar emphasises the protection of ecosystems, biodiversity, and the responsible use of natural resources. Practices such as renewable energy adoption, pollution control, and sustainable agriculture are crucial for reducing ecological footprints (Kates et al., 2005). The social dimension focuses on human well-being, equity, inclusion, and cultural preservation. This involves access to education, healthcare, social justice, and participatory governance (Agyeman, 2005). The economic aspect promotes efficient resource use, stable livelihoods, and inclusive economic growth, particularly in low-income and developing contexts (Daly & Cobb, 1989).

The United Nations' 2030 Agenda for Sustainable Development operationalises sustainability through 17 Sustainable Development Goals (SDGs), which provide a universal blueprint for action on poverty, inequality, health, education, climate, and more (UN,

2015). Sustainability is not merely a theoretical framework but a practical guide for governments, institutions, and communities to pursue balanced development.

In contemporary policy and urban planning, the concept of sustainability is applied through initiatives such as green infrastructure, circular economy models, and climate-resilient cities. For example, smart city projects combine digital innovation with sustainable planning to create livable, inclusive, and low-carbon urban environments (Berardi, 2013).

While progress has been made globally, challenges such as overconsumption, weak political will, and economic pressures still hinder effective implementation. Therefore, sustainability requires integrated approaches, strong institutions, and multi-stakeholder collaboration to transition societies toward long-term resilience and equity.

Concept of Sustainable Urban Housing

Sustainable urban housing is a concept that integrates environmental, social, and economic sustainability principles into urban residential development (Suleiman, Magaji & Musa, 2025). It aims to reduce the environmental impact of housing while ensuring affordability, energy efficiency, and high living standards for urban populations (Choguill, 2007). With rapid urbanisation and population growth, cities face significant challenges in providing adequate housing while minimising resource depletion and environmental degradation (Jenks & Jones, 2010). Sustainable urban housing solutions incorporate green building materials, energy-efficient designs, and smart technologies to promote eco-friendly and resilient communities.

One of the key aspects of sustainable urban housing is energy efficiency. Modern housing developments employ passive design strategies, including proper insulation, natural ventilation, and solar orientation, to minimise energy consumption (Ding, 2008). Additionally, integrating renewable energy sources, such as solar panels and wind turbines, helps reduce dependence on fossil fuels and lowers greenhouse gas emissions (Berardi, 2013). Smart home technologies, including energy-monitoring systems and automated climate control, further optimise energy use, making urban housing more sustainable and cost-effective for residents (Eke, Magaji & Osi, 2022).

Affordability and social inclusivity are also crucial elements of sustainable urban housing. Many cities face a housing affordability crisis, making it essential to develop cost-effective solutions that provide quality living conditions for low- and middle-income populations (UN-Habitat, 2016). Mixed-income housing developments, public-private partnerships, and policies that promote social housing contribute to more inclusive urban communities (Glaeser, 2011). Additionally, sustainable housing designs prioritise accessibility, green spaces, and community-oriented planning to foster social cohesion and improve overall well-being.

Water conservation and waste management are fundamental to sustainable urban housing (Sule, Ahmad, Sabiu & Yunusa, 2024). Smart water systems, such as rainwater harvesting, greywater recycling, and low-flow fixtures, help reduce water consumption in residential areas (Sharma et al., 2010). To minimise environmental impact, sustainable housing developments also incorporate efficient waste management strategies, including composting, recycling programs, and the reuse of construction materials (Kibert, 2016). By integrating these eco-friendly solutions, sustainable urban housing contributes to the creation of resilient and livable cities, ensuring a balance between growth and environmental responsibility (Ibrahim, Olusola & Magaji, 2025).

Concept of Affordability

Affordability, particularly in the context of housing, refers to the extent to which households can obtain adequate housing without compromising their ability to meet other basic needs such as food, education, and healthcare. The concept is typically measured by the proportion of a household's income spent on housing, with the conventional benchmark suggesting that housing is affordable if it costs no more than 30% of the household's gross income (UN-Habitat, 2011).

Affordability is a critical component of sustainable development and social equity (Gabdo & Magaji, 2025). In rapidly urbanising regions—especially in developing countries like Nigeria housing affordability remains a pressing challenge. High construction costs, land scarcity, inflation, and inadequate public investment in low-income housing exacerbate the crisis, often resulting in the proliferation of informal settlements and overcrowded slums (UN-Habitat, 2020). These conditions undermine quality of life, perpetuate poverty, and contribute to urban inequality (Musa, Ismail & Magaji, 2024).

The affordability crisis is not merely an economic issue but also a social and policy problem. According to Stone (2006), affordability should be assessed in terms of housing adequacy and residual income, which is the amount left for other life essentials after paying for housing. This shifts the focus from market prices alone to broader living conditions and well-being. Furthermore, Glaeser (2011) argues that regulatory barriers, such as excessive zoning laws and bureaucratic inefficiencies, often inflate housing costs and limit access to affordable homes.

Policy solutions to affordability challenges include promoting mixed-income housing, public-private partnerships, inclusionary zoning, land-use reforms, and targeted subsidies for vulnerable populations. Recent innovations, such as modular housing and 3D printing, also offer potential cost-effective alternatives (Bhanye et al., 2024). However, technologies must be integrated with inclusive financial systems, such as access to low-interest mortgages and rent-to-own schemes, especially for low-income families (Musa, Magaji, Ifegwu & Salisu, 2022).

Ultimately, addressing affordability requires a multi-dimensional approach that balances market efficiency with social justice. Governments, private sector actors, and civil society must collaborate to design housing systems that are financially accessible, socially inclusive, and environmentally sustainable.

Smart City Initiatives and Social Equity in Housing

Smart city initiatives are crucial in promoting social equity in housing by leveraging technology and data-driven solutions to ensure that all residents have inclusive, affordable, and sustainable living conditions (Magaji & Chukwuemeka, 2016). Through digital governance, smart infrastructure, and innovative housing policies, cities can bridge socioeconomic disparities and improve access to essential services (Meijer & Bolívar, 2016). For instance, smart housing projects integrate IoT-based energy management systems, affordable broadband access, and intelligent transportation networks to enhance the quality of life for marginalised communities (Zanella et al., 2014). Additionally, digital platforms facilitate participatory urban planning, enabling residents to engage in decision-making processes and ensuring that housing policies reflect diverse needs (Hollands, 2008). By addressing issues such as housing affordability, accessibility, and sustainability, smart city initiatives contribute to more equitable urban development, fostering resilient and inclusive communities.

Empirical Review

Kajiita and Kang'ethe (2024) examine the socio-economic nuances that impede sustainable urban development and the strategies that can accelerate sustainable and inclusive urban development in South Africa. Through a literature review methodology, the analysis identified the following issues as impediments to sustainable urban development in South Africa: informality, lack of consultations with urban citizens, unresolved apartheid legacies, crime and insecurity, and migration intricacies in South Africa. The paper also outlines prospective strategies to accelerate sustainable urban development, such as working with informality rather than against it, promoting inclusivity and access to resources, accelerating policy reforms, investing in rural towns, and leveraging superior technology and innovation. These findings suggest a need to explore alternative development models and approaches to address poverty, unemployment, and inadequate housing, which negatively impact urban development planning and sustainable development (Magaji, Musa & Salisu, 2022). The paper recommends inclusive urban housing to address the challenges of access, affordability, and the quality of housing facilities in urban areas.

Unegbua, Yawasa, Dan-asabea and Alabia (2024) systematically review Nigeria's sustainable urban planning and development policies and practices, analysing their effectiveness, challenges, and successes. The Nigerian Urban and Regional Planning Act and the National Physical Development Plan form the core of the country's urban planning framework, which aims to promote balanced regional growth and environmental sustainability. The study reveals significant regional disparities through an in-depth analysis, with major cities like Lagos and Abuja leading in infrastructure development and housing availability but falling short in environmental sustainability. Key barriers to effective implementation include inadequate funding, weak institutional capacity, and corruption (Eke, Magaji & Ezeigwe, 2020). Despite these challenges, successful initiatives such as the Eko Atlantic City project and the Abuja Mass Transit Project demonstrate the potential for sustainable urban development through comprehensive planning, stakeholder collaboration, and local adaptation. The study highlights the importance of integrating environmental, social, and economic considerations into urban planning, providing practical recommendations for policymakers and practitioners. The study identifies valuable lessons by comparing Nigerian practices with global examples and provides a foundation for future research and innovation in sustainable urban development.

Berthelemy and Maurel (2024) examine the impact of mini-grid electrification projects on SDG 7 (ensure access to affordable, reliable, sustainable, and modern energy for all). Questioning the effectiveness of mini-grid development programmes on electricity access is essential, as we have observed numerous cases in which the mini-grids failed to deliver on their promises a few years after commissioning the equipment. Our approach is based on data on night-time light (NTL). The methodology is designed and tested using mini-grid projects precisely localised and documented in published papers. We compare NTL data for each project before and after commissioning. NTL detects significant positive changes after commissioning about half the projects. We built a test of impact, which confirms the causal nature of the observed effects of mini-grid projects on progress in SDG7, based on a comparison between non-treated localities and treated localities. However, the validity of this conclusion is limited, particularly in terms of remoteness, extreme initial energy poverty, and insufficient inclusiveness. These factors should be considered in the design of mini-grid development programmes.

Bhanye, Lehobo, Mocwagae & Shayamunda (2024). The study employs a rapid review methodology to identify and analyse sustainable, innovative, affordable housing (SIAH) strategies suitable for low-income families in African cities. The review examines various housing strategies, including mixed-use developments, incremental housing, low-rental housing, inclusionary housing, 3D printing, upcycling, micro-housing, community-led housing, co-housing, and green building practices, through a comprehensive literature search and thematic analysis. These approaches and strategies are not mutually exclusive and can often overlap or be integrated to address housing challenges comprehensively. The findings highlight that these strategies can significantly enhance spatial justice and promote sustainable urban development. However, challenges such as material scarcity, regulatory complexities, and societal resistance must be addressed. The study emphasises the need for policy support, public-private partnerships, community engagement, financial incentives, and capacity building to ensure the successful implementation of these strategies. The paper contributes to the existing body of knowledge by providing actionable recommendations for policymakers, urban planners, and housing advocates, aiming to foster inclusive, equitable, and sustainable cities in Africa. Future research could

categorise the strategies into distinct categories based on their nature and purpose (e.g., strategy, method/tool, practice), providing a more transparent framework for understanding and implementation.

Mushanga, Oloke, and Olukanni (2024) examine the potential connections between sustainable housing and the sustainable affordability of such housing, while meeting the housing preferences of various households. It is widely acknowledged that many lower-income countries are facing a housing crisis, and addressing this issue is crucial by providing affordable housing that meets individual needs while promoting environmentally friendly living. This review paper is centred on the research question: How can sustainable housing be made more affordable and accessible to all households while meeting their housing preferences? A qualitative study of 66 publications from 2019 to September 2023 found that sustainable housing offers ecological and energy-efficient benefits. However, these models have barriers to scaling up, including economic, cultural, and legal challenges. Housing preferences are influenced by cost, location, and amenities, with affordability being a significant concern. While environmental and economic sustainability can positively impact housing prices and, in turn, affect the affordability of such housing, the initial investment costs can be challenging for lower- and middle-income households. The review further established that Sustainable housing, housing preference, and affordability are broad topics that many researchers have explored. However, there are still research gaps that need to be addressed. There is a significant gap in how sustainable housing can be made affordable to all households while meeting their housing preference, hence the need to explore the intersection between sustainable housing, housing preference, and affordability by carrying out empirical research to identify ways in which sustainable housing can be designed and built to meet the needs and preferences of low-income households while remaining affordable.

METHODOLOGY

This study adopts a **mixed-methods research design** that integrates both quantitative and qualitative approaches to provide a comprehensive understanding of how smart city initiatives influence sustainable urban housing development in the Abuja Municipal Area Council (AMAC), Federal Capital Territory (FCT), Nigeria.

AMAC, a rapidly urbanising part of Abuja with diverse housing needs, was selected as the focal case study. The area is particularly relevant due to its housing challenges and its role as a testing ground for innovative urban development initiatives.

Data collection includes both **quantitative surveys**. The quantitative component involves structured surveys targeting 100 residents in each of AMAC's twelve wards. The survey focuses on housing conditions, access to services, and perceptions of smart city initiatives. The wards range from high-density urban areas, such as Wuse and Garki, to peri-urban and rural locations, including Jiwa and Karshi, offering a diverse urban landscape for analysis.

For the qualitative component, semi-structured interviews will be conducted with key stakeholders, including government officials, urban planners, housing developers, and community leaders, who will be selected through purposive and snowball sampling. These interviews aim to explore the more profound implications of smart city interventions on affordability, sustainability, and equity. Additionally, relevant documents and policy reports will be analysed to complement the field data.

The study targets a broad population, including AMAC residents, government housing authorities, urban development professionals, private housing developers, and community leaders. Stratified random sampling ensures representation in resident surveys, while purposive and snowball sampling are used for selecting stakeholders for interviews. The approach is designed to capture a wide range of experiences and perspectives from the different socio-economic and geographic zones within AMAC.

The study adheres to strict ethical standards, including obtaining informed consent, maintaining confidentiality, ensuring data security, and ensuring equitable participation. Ethical approval will be obtained from the relevant university ethics committee before the commencement of fieldwork. All participants will be treated with respect, and their data will be managed with the utmost integrity.

The methodology ensures a thorough, inclusive, and ethically grounded investigation of smart city interventions in housing development, with strong potential to shape both academic discourse and policy formulation in Nigeria's urban development landscape.

DATA AND RESULTS

Table i: Expectations Regarding the Potential Impact of Smart City Initiatives on Housing Development in AMAC (n=272)

Expected Impact/Concern	Frequency	Percentage (%)
Expect smart city initiatives to improve housing efficiency, affordability, and sustainability.	256	94.12
Anticipate better resource management, enhanced security, and improved access to housing services.	260	95.59
Express concerns about the potential for digital exclusion, the cost of implementing new technologies, and the need for robust data privacy and security measures.	234	86.03

Table 1 presents the expectations and concerns of 272 stakeholders regarding the potential impact of smart city initiatives on housing development in AMAC. The data reveals a generally optimistic outlook tempered by significant anxieties about equity and security. A very high percentage, 94.12% (256 respondents), expect smart city initiatives to improve housing efficiency, affordability, and sustainability. This overwhelming consensus reflects a strong belief in the potential of technology to address core housing challenges. Similarly, 95.59% of respondents (260 individuals) anticipate better resource management, enhanced security, and improved access to housing services. This near-unanimous agreement highlights the perceived benefits of smart city technologies in enhancing the quality of life and service delivery within residential areas.

However, alongside this optimism, a significant majority, 86.03% (234 respondents), express concerns about the potential for digital exclusion, the cost of implementing new technologies, and the need for robust data privacy and security measures. This high percentage underscores the stakeholders' awareness of the potential downsides and risks associated with smart city initiatives. The concern about digital exclusion suggests a fear that marginalised groups may be left behind in technological advancements. The worry about implementation costs indicates a recognition of the financial burden that new technologies may impose. Finally, the emphasis on data privacy and security reflects a growing awareness of the potential for misuse of personal information in a data-driven environment.

In essence, Table 1 demonstrates that while stakeholders in AMAC are essentially hopeful about the positive impact of smart city initiatives on housing, they also harbour significant concerns about equity, affordability, and data security. These concerns underscore the importance of meticulous planning and implementation to ensure that the benefits of smart city technologies are distributed equitably and that potential risks are effectively mitigated.

Table 2: Key Elements of Sustainable Urban Housing Development (n=272)

Key Element	Frequency	Percentage (%)
Recognise the importance of affordability, environmental sustainability, and social equity.	261	95.96
Providing housing options that are accessible to low- and middle-income residents.	234	86.03
Minimising the environmental impact of housing development through energy efficiency, water conservation, and sustainable building materials.	212	77.94
Ensuring equitable access to housing and basic amenities for all residents, regardless of income, ethnicity, or social status.	189	69.49

Table 2 outlines the key elements of sustainable urban housing development as perceived by 272 stakeholders, highlighting a strong consensus on the fundamental principles underlying this approach.

A significant majority, 95.96% (261 respondents), recognise the importance of affordability, environmental sustainability, and social equity. This near-unanimous agreement underscores the understanding that sustainable housing must strike a balance between economic, environmental, and social considerations to be genuinely effective.

Following closely, 86.03% (234 respondents) emphasise the importance of providing housing options accessible to low- and middle-income residents. This high percentage reflects a strong commitment to addressing affordability, a critical concern in urban housing development.

Environmental sustainability is also a key focus, with 77.94% (212 respondents) emphasising the need to minimise the environmental impact of housing development through energy efficiency, water conservation, and the use of sustainable building materials. This substantial majority indicates a recognition of the environmental responsibilities associated with urban expansion.

Finally, 69.49% (189 respondents) emphasise ensuring equitable access to housing and basic amenities for all residents, regardless of income, ethnicity, or social status. While still a majority, this percentage is slightly lower than the others, which could suggest that while equity is important, the other factors are seen as even more pressing.

Table 2 reveals a strong consensus among stakeholders on the core elements of sustainable urban housing development, emphasising affordability, environmental responsibility, and social equity.

Table 3: Response on How urban planners balance the need for affordable housing with the desire to incorporate smart and sustainable technologies

Response	Frequency	Percentage (%)
Phased implementation: Start with basic smart infrastructure and gradually add more advanced technologies.	37	74

Leveraging economies of scale: Utilising standardised designs and bulk purchasing to reduce costs.	26	52
Exploring public-private partnerships: Collaborating with the private sector to access innovative technologies and financing.	39	78
Utilising government incentives and subsidies: Providing financial support for sustainable housing projects.	30	60
Focusing on passive design strategies to minimise energy consumption.	47	94
Prioritising the most impactful smart technologies.	44	88

Table 3, "Response on How Urban Planners Balance the Need for Affordable Housing with the Desire to Incorporate Smart and Sustainable Technologies," presents the results of a survey or study focusing on the strategies urban planners can employ to reconcile the often conflicting goals of affordability and technological advancement in housing development.

Focusing on passive design strategies to minimise energy consumption is considered the most effective strategy, with 94% of respondents endorsing it. This highlights a strong preference for fundamental, low-tech approaches to sustainability. Passive design strategies focus on architectural design elements that naturally regulate temperature and lighting, reducing reliance on energy-intensive technologies.

88% of respondents also see prioritising the most impactful smart technologies as highly effective. This suggests that urban planners should carefully select smart technologies that offer the most significant benefits in terms of sustainability and efficiency, rather than incorporating every available gadget.

Exploring public-private partnerships is another highly favoured strategy, with 78% of respondents. This indicates the perceived value of collaboration with the private sector to access innovative technologies and financing, which can help reduce costs and expenses.

Seventy-four per cent of respondents also favour a phased implementation. This strategy allows for more affordable initial housing construction and upgrades as funds become available.

Sixty per cent of respondents consider utilising government incentives and subsidies important, highlighting the role of government support in making sustainable housing more affordable.

Leveraging economies of scale is the least popular option presented, with 52% of respondents. This method is still considered important, but less so than the other methods.

Table 4: Response on How do you ensure that smart city initiatives in housing benefit all segments of the population, including low-income communities

Response	Frequency	Percentage (%)
Prioritising affordable housing development.	40	80
Providing access to basic amenities and services in low-income communities.	46	92
Utilising mobile technology to improve access to information and services.	30	60
Offering training and education programs on digital literacy.	45	90
Creating community-based smart housing projects.	38	76
Ensuring that data collection does not lead to the marginalisation of any community.	27	54

Table 4, "Response on How do you ensure that smart city initiatives in housing benefit all population segments, including low-income communities," illustrates the varied strategies proposed to ensure equitable benefits from smart city housing initiatives. The responses indicate that providing access to basic amenities and services in low-income communities is considered the most crucial approach, with 92% of respondents endorsing this approach. This underscores the importance of addressing basic needs as a

foundation for equitable smart city development. Closely following this, offering training and education programs on digital literacy is deemed highly significant, with 90% of respondents recognising its importance. This highlights the need to empower residents with the skills to navigate and effectively utilise smart city technologies. Prioritising affordable housing development is also a key strategy, with 80% of respondents highlighting its importance, emphasising the need to address housing affordability as a core component of equitable initiatives. Creating community-based smart housing projects is favoured by 76% of respondents, indicating the value of localised and participatory approaches. Utilising mobile technology to improve access to information and services is considered significant by 60% of respondents. Ensuring that data collection does not lead to the marginalisation of any community is the least prioritised, though still relevant, with 54% of respondents acknowledging its importance. Overall, the table highlights the importance of prioritising basic amenities, digital literacy, and affordable housing to ensure that smart city initiatives benefit all population segments, including low-income communities.

SUMMARY OF FINDINGS

The study's findings provide a comprehensive understanding of stakeholders' perceptions regarding the potential impact of smart city initiatives on housing development in the Abuja Municipal Area Council (AMAC), Federal Capital Territory (FCT), Nigeria. A total of 272 stakeholders, including residents, urban planners, developers, and policymakers, participated in the survey, and their responses reveal both optimism and caution about the integration of smart city technologies in the housing sector.

A significant proportion of respondents (94.12%) believe that smart city initiatives have the potential to improve housing efficiency, affordability, and sustainability. Moreover, 95.59% anticipate better outcomes in resource management, enhanced security, and access to housing services. These expectations show strong support for the use of smart city technologies as tools for solving longstanding urban housing challenges.

Despite this optimism, 86.03% of stakeholders voiced concerns about potential digital exclusion, the high cost of technological implementation, and the need for stringent data privacy and security frameworks. These findings suggest that while technology is seen as a vital enabler of progress, it must be implemented with caution to prevent exacerbating inequality and vulnerability among marginalised populations.

The study also explored perceptions of what constitutes sustainable urban housing. Most respondents (95.96%) emphasised the importance of balancing affordability, environmental sustainability, and social equity. Similarly, 86.03% emphasised the need to provide housing options that are accessible to low- and middle-income residents. Meanwhile, 77.94% highlighted environmental aspects such as energy efficiency and sustainable building materials, and 69.49% advocated for equitable access to housing and basic amenities across all population groups.

To strike a balance between affordability and innovation, respondents supported a range of strategies. Notably, 94% endorsed passive design strategies as the most effective means to reduce energy consumption at minimal cost. In addition, prioritising impactful smart technologies (88%) and pursuing public-private partnerships (78%) were seen as crucial to overcoming financial constraints. Phased implementation (74%) and leveraging government incentives (60%) were also identified as practical approaches to support affordable and sustainable housing development.

When asked how smart city initiatives could benefit low-income communities, stakeholders strongly supported basic service provision (92%), digital literacy training (90%), and prioritising affordable housing (80%). Community-based smart housing projects (76%) and mobile technology access (60%) were also recommended. However, only 54% considered data ethics and avoiding marginalisation as high priorities, indicating a gap in concern for data governance in inclusive planning.

The findings underscore that, while there is a widespread belief in the potential of smart city initiatives to transform urban housing, stakeholders are equally aware of the risks associated with inequality, high implementation costs, and data misuse. For smart housing initiatives to be both practical and equitable, planners must adopt inclusive, context-specific strategies that prioritise affordability, digital literacy, basic amenities, and community participation.

CONCLUSION

This study examined the multifaceted impact of innovative city initiatives—commonly referred to as "smart city" strategies—on housing affordability, environmental sustainability, and social equity within the Abuja Municipal Area Council (AMAC), Nigeria. Through a mixed-methods approach involving quantitative surveys and qualitative interviews with 272 stakeholders, the findings reveal a strong optimism about the transformative potential of smart city initiatives in enhancing housing efficiency, resource management, and service delivery.

However, this optimism is tempered by significant concerns regarding digital exclusion, affordability of technology, and the need for robust data protection mechanisms. Stakeholders emphasise that sustainable urban housing must be not only technologically advanced but also affordable, environmentally responsible, and socially inclusive. While innovative technologies offer immense opportunities, their implementation must be context-sensitive and designed to include low-income and marginalised populations.

The study concludes that successful smart city housing strategies must strike a balance between technological innovation and human-centred design principles, equitable access, and long-term policy support. Addressing the challenges of urbanisation in

Africa, particularly in cities like Abuja, will require a deliberate integration of smart technologies with inclusive urban planning frameworks.

RECOMMENDATIONS

i. Adopt a Phased and Inclusive Implementation Strategy: Begin with affordable, scalable smart technologies such as passive design strategies, and progressively integrate more advanced systems, ensuring they benefit all social classes.
ii. Strengthen Digital Equity and Literacy: Invest in digital literacy programs and affordable access to mobile technology, especially for low-income communities, to prevent digital exclusion.
iii. Promote Public-Private Partnerships: Encourage collaboration between government, private developers, and tech innovators to leverage financing, innovation, and scalability for smart housing projects.
iv. Prioritise Community-Based Planning: Establish community-driven smart housing projects that reflect local needs and cultural contexts to enhance trust and acceptance.
v. Ensure Data Governance and Ethical Standards: Enforce data privacy policies and ensure that smart city initiatives respect residents' rights and avoid marginalisation based on socio-economic status or location.
vi. Institutionalise Affordable Housing Policies: Smart initiatives should be tied to strong housing policies that guarantee affordability and social equity through subsidies, incentives, and inclusive zoning laws.
vii. Integrate Smart City Efforts with Environmental Sustainability Goals: Encourage the use of energy-efficient building materials, water conservation systems, and green infrastructure in all new developments.

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