CONSTRUCTION AND HUMAN SETTLEMENTS MANAGEMENT JOURNAL

Special Issue

SUSTAINABLE COMMUNITIES IN DEVELOPING COUNTRIES: MOVING AWAY OR MERGING THE FORMAL, WITH THE 'UN-FORMAL' AND/OR INFORMAL

Edited by B.W Wahab, S.B. Agbola, A.A Popoola, and L. Chipungu

April 2024

Volume 3 Special Issue 1 **ISSN 2790-816X**

CHSMJournal

Preamble

One of the most reputed mediums of exchanging the outcomes of research activities is the academic journal, and it is germane, as scholarship is about the creation and sharing of knowledge. This journal is domicile and published in the Department of Construction Management, School of Built Environment and Civil Engineering, Faculty of Engineering, the Built Environment and Technology (EBET), Nelson Mandela University, South Africa.

The reasons for the creation of the Construction and Human Settlements Management Journal (CHSMJ) include:

i. Providing a unique record of scholarly activity in Construction and Human Settlements Management while presenting an African perspective to the academic community.
ii. Scholarly recognition it brings to the Nelson Mandela University.
iii. Creation and sharing of new ideas and knowledge which contributes to the economic and cultural development of the built environment in South Africa, Africa and beyond.
iv. It also supports the goals of Nelson Mandela University by giving national and international recognition, further demonstrating the ability of the university to compete with other research agencies in the production of knowledge while also forming a basis of new collaborations between local, regional, and international researchers, research departments, and institutions.
v. The publication helps close the "knowledge gap" between the developed nations and the often-overlooked ideas, innovations, and discoveries from the African continent.
vi. The enrichment of the research areas of construction and human settlements management, and
vii. The Journal does, through sharing local knowledge and perspectives, make local research more visible throughout Africa and to researchers, students, and scholars globally.

Topics

The Construction and Human Settlements Management Journal, although not limited to, covers the following topics:
Construction project management; Project management; Design and construction management processes; Housing and infrastructure development; Stakeholder management; Project planning and impact assessments; Design and implementation of labour-intensive projects; Procurement management; Management of construction companies; Industry development; Knowledge management in construction; Empowerment of women; Innovation; Human settlement development and management; Real estate development and management; Industry 4.0; Housing; Spatial planning; Project financing; Performance management in construction and projects; Human factors in construction and projects; Health, safety and well-being in construction and projects; Scholarship of Construction and Human Settlements; Current and emerging infrastructure issues in developing countries.

Access

Cover design and picture: Popoola AA

Scientific/Editorial Board

Volume 3 Special Issue 1

ISSN 2790-816X

Contents

Editorial

Dear Colleagues in the academic and research community. We are delighted to introduce to you Volume 3 of the Construction and Human Settlements Management Journal. Volume 3 is a Special Issue which was hosted by Guest Editors BW Wahab, A.A Popoola, S.B. Agbola, and L. Chipungu. The special issue covers a wide-ranging set of construction and human settlements topics on matters that impact everyday life. In the Issue Adeyemi and Adesina explore the use of modular fabricated units and Adeyemi et al. assess the environmental quality of public residential estates. Jimoh and Popoola looked at conveniences in incremental housing while Oyesomo et al. ascertained how virtual reality could improve real estate marketing. Ibrahim et al. appraised the nature and characteristics of road traffic calming devices and Akande et al. looked at the spatial planning of educational facilities. The last paper in the issue by Ojekere et al. tackled the transport issues impacting children with disabilities.

We trust that you will find Volume 3 a very interesting and engaging issue of the journal.

The papers are available for download or onsite access at https://sbe.mandela.ac.za/Construction-and-Human-Settlements-Management-Jour

With warmest regards,

Winston Shakantu and Ayo Adeniran

Managing Editors

Sustainability for Formal and 'Un-formal' Spaces and Residents: The Editorial

Bolanle Wahab[1]., Ayobami Popoola*[2]., Samuel Agbola[1], and Lovemore Chipungu[2].

[1]Department of Urban and Regional Planning, University of Ibadan, Nigeria.
[2]SARChI Chair for Inclusive Cities, University of KwaZulu-Natal, South Africa
*Corresponding author: bcoolay2@yahoo.com

1.0 Introduction

Settlement formation and arrangement across the globe are characterised by formality and informality. The evolution can be from formal to informal and vice versa. For instance, some authors wrote that the environmental degradation resulting from industrialization led to the emergence of slums (Maiti and Agrawal, 2005; Awadall, 2013; Ezeh et al., 2017; Surya et al.,2020). The emergence of slums, squatter settlements, and informality provoked most of the formal writings and thinking of planning utopians. Exemplifying the making of settlements in developing nations, it was identified that settlement formation can be traditional (unformal/informal/pre-colonial) or formal (colonial and post-colonial). Scholars have extensively documented the role of traditional and indigenous institutions in the formation, shaping, arrangement and rearrangement of settlements and land uses (Dzingirai, 1994; Wahab 1996, 1997; Goebel, 1998; Robins, 2001; Pratiwi et al., 2010; Popoola et al., 2022; Popoola, 2022).

Iterating the need to blend formal (space, and principles) with informal, Pratiwi et al. (2010) in their study wrote that the local concerns expressed by indigenous/traditional leaders demanded place-making or planning practice modification through some hybrid form of governance that would accommodate traditional institutions and their behavioural features. It was argued in these writings that collective planning through local people involvement and consensus building were key to promoting liveability, and sustainability such that the local culture which is "the perceived non-formal or informality' was the driver to the formation of communities. The surprise and somewhat convoluted arguments' as presented by Wahab (2023), Wahab (2017) and Wahab and Agbola (2017) are that the communities that have not followed the common formal western planning ideologies and/or training have been derogatorily referred to as informal and or illegal.

The perceived informality or illegality is derived from the shift or neglect of formal planning principles. Thus, undermining the local placemaking identities that have promoted spatial sustainability over the years. This neglect is evident in the continued 'formal' ideologies of urban renewal, city regeneration, and the emergence of urban estates in rural areas. Yet, it continues to be characterised by failing 'formal planning'. This is evidently so, as formally planned settlements continue to be characterised by environmental disaster. Thus, a colossal mismatch and/or confusion to the making of settlements in developing nations.

The argument towards 're-evaluating' how settlement should emerge is drawn for the continued failure or limitation of western planning ideologies to respond to the local needs of the people. In their

writings, scholars have forwarded arguments along the applicability and limitation of western planning ideologies, processes, and approaches towards sustainable settlements (Graham and Healey, 1999; Hann, 2002; Sandercock, 2004; Rodríguez-Pose, 2008; Kleemann et al., 2017). In Africa, scholars have reported on the limitations of western planning on local settings (Muzorewa et al., 2018; Khumalo, 2020; Ogunsanya, 2022; Whelan, 2022; Anand and Dutta, 2022). Many, if not all, alluded to the need for decolonisation of planning practice, learning and practice towards local place identity formation and sustainability. Drawing from the example in Bangladesh, Sikder et al. (2015) mentioned that formal planning practice does not allow informal settlers to be self-confident and free from the vicious cycle of poverty. This study concluded thus because the formal planning system discriminated against informal settlements despite their formal recognition as part of the urban enclave.

These arguments and thinking are further supported by the continued forward preposition towards the decolonisation of planning education and training across the globe. Reasons identified include the need to embrace local culture, localisation of planning solutions, the need for impactful training and practice, identity formation and socio-political movement (Wotherspoon and Schissel, 1998; Le Grange, 2016; Fomunyam and Teferra, 2017; Khoza and Biyela, 2020) towards achieving sustainable communities.

2.0 The contributions to the special issue

The first paper by Adeyemi and Adesina on thinking away from conventional housing and settlement process was Exploring the Use of Modular-Prefabricated Units (MPUs): A Resettlement Solution in Ijora-Badia, Ijora-Olopa and Abule-Nla Lagos-Nigeria. The article was an explorative study towards the housing resettlement in Lagos megacity by the State government. The earlier writing of Popoola et al. (2020) and Olatunde et al. (2021) supports the housing demand crisis which is reflected in urban eviction in the Ijora-Badia area. This crisis emerges from difficulty in meeting the housing demand. To solve this problem, the article of Adeyemi and Adesina in this special issue points towards a housing prototype that is cost-effective and provides a ready material to manage the housing development raw material deficit. The interest of the author was to provide affordable housing for residents within the informal corridors that are characterized by precarious housing conditions within the urbanizing megacity. The author concluded that to meet the global best practice of mass housing provision, there has to be the development of fast, cost-friendly, and energy-efficient MPUs. The editors of the special issue also recognize that the housing production process remains one of the viable alternatives towards housing the poor and urban residency inclusion.

Towards ensuring a balanced narrative of the housing dilemma in Africa mega-cities, the article of Adeyemi et al. titled an Assessment of Environmental Quality of Public Residential Estates in Lekki Peninsula, Lagos which captures the housing and residential quality within estates in the city provides an entry point towards formal housing arrangement. The author reported on the issue of environmental quality of the housing conditions reflected in damaged roofs, structural defects and

poor housing quality that characterises the city. Through the thematic analysis, it was revealed that poor environmental management is becoming a built environment feature of the sampled houses. The author attributed the environmental collapse to, the low frequency of source of solid waste collection, moderate agreement to the presence of structural defects and the incidences of building collapse are the most significant factors. It was argued that maintenance of facilities remains a sustainable part of ensuring residential sustainability. This finding is related to the Jimoh and Popoola's study that examined the impact of conditions of private conveniences on residents of incremental housing.

Incremental housing according to Alabi et al. (2021) has become a fast and easy route to home ownership in peri-urban communities. The informality in the development process and lived experience of residents of incremental houses is what makes the article of Jimoh and Popoola titled the impact of condition of private convenience on residents of incremental housing in, Ibadan an interesting read. In a sample of 184 incrementally developed houses and households, the authors alluded that private convenience can be classed as poor. The argument was that this does not just reflect the housing and livelihood struggle of homeowners but is a reflection of a weak planning process and framework (see Popoola et al., 2015). It was alluded by the authors, that while many of the residents make use of unconventional house financing sources such as loans and thrifts, the materials used in the construction are often sub-standard. Most importantly, residents engage in open defecation as an adaptive strategy away from prioritising private convenience in the construction process. The authors suggested the prioritisation of construction of private conveniences during the incremental building process, disengagement in open defecation, improvement of environmental sanitation and regular cleanliness of their private conveniences.

Across many developing nations, autonomy in both planning and other built-environment disciplines remains questionable (Patrick et al., 2022). This is because sharing collaborative and creative experiences through international and local best practices, and their policy implications on place-making is key to local sustainability. The writing of Popoola et al. (2022) has alluded to the need to embrace technology in teaching and learning following the recent COVID-19 pandemic. In recognizing the need to adopt technology, perhaps a look at the processes and approaches through a multi-disciplinary lens that somewhat approves of and integrates the 'perceived informal or un-formal' with the formal may be critical to achieving local place(s) sustainability. This is what makes the writing of Oyesomo at al. unique. The article titled Virtual Reality: Modernizing Real Estate Marketing Business With 360 Virtual Circuits provides an entry point towards responsive planning and globalization post-covid. The interest of the authors was to explore limitations to the adoption of technology amongst real estate professionals. It was also gathered that the key barriers to the application of virtual reality were lack of awareness, application cost-in-use and the fear of unacceptability among prospective clients. This study concludes that there is a need for estate surveyors valuers and other real estate professionals to revolutionize the real

estate marketing industry by adopting the application of virtual reality.

An example of such technology within the built environment is the speed breaker. Ibrahim et al. appraised the nature and characteristics of road traffic speed breakers in the city of Osogbo. The interest of the authors was to examine the condition of speed breakers in the selected major, distributor and service roads, the volume of traffic as well as the road user's perception on the effects of speed breakers. The article moved away from existing literature on road traffic speed breakers predominantly covering general aspects of traffic calming measures and their impact on road safety. The nature factor captures the issue of the design of speed breakers in the city. The study reveals that long and wide speed humps were effective in reducing car speeding. The article contributes significantly to the existing knowledge by highlighting several crucial aspects such as road typologies and speed breakers, city facility maintenance and its associated health implications for diverse city residents.

Recognising the needs of diverse residents, the last two articles by Akande et al., (Spatial Analysis of Journey-to-School by Secondary School Students in Minna, Nigeria) and Ojekere et al. (Inclusive Mobility among School Children with Disabilities in Benin City, Nigeria) documented the need for ease of mobility and access for children in the city. In Stanley et al. the focus was on the mobility experience of school children living with disabilities. The authors captured the challenges of mobility experienced by school children living with disabilities. To address the mobility barriers of this minority group, the study recommends a paradigm shift towards an inclusive-based approach to public transport planning. Akande et al. suggested that proper education infrastructure planning within the neighbourhood should be prioritized.

3.0 Conclusion

Along with the need to achieve local space sustainability, this special issue was geared toward embracing local processes, ideals, and approaches towards true spatial emancipation of and in developing nations. The special issue captures local lived experiences towards local interest by embracing the few local informality or un-formal traits. The special issue achieved the aim of casting a critical eye on the interdisciplinary prisms, and to evolve and/or exemplify the necessity for the co-habitation of the formal, informal, or un-formal processes in some settings.

The papers in this special issue touched on the keen interest of Professor Bolanle Wahab over the past four decades. Professor Bolanle Wahab's research and teaching experience centres on environmental and rural planning and indigenous knowledge systems. The articles further contribute to the gap in knowledge on the planning process through unconventional approaches.

References

Alabi. M., Babalola, T. and Popoola, A. (2021). Tenure insecurity and incremental housing development in the peri-urban interface of Ibadan, Nigeria. *CIDADES, Comunidades e Territórios*. 43(Dec/2021), 185-206. DOI: 10.15847/cct.21000

Anand, G., and Dutta, N. (2022). In a state of flux: urban planning programmes in Asia and Africa. In *Planning Cities in Africa: Current Issues and Future Prospects of Urban*

Governance and Planning (pp. 71-102). Cham: Springer International Publishing.

Awadall, H. I. (2013). Health effect of slums: A consequence of urbanization. *Scholarly Journal of Medicine*, *3*(1), 7-14.

Dzingirai, V. (1994). Politics and ideology in human settlement: Getting settled in the Sikomena area of Chief Dobola. *Zambezia*, *21*(2), 167-176.

Ezeh, A., Oyebode, O., Satterthwaite, D., Chen, Y. F., Ndugwa, R., Sartori, J., and Lilford, R. J. (2017). The history, geography, and sociology of slums and the health problems of people who live in slums. *The lancet*, *389*(10068), 547-558.

Fomunyam, K. G.,and Teferra, D. (2017). Curriculum responsiveness within the context of decolonisation in South African higher education.

Goebel, A. (1998). Process, perception, and power: Notes from 'participatory' research in a Zimbabwean resettlement area. *Development and Change*, *29*(2), 277-305.

Graham, S., and Healey, P. (1999). Relational concepts of space and place: Issues for planning theory and practice. *European planning studies*, *7*(5), 623-646.

Hann, C. M. (Ed.). (2002). *Postsocialism: Ideals, ideologies, and practices in Eurasia*. Psychology Press.

Kleemann, J., Inkoom, J. N., Thiel, M., Shankar, S., Lautenbach, S., and Fürst, C. (2017). Peri-urban land use pattern and its relation to land use planning in Ghana, West Africa. *Landscape and Urban Planning*, *165*, 280-294.

Khumalo, L. L. (2020). *The exploration of Afrocentric decolonization in the built environment: a proposed mixed-use development in Skukuza Kruger National Park* (Doctoral dissertation).

Khoza, S. B., and Biyela, A. T. (2020). Decolonising technological pedagogical content knowledge of first year mathematics students. *Education and Information Technologies*, *25*(4), 2665-2679.

Le Grange, L. (2016). Decolonising the university curriculum: Leading article. *South African Journal of Higher Education*, *30*(2), 1-12.

Maiti, S., and Agrawal, P. K. (2005). Environmental degradation in the context of growing urbanization: a focus on the metropolitan cities of India. *Journal of Human Ecology*, *17*(4), 277-287.

Muzorewa, T. T., Nyawo, V. Z., and Nyandoro, M. (2018). Decolonising urban space: Observations from history in urban planning in Ruwa town, Zimbabwe, 1986-2015. *New Contree*, (81).

Olatunde, M., Agbola, B., Popoola, A., Adeleye, B. and Medayese, S. (2021). Urban Eviction in Badia, Lagos: A Look at Evictees Wellbeing and Environmental Burden. Researchers Review of the Department of Geography, Tourism and Hotel Management, 50(1), 33-51

Ogunsanya, L. B. (2022). Rethinking The Architectural Literacy of Higher Education Institutions: A Case Study Of University Of KwaZulu-Natal: Howard College. *Journal of Inclusive Cities and Built Environment*, *2*(4), 77-92.

Patrick, H., Khalema, N.E., Popoola, A., and Puplampu, K.P. (2022). Editorial: (DE)-Coloniality, Autonomy, Identity, and Spatial Justice in Africa: An Overview. Journal of Inclusive cities and Built environment. 2(4), iii-viii. https://doi.org/doi/10.54030/2788-564X/2022/sp1ed1

Pieris, A., and Lu, D. (2016). Interrogating Asia: SAH-Asia Research Forum. *Fabrications*, *26*(3), 392-398.

Popoola, A., Tawose, O., Abatan, S., Adeleye, B., Jiyah, F. and Majolagbe, N. (2015). Housing Conditions and Health of Residents in Ibadan North Local Government Area, Ibadan, Oyo State, Nigeria. *Journal of Environmental Sciences and Resource Management*, 7(2), 59-80.

Popoola, A.A., Olatunde, M.O., Magidimisha, H.H., Abiodun, A., Adeleye, B.M. and Chipungu, L. (2020). Urban Forced Evictions: Experiences in the Metropolitan City of Lagos, Nigeria. *Indonesian Journal of Geography,* 52(1), 112-127

Popoola, A., Pretorius, O., Blamah, N., Chipungu, L., and Magidimisha-Chipungu, H. (2022). In the Middle of the Pandemic: Experiences for Built Environment Education. In W. Shahzah., E. Rasheed & J, Rotimi, *Creating Capacity and Capability for the Future of the Built Environment* (pp. 42-52)*,* Proceeding of the 7th New Zealand Built Environment Symposium (NZBER), 2022, held on 17th – 18th February, 2022 at Massey University, Albany, New Zealand. ISBN: 978-0-473-62031-8

Popoola, A., Magidimisha-Chipingu, H., and Chipungu. (2022). Towards rural inclusion: improving the governance of service delivery in Nigeria, Cogent Social Sciences, 8:1, 2118793, DOI: 10.1080/23311886.2022.2118793

Popoola, A. (2022). The Politics of Infrastructural Provision in Rural Areas of Oyo State Nigeria. *African Sociological Review*, 26(1), 94-126

Pratiwi, W. D., Soedarmadji, N., and Yanindraputri, P. (2010). Place-making for tourism in rural settlements and the institutional collaboration. In *Arte-Polis 3 International Conference* (p. 373).

Robins, S. (2001). NGOs, 'Bushmen' and Double Vision: The pkhomani San Land Claim and the Cultural Politics of' Community' and 'Development' in the Kalahari. *Journal of Southern African Studies*, *27*(4), 833-853.

Rodríguez-Pose, A. (2008). The rise of the "city-region" concept and its development policy implications. *European planning studies*, *16*(8), 1025-1046.

Sandercock, L. (2004). Towards a planning imagination for the 21st century. *Journal of the American Planning Association*, *70*(2), 133-141.

Sikder, S. K., Asadzadeh, A., Kuusaana, E. D., Mallick, B., and Koetter, T. (2015). Stakeholders' participation for urban climate resilience: A case of informal settlements regularization in Khulna City, Bangladesh, Journal of Urban and Regional Analysis, VII(1) 5 - 20

Surya, B., Saleh, H., Suriani, S., Sakti, H. H., Hadijah, H., and Idris, M. (2020). Environmental pollution control and sustainability management of slum settlements in Makassar City, South Sulawesi, Indonesia. *Land*, *9*(9), 279.

Wahab, Bolanle (1996). 'Indigenous Knowledge Systems and the Human

Settlements: Towards Integration into Education Curriculum', in Warren, D. Michael; Egunjobi, Layi and Wahab, Bolanle (eds.) *Indigenous Knowledge in Education,* Ibadan: Indigenous Knowledge Study Group, Centre for Urban and Regional Planning, University of Ibadan, pp.63-77.

Wahab, W. B. (1997): "The traditional compound and sustainable housing in Yorubaland, Nigeria: a case study of Iseyin". Unpublished PhD Dissertation, Heriot-Watt University, Edinburgh.

Wahab, B., and Agbola, B. (2017). The place of informality and illegality in planning education in Nigeria. *Planning Practice & Research*, *32*(2), 212-225.

Wahab, B. (2017). Transforming Nigerian informal settlements into Liveable communities: Strategies and challenges. *the 2017 Edition of Mandatory Continuing Professional Development Programme (MCPDP) of the Nigerian Institute of Town Planners*.

Wahab, B. (2023). Informal Communities and Planned Slums: The Tragedy of Environmental Planning Without Indigenous Knowledge Systems. An inaugural lecture delivered at the University of Ibadan, on Thursday, 27th April 2023. University of Ibadan, Nigeria

Whelan, D. (2022). Colonials, protest and aspiration: current polemic in 'decolonised' South African vernacular architecture. *Transformation: Critical Perspectives on Southern Africa*, *108*(1), 35-58.

Wotherspoon, T., and Schissel, B. (1998). Marginalization, Decolonization and Voice: Prospects for Aboriginal Education in Canada. Available at: https://files.eric.ed.gov/fulltext/ED467991.pdf

Exploring The Use of Modular-Prefabricated Units (MPUs): A Resettlement Solution in Ijora-Badia, Ijora-Olopa and Abule-Nla Lagos-Nigeria

Oginni O. Adeyemi[1]* and John Adekunle Adesina[1].

[1]Department of Architecture, University of Lagos, Nigeria
Corresponding Email: oginniadeyemi@gmail.com

Abstract

This study makes a case for the inclusion of prefabricated units as an option for low-income housing in Ijora low-income communities in the Lagos Metropolitan area. Rapid urbanization, failure of adequate planning, and supply of infrastructure have led to inadequate shelter for the less privileged in the metropolis. The absence of proactive redevelopment strategies alongside the increasing population densities has resulted in the proliferation of illegal and unapproved dwellings in the Lagos metropolis. This study elucidates the stakeholders' perception of using prefabricated units for low-cost housing alternatives; proposals for prototypes of container housing modules to be adopted for use, and finally the historical worldview of the displacement of Ijora settlers by the Lagos State Government. The study conducted interviews with randomly selected respondents, squatters, and homeless residents within the neighbourhood. A situational analysis of the site was carried out as well as interviews with stakeholders, and representatives of the slum dwellers. Findings from the study revealed that in Ijora, about 50% of residents in informal settlements and waterways areas were vulnerable to poor infrastructural facilities, sub-standard, often unhealthy, living conditions, and stigmatization. These areas are under-serviced with public infrastructure, and they have highly populated neighbourhoods. Housing affordability, complete model-city masterplan, prefabricated unit restrictions, resettlement, distribution, and allocation strategies regarding the selected study areas and the whole of Lagos are some of the topical issues discussed. Failure by the government to adopt alternative housing materials and solutions has resulted in a housing deficiency in the Lagos Metropolitan area.

Keywords: *Alternative housing; prefabricated units; slums; housing strategy; resettlement.*

1.0 Introduction

According to a 1982 UN-Habitat definition of slums, slum settlements are very impoverished urban regions that lack the means to maintain the neighbourhoods' socio-economic structure (Debela, 2021). Urban slums may be a risky setting for the quick transmission of diseases and viruses, which might be extremely dangerous for the larger city. No study on housing provisions would be complete without taking affordability and cost evaluations into account to support the feasibility of any housing choice (Arinabo, 2022). The majority of residents lack even the most basic kind of accommodation and those who do typically live in hazardous circumstances for both their health and their lives (Azhar, Buttrey and Ward, 2021).

As a sign of its dedication to social inclusion and to alleviate the suffering of those who had to experience the humanitarian catastrophe of forcible

displacement and financial hardship during the previous Badia redevelopment, the Lagos State government planned to build 1008 housing developments of various construction types, some of which could be Modular-Prefabricated Units (MPUs) for mass housing development in Lagos state. This was necessitated by previous evictions of the urban poor to make room for the wealthy, such as the Maroko eviction procedure in 1990, in Lagos. The state government's goal has thus far remained unfulfilled. The Maroko 1990 incident, which some have referred to as social development and urban upgrading, resulted in the eviction of residents from their houses. The most at-risk population in Ijora-Badia and the surrounding communities were young children and their mothers.

The objective of this study was to acquire enough information to offer low-income mass housing alternatives that will satisfy the needs of the urban poor. Prefabricated modules are a modular building concept that is adaptable, inexpensive, and lightweight (Debela, 2021). This home concept can be used to preserve social peace and promote healthy living in urban settings. Affordability and social sustainability are related since the target customers should be able to purchase these units. Urban poverty is known to be greatly associated with poor and insecure housing conditions. In the majority of large developing-world cities, the official market only caters to a tiny part of the population. Between 30 and 70 percent of the city's residents are said to reside in "irregular" settlements, and up to 85 percent of newly built residences are erected unlawfully, which has detrimental social and environmental repercussions (Bhandari, Riggio, Jahedi, Fischer, Muszynski & Luo, 2022). The new paradigm hasn't been very successful, though, in becoming a practical and sustainable policy. There are two related problems with relocation plans, social housing, slum upgrading, and other sites and services: first, they are much too little in scope to satisfy the growing demand, and second, the goods are way too expensive to be affordable for low-income individuals. As opined by Uleme (2021), the research suggests that state measures may emulate the informal sector's progressive expansion and enhancement of housing and infrastructure (Uleme, 2021).

There are major physical developmental changes that are currently going on in Lagos and more public infrastructure is being built every day. This direction of urban development and most times urban renewal initiatives are going on and the spectacular outcomes thus far have the authorities and the people ecstatic. Thousands of low-income houses have suffered evictions and other negative repercussions majorly due to the implementation of the master plan. Relocating people from the inner city to new resettlement locations in the periphery has resulted in significant transportation costs, which have harmed people's business relationships with clients, destroyed their informal networks of support, caused them to lose their locational advantage and employment, and damaged many people's informal business relationships (Bhandari et al., 2022). The majority of those who relocated claimed to have seen a significant decline in income (Okafor, Iwuagwu, Onyegiri, Okpechi, and Ukanwa, 2023). There have been problems with access to water, sanitization, healthcare, and education in many moved households. The high prevalence of homelessness and the growth of slums are

examined in this fieldwork-based paper's analysis of the socio-economic and infrastructural implications as seen in the Ijora-Badia, Ijora-Olopa, and Abule-Nla which are the case study sites. It implies that the inhabitants of the current Ijora slum communities are proof that the government's first choice to evict the citizens of Oluwole and relocate them to Badia was ill-considered. At that time, Badia had an urgent need for both economic and social infrastructure, and the issue was made worse by population expansion. The evictees were also neither warned nor given any opportunity for consultation (Okafor et al., 2023). The city has recently been grappling with this issue. This research examines how urban development practice and policy impact displaced low-income households and makes recommendations for ways to lessen the impact of development on livelihoods. This study also considers the need for low-cost housing development policies and documentation on MPU problems in the Lagos Metropolitan area.

1.1 Why Prefabricated Units for Low-Income Housing Projects?

Okafor *et al*. (2023) stated that factory-built housing offers cost reductions for developers as well as some extra benefits for inhabitants and their communities. Saving money is what draws people to MPUs. Even though stated cost reductions vary from project to project, the majority have shown savings of around 20%, and as the sector matures, far bigger savings are expected (Okafor *et al.,* 2023). Due to the great production productivity of MPUs, labour expenses are considerably reduced, the working environment is better and healthier, and stringent quality control is achieved. On-site labour is frequently more cost-effective since it is less specialized, more efficient when organized in an assembly line, and less susceptible to weather delays. Efficiency of scale in material stock also results in cost savings by removing subcontractor overhead because orders for bigger amounts of material may be placed. As the costs of conventional site-built construction continue to rise, the cost savings provided by MPUs will become more and more tempting (Olawumi, Chan, Ojo, and Yam, 2022). The use of Modular-Prefabricated Units (MPUs) for a low-cost housing and resettlement solution in Ijora-Badia, Ijora-Olopa, and Abule-Nla Lagos-Nigeria is the focus of this study while its *objectives* assessed the affordability, government policies, resettlement programs, distribution pattern, and allocation strategies in the state.

Table 1. Table showing the perception of Selected Community Stakeholders on the Adoption of MPUs in Low-cost Housing Provision and Slum Renewal in Lagos

MODULAR-PREFABRICATED UNITS	
Modular design	Has a uniform width, a typical height, and a regular length, may be connected to form bigger buildings, and makes design and planning easier.
Strength and durability	Built to withstand extreme conditions, such as those found on ocean-going boats and long-distance transit on roadways, and to bear enormous weights and to be piled in high columns.
Low cost of labour	For fabricating and welding baggage containers, less labour is required compared with traditional building techniques.

Low initial cost	Cheap old cargo containers are readily available.
Waste generation	MPUs save over 50% of waste production.
Construction completion time	Shorter time to finish. Ten units may be finished in around three days as opposed to the usual three months.
Transport to site convenience	Ease of movement and transportation to various sites or locations.
A Resettlements Solution for Urban Slums Transformation in Ijora, Lagos	

2.0 Literature Review

Housing has long been a topic of discussion regarding the delivery of social services (Oginni and Mayor-Olabiyitan, 2017). The argument focuses on the issue of whether housing is a good that can be purchased on the open market or a crucial social service supplied by the government as part of the welfare state (Solymári, Mangera, Czirják, and Tarrósy, 2021). The relationship between housing and the other welfare state pillars is shown by the frequent correlation between improved housing conditions and improved mental health (Akinradewo, Aigbavboa, Aghimien, Oke, and Ogunbayo, 2023). Additionally, in terms of health, research has revealed that adolescent development anomalies, a range of emotional problems, and bad social relationships are all caused by overcrowding, which commonly leads to insufficient housing (Solymári *et al*., 2021).

2.2 What Exactly Is a Prefab House?

Prefabricated houses, sometimes referred to as prefabricated residences, receive their name from the fact that the majority of their construction is completed off-site before being shipped and assembled on-site (Sánchez-Garrido, Navarro, García and Yepes, 2023; Mohamed, Elkaftangui, Zureikat and Hiyasat, 2023). Since they were frequently utilized to construct low-quality, mass-produced homes to replace ones already obliterated and damaged. Even though some prefabs are still in use today, their use was always temporary, which is a result of the standards to which they were constructed. Even while the word still carries a bad connotation, modern prefab homes are increasingly associated with effectiveness and quality (Khan, Yu, Liu, Gu and Walsh, 2023). Prefabrication is often defined as "made beforehand." Traditional house-building methods have historically included prefabricated components, including the fabrication of materials like hardwood trusses for the roof. "Prefab" refers to a more modern approach to construction. Most manufacturers are using this building technology to come up with different designs that are unique and adaptable to the location where it would be built. It is ambiguous and because many people think it only refers to a modern, cost-effective construction method, the phrase "prefab" is used frequently (Bello, Khan, Idris and Awwal, 2023). But if any part of a house was built before it was brought to the site, it might be said to be prefabricated- '*prefab*' (Musa, Yusof, Mohammad, Mahbub, Alam and Com, 2014).

2.2.1 What are Modular and Volumetric Homes?

The fit-out, however, will take months to complete once the construction membrane is in place, and as with all prefab homes, the foundations must already be constructed.

According to a report on the state of modular buildings, "Modular is not delivering, here's why." A modular residence is a kind of prepared home that is built from substantial components, such as the roof and wall panels, much like a sizable Brick set. The bulk of us have undoubtedly seen pictures like the one below when a whole wall is craned onto the site (sometimes with already-existing panels) (Ali, Elyamany, Ibrahim, Kineber and Daoud, 2023). Modular manufacturers support modular builders who prefabricate whole wall parts at a factory and then crane them into place on-site (Baufritz, 2022). This usually gives the idea that putting up a home will only take a few days, even though some may be built in under a week. It can also have multiple levels and be made of continuous fibre-reinforced composites. Baufritz (2022), asserted that volumetric modular building, proprietary kits of standardized components, and structures built off-site have all reemerged during the past century in various ways, but they have not materially changed how we build, nor transformed the business. Volumetric refers to the amount of air in a room or specific region of a house and is described as a "measurement of volume" in this context. Volumetric modular manufacture involves prefabricating multiples of larger, fully finished items (see Figure 1).

Figure 1. A typical design of a sustainable one-bed single-unit low-cost modular prefabricated home.

Source: https://www.compositesworld.com/articles (accessed in October 2023).

These geometrically adjustable parts, which are viewed as a form of modular housing, will be assembled altogether on-site to build complete structures. Doors, windows, heating, plumbing, electrical wiring, and interior finishes may all be pre-installed in these units at the manufacturer. It is frequently used for major improvements, has the highest level of homogeneity, and because so much is accomplished in the production environment, it enables exceedingly quick installation timeframes on the job site (Wuni and Shen, 2022).

Figure 2. (a) Modular prefabs
Source: Solymári, et al. (2021).

Figure 2. (b) Volumetric prefabs

Source: Solymári, et al. (2021).

An installation of proportionate house-buildings is seen in Figures 2 a and b. Finding a site that is perfect for this type of conventional housing may be challenging because both modular and volumetric homes still rely on standardization and have a production and assembly line (Solymári *et al.,* 2021; Musa, Yusof, Mohammad and Samsudin, 2016).

2.2.2 MPUs and safety regulations and standards

Safety regulations for modular prefabricated units in developed cities like Lagos are crucial to ensure adherence to basic construction standards. Consultation with local building codes and local authorities is also crucial for the efficient use of MPUs in any region of the world. Some considerations are:

i. Adherence to Local Building Codes: the local building codes and regulations in Lagos should be adhered to, which may include specific provisions for construction in warm and humid climates. These codes will dictate structural requirements, safety standards, and materials suitable for this local climate.
ii. Foundation Design: the foundation design should account for the high water table and potential for soil subsidence in a humid environment. Adequate site preparation, drainage, and foundation materials are essential.
iii. Wind and Seismic Considerations: Since Lagos may experience strong winds during storms and is located in a seismically active region, the units should be designed and installed to withstand these forces.
iv. Heat and Humidity Resistance: Modular units should be constructed with materials that can withstand high temperatures and humidity, as well as proper insulation to manage internal temperatures.
v. Ventilation and Air Quality: Ensure that the units have adequate ventilation to prevent heat buildup and maintain airflow to improve occupant comfort.
vi. Electrical and Fire Safety: Fire-resistant materials should be used. Local electrical codes and fire safety regulations to ensure safe electrical installations and fire prevention measures should be adhered to.
vii. Accessibility: Consideration must be given to people with physical disabilities, special needs, care, and support.

viii. Water Management: Water management through proper drainage of roofing and site environment to prevent flooding and rusting of elements of the building.

3.0 Research area

Ijora is a neighbourhood of Lagos and is situated between latitude 30 23' and longitude 40 22' in Lagos State's Apapa Local Government. The Ijora-Badia, Ijora-Olopa, and Abule-Nla were the three principal settlements that were visited for this study. The Ijora-Oloye which is also a small slum, densely-inhabited community directly adjacent to Ijora-Olopa within the Ojora family territorial boundary was not considered for this study due to on-site visit limitations. Rather than a creative evaluation of the roles it can serve, a train to Apapa defines the eastern limit where these containers are expensively returned empty to the port and delivered back to separate departure nations. According to "the declaration of title under Nigerian Native Laws and Custom," the Ojora leadership family possessed the majority of the Ijora territories. Ajegunle, a suburb of Lagos Slum, forms the southern boundary. In the very early 1910s, Badia was a marshy region and a waterlogged community where inhabitants could go to their houses using canoes. Up until the 1960s, when the Lagos State town planning authority and the national government began zoning some areas for reclamation, Badia was known as Oluwole Village. This led to the industrial villages that are still present in the region today. One of the 42 slums in Nigeria listed by the UN, Badia is 160 hectares in size and home to over 600,000 people (see Figure 3). It is underserved yet has a high population density.

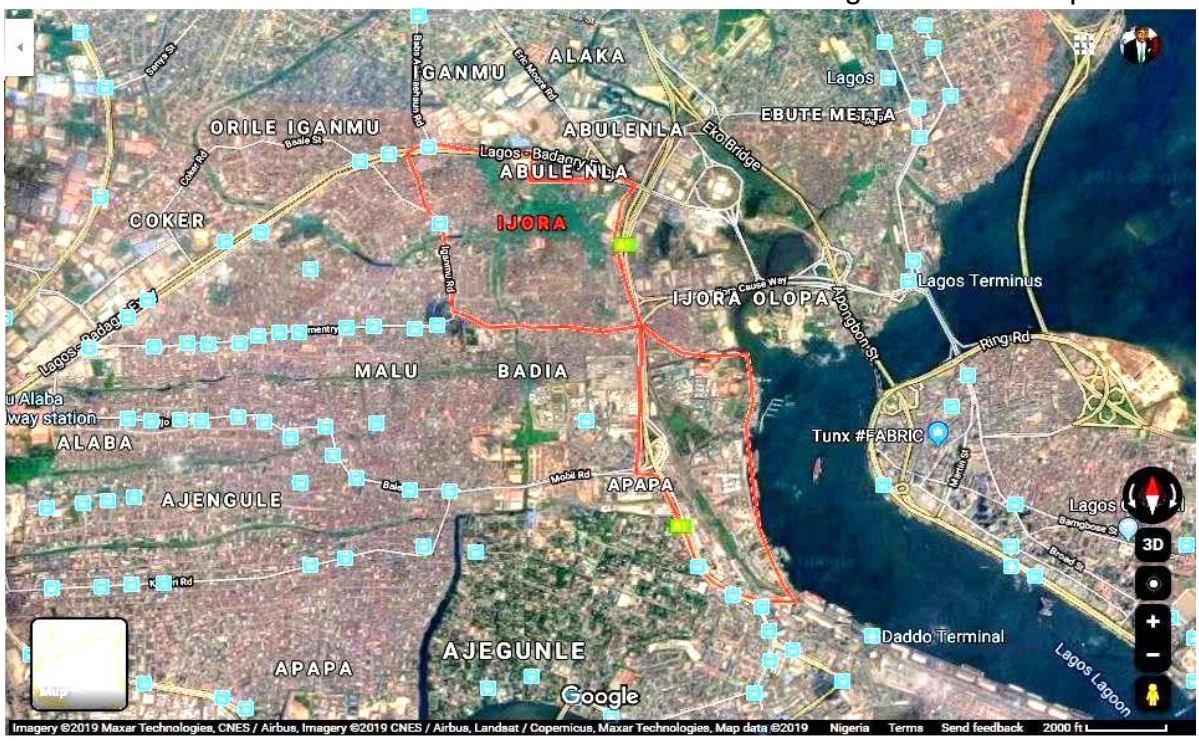


Figure 3. *Map showing Ijora (Badia to the right and Olopa to the left) and the small Abule-Nla community above.*
Source: Google Earth Pro Imagery (2023)

About 75% of inhabitants live in one-room homes with a population density

of five to seven people, while eight to ten families share a kitchen, bathroom, and toilet in a "face-me-face-you" configuration. The Nigerian National Port Authority, where hundreds of containers enter every single day, is bordered by this road. Lagos is the ninth-largest megacity in the world, which puts the world's Millennial Development Goal—to reduce the number of slum dwellers worldwide to 1.4 billion by 2020—in jeopardy. We build homes primarily for shelter, a comfortable living environment, and beauty. Indicators of housing features, such as prices, rents, size, and quality concerning the option of container housing, as well as complete data covering the economic, social, and demographic factors of slum households are all necessary for the scope of this research.

The evicted people were otherwise left to fend for themselves and muster the means and resources to construct new homes for their families. To build shelters that each family could afford, the resettled people used stilts and corrugated iron sheets in a variety of sizes and designs. Other populations that were evicted due to development operations now reside in Ijora. It has an ideal position and closeness to a lot of business activity making it an economically strategic area to reside. It has grown to be quite desirable for demolition to make room for Apapa's growth and serve the demands and interests of major enterprises. Most of the time, the construction products are of extremely poor quality, and if repairs are required, the cheapest materials are used. Low-income individuals live in Ijora-Badia since it is a designated slum neighbourhood. The standards are very low, and the accommodations are of terrible quality. This research does address the general perceptions of the people on the need to adopt MPUs as the best and quickest fix to address the impact of shortages of housing in the area. However, this study may not be able to

Figure 4. *Map showing Badia*
Source: Google Earth Pro Imagery (2023)

unravel the detailed initial cause of the displacement and eviction of the old settlers and prospective migrants and hoodlums who likely migrated to Ijora to join criminal syndicates or seek assistance with cut members and other low-wage individuals who cohabit the area. In addition to Ijora's important position and proximity to famous locations like Iganmu, Apapa, FESTAC, and Lagos Island, it is also necessary to completely rethink the natural beauty and tranquility of the region as a whole.

As shown in Figure 4, Badia covers approximately 6 square kilometres along a distance of about 18 kilometres. Ijora-Badia's ownership, development, housing, and residency (see Figure 3 and Figure 5a-d) is contentious. With approximately 140,000 people per hectare, Ijora communities span more than 300 hectares of land and are one of the four areas designated as blighted in the Apapa Model City Plan (2010).

Slum growth and frequency in the area are related to social and economic issues. Measures to maintain peace in Ijora-Badia's housing, land accessibility, and physical development are in place. The majority of the people who have moved into the slums in the Ijora Badia land region come from, Ijora-Olopa and Abule-Nla which stretches to Orile Iganmu at Apapa Iganmu LCDA, Ifelodun LCDA, Coker Aguda LCDA, Lagos Mainland, and Amuwo-Odofin are Ilajes Ese-Odo migrants from areas of Lagos, Ondo, and Delta states.

Figure 5. *Pictures showing Ijora filled with shanties and poor hygiene for its residents at Badia and connecting neighboring communities.*

4.0 Methodology

The current investigation used a mixed-methods approach to research. Five focus groups were conducted for this study, with a professional moderator leading each one. Focus group participants included commuters, market women/men, community leaders, Baales and community heads, landlord association executives, and family representatives of the people who were displaced.

Participants were chosen based on the many roles they performed in the fostering process. Each of the five focus groups for the assessment was deemed to be a suitable representative sample because Ijora City's stakeholders made up the population. The first group was made up of family representatives, the second was made up of community leaders, and the third, fourth, and fifth groups were made up of commuters, NURTW trade unionists, and market vendors. These groups are used to gather information on the opinions of everyone involved in city development, leadership, and housing provisions. This approach of a qualitative research methodology was adopted to assess the people's perception generally. A personal site visit and observations made during the area's field survey were used to update the Google Earth Pro 2023 identification of the current site conditions. At various nodes and clusters within the Ijora communities, a quantitative survey using focus groups was conducted to determine the main needs of the people as well as to determine the respondent perceptions and preferences using indices that were predetermined from existing literature and information from conversations with real estate experts.

4.1 Data Collection

The groups were instrumental in identifying the evaluation criteria used by the various stakeholders and perhaps developing a set of universal standards. Instead of encouraging participants' creativity as brainstorming does, this approach aims to help them express their evaluation criteria for a certain topic. The following are a few important questions (see Table 2):

i. Displacements and indigeneity: Steps must be taken to identify the community's original settlers as well as any migrants who may have come to Ijora to conceal themselves or engage in criminal or illegal activity.
ii. Earnings: If accommodation is supplied, do the persons who will reside there have a stable job to pay back the loan?
iii. Household size: In Ijora, a family is typically composed of five children and seven adults. Seven children and two women are present in some of the homes inspected.
iv. Affordability: Are the units affordable on all levels for the general public?
v. How long would the initial phase of the building take?
vi. Would individuals oversee and take care of the infrastructure?
vii. Where will residential construction and revitalization of cities rethink land connectivity, construction of homes, and habitation in Lagos State's Ijora neighbourhood?
viii. There are now measures for equality in housing distribution.
ix. Do current laws and documentation pertain to physical planning and do the displaced mention their specifics?
x. What impact will the enforcement of current physical planning regulations have on the populace?
xi. To what extent would the

provision be adequate to accommodate individuals uprooted and minimize violence in the city?

xii. Conduct interviews with influential families and local ones in charge. relating to the Ijora people's desire for affordable homes and the extent to which the community has backed them in securing land.

5.0 Results

Audio-video recordings were taken by each focus group, and the recordings were later transcribed and interpreted. The focus group interviews covered 12 essential criteria and questions about each stakeholder. Finding the criteria to assess the outcomes to be attained in the construction of homes utilizing the constructed low-cost was the third duty assigned to the focus group participants. Extreme, critical, fair, and no/low impacts were utilized as the 'X' elements to evaluate and tabulate the data, which were then used to create four grades.

According to data from earlier studies in Lagos State, there are approximately 1,000 residential buildings in Ijora and the surrounding communities in Lagos. Seventy-five percent of the residents live in room households with about 7 people, 20% of them are families of 10 or more who live in neighbourhood condominiums known as face-me-and-face-you, and the remaining 5% are people who, according to the Local Government Authority, live in "makeshift houses" and sleep in vehicles. If their home is suitable for their income, people in slums can afford to live in nicer housing as opposed to the current filth. Before the current administration assisted, the Lagos State government opted to destroy shanties and booths in 2013, which resulted in the displacement of approximately 40,000 individuals. Despite being referred to as a slum, Badia is home to residents from various regions of the country as well as from neighbouring West African nations, particularly craftsmen from Togo, Ghana, and the Benin Republic. In every location, the issue of inadequate housing typically results in a higher rent price. In the shantytowns, people reside and do commerce. The worrying aspect of it is that food is prepared and served in unclean conditions, yet children are born and nurtured in these slums. It is concerning that there are no public services or basic facilities in this region, like clinics and schools. In line with the aforementioned data, focus groups revealed that there is still a homeless population living on the streets, in parks, in cars, abandoned vans, shops, and roadside trailers, in cheap motels, empty buildings and lots, in unauthorized and unlicensed transit garages (under bridges), in all-night theatres, restaurants, and open public buildings.

Table 2. *Table showing the perception of selected community stakeholders on the adoption of MFUs in low-cost housing provision and slum renewal in Lagos*

Respondents	Issue of Displacements and Indigeneship	Income	Family Size	Affordability	Construction Time	Facilities Management and Maintenance
Traditional Leaders (Baales)	X X	X X X X	X X X X	X X X X	X X	X X X X
Community Heads/Leaders,	X X	X X X X	X X X X	X X X X	X X	X X X X
Landlord	X X X	X X X X	X X X X	X X X X	X X	X X X X
Association Executives						
Commuters	X X X	X X X X	X X X X	X X X X	X X	X X X X
Market Women/Men,	X X	X X X X	X X X X	X X X X	X X	X X X X
Family Representative	X X	X X X X	X X X X	X X X X	X X	X X X X
Youth Support Groups	X X	X X X X	X X X X	X X X X	X X	X X X X
Trade Unions (NURTW)	X X X X	X X X X	X X X X	X X X X	X X	X X X X
Association of Artisan	X X	X X X X	X X X X	X X X X	X X	X X X X
LCDA Govt. Officials	X X X X	X X X X	X X X X	X X X X	X X	X X X X
Private Companies/ Establishments	X X X X	X X X X	X X X X	X X X X	X X	X X X X
Displaced People and Squatters	X X X X	X X X X	X X X X	X X X X	X X	X X X X

Note: 4*(extreme impact), 3*(critical impact), 2*(fair impact), 1*(no impact)

Table 3. *Housing Needs Projections for the First Phase (Housing Units and Apartments)*

Proposals	Building Design 1	Building Design 2	Building Design 3
Housing Type	One-bed terrace units	Two Bed terrace units	Three Bed Units
Apartments	(8 apartments per unit) - 50x8=	(6 apartments per unit) - 50x6=	(5 apartments per unit) - 50x5=
Total Units	400	300	250
Average Family Size (7 person/family)	2,800	2,100	1,750
Total Occupants		6,650	

For the percentage distribution of the current circumstances of the shanties that are now being utilized as homes, see Table 4 for the effect that a sizable number of homeless wanderers, "garage people," and hotel occupants are producing. Many children are reared in these slums, and some people have many wives. The total number of persons (estimated at 6,650) who would be removed from the streets in the first phase may be analyzed using Table 1. These folks either lack adequate (conducive) shelter or are homeless. Table 3 shows the projected housing needs for the first

phase (housing units and apartments) as Type 1 and Type 2 buildings. Building type 1 is made up of 4 No. 40 Feet ISO Containers joined together to create 6 No. Studio Apartments. An outline of a typical low-cost home is provided in this section. Building type 2 is made up of many containers that are combined to create two apartments. In each area, cross-ventilation was taken into account. Table 8 shows the technical specifications of low-cost house construction specifications and details and a cross-section of container house details.

Table 4. *Distribution of Respondents by Age*

Age Distribution	Frequency	Cumulative Valid Percent (%)
18-30	420	44%
31-45	225	24%
46-60	205	22%
61-100	107	10%
Total	957	100%

Table 4 is a presentation of respondents' demographic characteristics identified in the study. Table 4 reveals that 420 or 44% of respondents were between the ages 18-30 years of age, 225, or 24% respondents were within the age bracket of 31-45 years, while 205, or 22% of respondents were within the age brackets of 46-60 years and as for the seniors (61-100) with a total identified as 107 or 10% who stay in the house long-term because they could not do lots of hard hassle.

Table 5. *Distribution of Respondents by Gender*

Gender Distribution	Frequency	Cumulative Valid Percent (%)
Male	556	58%
Female	401	42%
Total	957	100%

This table's results are not surprising since it shows that most young adults that are between 18 and 30 years of age responded to the questionnaire – this is the expected age bracket of the people mostly displaced and homeless in Ijora. Table 5 shows the distribution of the respondents by gender, 556 or 58% of the respondents were male, while the remaining 401, or 42% were female. This indicates that the majority of the respondents who attended the questionnaire were male. Through physical assessment and on-site random counting of the existing building and the displaced people (without any prior permission and formal request).

While they come back home to reorganize and modify their different places for habitation, a sizable number of homeless wanderers—including those in the categories of "no place to call home," "slum settlers," and "garage people" as determined in this study—are effectively counted physically day and night (see Table 6).

Table 7 shows the collaborative model, which is typically a decentralized model that integrates the representations of many different disciplines, and benefits from the contributions of each expert's discipline-specific knowledge. Types of clustering enable a variety of benefits, including the ability to observe all models and interact in a single space, increased design cooperation and output, improved conflict mitigation and detection, and increased time and cost results. The total number of AEC professionals (at different professional membership, registration, and prefabricated construction experience levels). At the time of the visit, among other important actors who are equally significant but who were chosen because they are the technical staff, structured interviews were held directly with the local professionals and major stakeholders in the industry. The architects, contractors, structural

engineers, quantity surveyors, and potential financiers/developers are among them. Key participants and local experts who were present during the preliminary stage, construction and execution stage, and post-construction stages participated in joint interviews.

Feedback average was utilized to establish whether or not the impact on the MPU's housing delivery would be excessive following the criteria in the table above. The answers to the questions and the interviews indicated the major stakeholders' viewpoints on how the potential barriers to collaboration could be overcome. Such are the requirements for greater research, various levels of training, and the creation of core professional and ethical standards that would promote expert collaboration. No matter how a professional collaboration for a building project begins, the following are some of the early discussions or considerations that were made to help find common ground and assess their various ratings as shown in Figure 4. One of the issues that had to be addressed by the chosen professionals was, "Who among the professionals delivers what?". Who is bringing what? Who is contributing what in terms of technical competence, knowledge, and skills? The skills of the builders and structural engineers, the quantity surveyor's understanding of the intricacies of the cost plans, and the creativity and knowledge of the architects' ideas are all important contributions to the success and quality of any building project.

5.1 Product Description

Table 8 gives and explains a detailed description of the product, however, some benefits of using it include its lightweight and sturdy steel construction, wind resistance of >220-280 km/h, and earthquake resistance of >grade. Completely galvanized steel frame, which is anti-rust and ideal for places with high humidity and the sea; quick and simple assembly: One conventional unit may be put together in three hours by two competent workers, and it is simple to integrate numerous modular structures both horizontally and vertically. Numerous uses include storage facilities, residences, villas, restrooms, baths, stores, inns, campgrounds, workshops, offices, and medical facilities, among others. The transport method that is affordable, simple, has great mobility and is simple to shift from one location to another.

Table 6. *Distribution of the Existing Condition of the Houses*

Existing Condition	*Frequency*	*Cumulative Valid Percent (%)*
Private residential buildings	610	45
Face-me-face-you	320	14
Illegal Shanties	505	15
Shops (Mix-used)	215	20
Cars roadside trucks and abandoned vans and roadside trailers	45	12
Underbridge and transit garages (under bridges	32	16
Streets and parks	52	20
Cheap motels	25	5
Vacant buildings and lots	102	5
Open public buildings	55	10
No place to call home (Others)	291	20
Total	2,127	100

Table 7. *Checklist on the perception of selected construction experts on the impacts of the MFUs.*

Technical Personnel/Factors	Architects (ARC) (17)	Builders (BLDR) (8)	Quantity Surveyors (QS) (5)	Civil/Structural Engineers (ENGR) (13)	Town Planners (TPL) (5)	Private Investors (Developers) (10)
Modular designs	X X X X	X X	X X	X X	X	X X
Strength and durability	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X
Low labour cost	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X
Low-cost construction	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X
Buildability	X X X X	X X X X	X	X X X X	X X X X	X X X X
Serviceability	X X X X	X X X X	X	X X X X	X X X X	X X X X
Manageability / Maintainabilit y	X X X X	X X X X	X	X X X X	X	X X X X
Waste generation	X X X X	X X X X	X X X X	X X X X	X X X X	X X X X
Construction completion time	X X X X	X X X X	X X X X	X X X X	X	X X X X
Transport to site convenience	X X X X	X X	X X X X	X X	X	X X X X
Financing	X X X X	X	X X X X	X X	X	X X X X

Note: 4*(extreme impact), 3*(critical impact), 2*(fair impact), 1*(no impact).

6.0 Discussion of results

Following the assessment from the data collected, 30–50% of the population in Ijora primarily the Badia community lives in informal settlements, making the area's waterways vulnerable due to unstable housing conditions, a high risk of eviction, inadequate infrastructure, poor living conditions that are frequently unhealthy, and stigmatization. Public agencies are not investing, and citizens are not investing because they are afraid of being evicted. Governmental acts in the past: mass relocation of unofficial settlements to high-rise buildings in ecologically sensitive locations outside or near the metropolis. Comprehensive

plan from the family or the Lagos State Government that addresses housing and infrastructure development under the Ojora Family's territory. The Ijora communities, which are largely residential and have endured neglect and haphazard urban planning in the past, have to be redesigned to include all the amenities required of a megacity. Due to its proximity to inland waters, the area is mostly a riverine settlement, which attracts residents from nearby states and nations.

6.1 House Affordability in Ijora Communities (Badia, Olopa and Abule-Nla)

Table 3 explains the housing needs projections for the first phase (housing units and apartments) and Table 6 identifies the Percentage Distribution of the Existing Condition of the Houses, the question would then be; What exactly are the competing concerns regarding the affordability of homes in Ijora taking into account the low cost and relaxed lifestyle of the settlers, development, the potential for a sustainable MPU housing project, and residence in Ijora? What is the Lagos state government's complete strategy for delivering sustainable and quality services including roads, water, power, and other communal facilities to make the neighbourhood a notable low-cost housing development in the city? Ae there any housing investment initiatives from private parties, or projects that are inclusive, participative, inexpensive, and take into account the unique accessibility to housing desires? To at least accommodate 50% of those in dire need of housing, the first phase would consist of 1,500 apartments, and the second phase would likewise consist of 1,500 units. The outcomes of the first and second phases would decide the third phase and any others that followed.

6.2 Ijora's Complete Model-City Masterplan

Some of the respondents referred to the implementation of the Apapa Model City Plan which illustrates the Apapa Model City Plan's context within the framework of the available access to land, markets, and other factors. The housing initiative at Ijora has to have this as its direction while implementing the master plan. The Lagos State Government will step up its attempts to keep the homeless out of suburban communities. In the places where they have relocated, the growing numbers of homeless suburbanites have already sparked opposition. Conflicts arising over the homelessness issue have so far been contained within the conventions of traditional politics. Various municipal interest groups related to the topic have emerged, ranging from those who advocate for the homeless to those who are focused on evicting them from homes and businesses.

6.3 Prefabricated Unit Restrictions

Multi-habitation is suggested as a low-income urban dwelling approach in the most current draft of Lagos' housing policy. However, several studies show that families that live in multi-inhabited homes must deal with a variety of difficulties. Conflict over shared amenities is one of these difficulties noticed from the onsite survey. While exploring the housing fulfilment of multi-habited household members, it was discovered that respondents' residential happiness is negatively impacted by building attributes, materials, finishes, and components. The design, placement, and upkeep of such homes demonstrate the impact of this result on the creation and planning of multi-habitat housing in

Lagos. These houses and their immediate settlements ought to be more than just a place to live, they ought to mix in with the city's contemporary buildings and urban settings.

6.4 Resettlement, Distribution, and Allocation Strategies

The method of choice must be accepted by all parties involved and be in line with the suggestions and criticisms made by the chosen focus groups to be equitable and fair. The approach must lay forth requirements for resettlement, limiting relocation based on things like financial earning ability, employment status, family size, and immigration status. Each informal colony is unique, comprising different cultures, languages, and customs (research found that the majority of inhabitants were not Yoruba-speaking tribes from Lagos but migrants from other states and neighbouring countries). They also all face unique problems. Since the government might not be able to provide and support some of these services, the private sector or organizations have a role to play in preparing installing and preserving infrastructure for the framework to perform properly. Due to the lack of accessible land spaces throughout the city, it would be necessary to establish a new town somewhere in Epe or a nearby suburb, where the people would be relocated and provided with access to inexpensive transportation so they could commute back to the city to continue with their source of subsistence (business), which would be necessary for them to pay their mortgage payments.

7.0 Conclusion

The research notes that the inhabitants of the current Ijora slum communities are in urgent need of both economic and social infrastructure, and the issue was made worse by population expansion which is increasing daily and the level of criminality within the area is also worsening from reports by the various law enforcement agencies. But to meet the global best practice of mass housing provision, there has to be the development of fast, cost-friendly, and energy-efficient MPUs. This can either be produced off-site and brought to the site or a mixed hybrid adoption of both off-site and on-site construction (installation). However, some manufacturers assert that off-site manufacturing allows for the development of components with more accuracy, resulting in tighter envelopes and fewer thermal bridges, further lowering operating energy consumption. Additionally, because the impact of design decisions is amortized across numerous projects rather than just one, prefabricated structures might need more time, effort, and money to attain energy- and resource-efficient results. With several units working on many tasks, even little deviations from the baseline might become rather substantial.

In contrast to popular belief, the majority of MPU units are not designed to be moved after being installed. As a result, the end-of-life effects of a wood frame are fairly comparable to those of a typical site-built structure. On the other hand, steel-framed MPUs offer a larger potential for reducing the life cycle effect. On average, disassemble screws and rivets are used to build titanium MPU modules. Steel components are likely to be recycled more frequently than mortar or concrete. The energy that is embodied

in MPU projects that are constructed to be moved to a separate location can be used again, resulting in a less significant effect. The results of a life cycle evaluation illustrate a 5% lower life cycle energy consumption and a 3% decrease in GHG emissions since materials are discarded less and recycled more. Other research yields different findings, with one showing that worker mobility represents the only major variation in overall carbon dioxide emissions. MPUs are less carbon-intensive overall, according to the studies we looked at, but their differences on important points show that additional study is necessary.

MPUs offer developers, project teams, and occupiers an advantage over traditional construction in terms of quality control in addition to cost and timeline. Building components that are finished, examined, and sealed in a single facility that manufactures them repeatedly to identical specifications results in increased quality control. The method is more effective and accurate as a result of the assembly line technology at its core. In an industrial environment, for instance, tracking deliveries, installations, and general material movements may be better coordinated and digitalized, lowering the risk of lost and damaged supplies. Through the use of thermal bridges, accuracy may lower the building's energy consumption while also improving its sturdiness, culpability, and stability. Public controversy surrounding the equitable distribution of housing units in the Lagos HOMS Initiative, which is not affordable is mostly due to the building process and the number of units projected and constructed that would not satisfy the deficiency in demand that is necessary.

Is it possible to adopt and implement the MPUs and other kinds of quick-fix building production approaches? Can approaches and construction strategies that would adopt reusing shipping containers, steel scraps or other composite materials that are low-cost be used in housing delivery for the urban poor in Ijora and other slum communities in Lagos? The metropolis is currently covered with several containers that are used for retail stores and other business endeavours. It is suggested that prefabricated modular homes can be flexible and adaptable to each user's demands on a wide scale. As opined by some of the respondents (stakeholders in the construction sector) this is going to be advantageous for low-cost construction methodologies, specifically regarding the utilization of MPUs for low-income housing developments and resettlement options for urban slum improvement in Ijora and throughout Lagos state.

References

Adeyemi, A. A., Junaid, A. M., and Sanni, L. M. (2022). Mapping of Indices of Slum and Informal Housing Development in Akure, Ondo State, Nigeria. http://repository.futminna.edu.ng:8080/jspui/handle/123456789/15606.

Akinradewo, O., Aigbavboa, C., Aghimien, D., Oke, A.,and Ogunbayo, B. (2023). Modular method of construction in developing countries: the underlying challenges. *International Journal of Construction Management*, *23*(8), 1344-1354. https://www.tandfonline.com/doi/abs/10.1080/15623599.2021.1970300.

Ali, A. H., Elyamany, A., Ibrahim, A. H., Kineber, A. F., and Daoud, A. O. (2023). Modeling the relationship between modular construction adoption and critical success factors for residential projects in

developing countries. *International Journal of Construction Management*, 1-12. https://www.tandfonline.com/doi/abs/10.1080/15623599.2023.2185940.

Arinabo, D. (2022). Unveiling the role of contextual factors in the evolution of urban floods in Sub-Saharan Africa: Lessons from Kampala city. *Environmental Science & Policy*, *137*, 239-248. https://doi.org/10.1016/j.envsci.2022.09.001.

Azhar, A., Buttrey, H., and Ward, P. M. (2021). "Slumification" of Consolidated Informal Settlements: A Largely Unseen Challenge. *Current Urban Studies*, *9*(3), 315-342. DOI: 10.4236/cus.2021.93020.

Bello, A. O., Khan, A. A., Idris, A., and Awwal, H. M. (2023). Barriers to modular construction systems implementation in developing countries' architecture, engineering, and construction industry. *Engineering, Construction, and Architectural Management*. Vol. ahead-of-print No. ahead-of-print https://doi.org/10.1108/ECAM-10-2022-1001.

Bhandari, S., Riggio, M., Jahedi, S., Fischer, E. C., Muszynski, L., and Luo, Z. (2022). A review of modular cross-laminated timber construction: Implications for temporary housing in seismic areas. *Journal of Building Engineering*, 105485. https://doi.org/10.1016/j.jobe.2022.105485.

Debela, E. B. (2021). An overview of squatter settlements in Addis Ababa, Ethiopia. *Journal of Governance and Development (JGD)*, *17*(2), 77-101.

Farooq, M., Mushtaq, F., Meraj, G., Singh, S. K., Kanga, S., Gupta, A., and Avtar, R. (2022). Strategic Slum Upgrading and Redevelopment Action Plan for Jammu City. *Resources*, *11*(12), 120. https://doi.org/10.3390/resources11120120.

Khan, A. A., Yu, R., Liu, T., Gu, N., and Walsh, J. (2023). Volumetric Modular Construction Risks: A Comprehensive Review and Digital-Technology-Coupled Circular Mitigation Strategies. *Sustainability*, *15*(8), 7019. https://doi.org/10.3390/su15087019.

Mohamed, B. E., Elkaftangui, M., Zureikat, R., and Hiyasat, R. (2023). Design and delivery of national housing in the UAE: an alternative approach. *Frontiers in Built Environment*, *9*. DOI Link. 10.3389/fbuil.2023.1153892. https://zuscholars.zu.ac.ae/works/6004/.

Moreno, E. L. (2003). *Slums of the world: The face of urban poverty in the new millennium?: Monitoring the millennium development goal, target 11--worldwide slum dweller estimation*. UN-Habitat. https://books.google.com.vn/books?hl=en&lr=&id.

Musa, M. F., Yusof, M. R., Mohammad, M. F., and Samsudin, N. S. (2016). Towards the adoption of modular construction and prefabrication in the construction environment: A case study in Malaysia. *Journal of Engineering and Applied Sciences*, *11*(13), 8122-8131.

Musa, M. F., Yusof, M. R., Mohammad, M. F., Mahbub, R., Alam, S., and Com, F. (2014, April). Characteristics of modular construction: meeting the needs of sustainability and innovation. In *Colloquium on Humanities, Science*

and Engineering (pp. 216-221). https://d1wqtxts1xzle7.cloudfront.net/46672384/Characteristics_of_Modular_Construction_20160621-32560-13i07kt.

Oginni A. O., and Mayor-Olabiyitan O. (2017). Container Housing: A Sustainable Approach to Low-Income Housing Provisions for the Urban Slums in Ijora-Badia Lagos. J. of Environmental Science and Resources Management, 9(2), 44-52.

Okafor, M., Iwuagwu, B. U., Onyegiri, I., Okpechi, C., and Ukanwa, O. E. (2023). Evaluation Of Residents' Satisfaction Level With Physical Qualities Of Slum Dwellings In Urban Centres, Abia State, Nigeria. *African Journal of Environmental Research*, *4*(1), 223-242.

Olawumi, T. O., Chan, D. W., Ojo, S.,and Yam, M. C. (2022). Automating the modular construction process: A review of digital technologies and future directions with blockchain technology. *Journal of Building Engineering*, *46*, 103720. https://doi.org/10.1016/j.jobe.2021.103720 .

Sánchez-Garrido, A. J., Navarro, I. J., García, J., and Yepes, V. (2023). A systematic literature review on modern methods of construction in building: An integrated approach using machine learning. *Journal of Building Engineering*,106725. https://doi.org/10.1016/j.jobe.2023.106725.

Solymári, D., Mangera, J., Czirják, R., and Tarrósy, I. (2021). Overview of Kenyan Government Initiatives in Slum Upgrading: The Case of KENSUP and KISIP Projects. *Hungarian J. Afr. Stud.*, *15*, 37.

Uleme, C. (2021). *Slum Upgrading and the Rental Housing Sector: A study of landlord-tenant relationships in a Lagos (Nigeria) slum* (Doctoral dissertation, University of Northampton).

Wuni, I. Y., and Shen, G. Q. (2022). Towards a decision support for modular integrated construction: An integrative review of the primary decision-making actors. *International Journal of Construction Management*, *22*(5), 929-948.

An Assessment of Environmental Quality of Public Residential Estates in Lekki Peninsula, Lagos, Nigeria.

Iniubong S. Adeyemi, Micheal B. O. Adegbile, and Babatunde A. Adeyemi

Department of Architecture, University of Lagos, Lagos, Nigeria
[1]iniubongadeyem@gmail.com

Abstract

The need to improve environmental quality in Public residential states has become an area of concern to housing scholars in developing nations like Nigeria. There has been limited environmental quality analysis adopting empirical research to investigate the built environment in the study area. The aim is to examine the environmental quality of public residential estates in the Lekki peninsula, Lagos, Nigeria, to improve environmental planning and design. The methodology adopted was triangulation. The quantitative aspect had a sample frame of 1542 in three purposively selected estates. A sample frame of 7.5% was adopted as the sample size. In the qualitative approach, a random sample of fifteen respondents in each of the three estates was selected to authenticate the quantitative method. Systematic random techniques were adopted. The quantitative result's Principal components analysis showed four components using the Varimax method of 4.858, 3.419, 1.940, and 1.468. The total variance explained was 77.908%. Though consistent with the quantitative result, the qualitative result revealed a slight emphasis on structural defects as well as a few incidences of building collapse with physical evidence of cracks and dampness on the walls as well as damaged roofs. The slight existence of the incidence of building collapse and the presence of structural defects as harmful to good housing qualities was revealed. The paper suggested that more attention should be given to the structure of the residences, environmental sanitation and frequency of solid waste collection under the housing quality by inclusion in urban environmental policy planning and design.

Keywords**:** *Built Environment, Environmental Quality and Residential Quality.*

1.0 Introduction

The environmental quality of residential estates is an important issue that has a direct influence on the lives of residents (Mazur, Bac, Vaverkova, Winkle, Nowysz and Koda, 2022). Quality of life is a broad concept encompassing environmental quality. The residents' shelter or the lack of it is vital in defining their quality of life (Onifade, 2021). Dai and Chen, (2022) explain that the basic provision of infrastructure, mechanical services and sanitation may have led to the understanding that the quality of life for residents in public residential estates tends to be worse than in private residential estates.

Chu, Fenelon, Rodrigue, Zota and Adamkiewicz (2022), noted that environmental quality being complex involves subjective perceptions and attitudes which vary among residents. Residential estates have a tremendous impact on residents' lives as such the improvement of their quality of life is seen as important. Residential estates mainly consisted of inadequate access to basic services, both social and

physical. The characteristics of urban areas are not limited to lack or inadequate access to basic infrastructure, poor building structures, criminality and unhealthy living conditions (Ojo and Ojewale, 2019).

In various academic literature, related concepts such as livability, quality of life and sustainability have been popular in gaining recognition in policy-making and urban development but environmental quality has varying representation in research, design and environmental policy formulation. Kamp *et al*. (2003), have explored various theoretical environmental quality models relating humans to their environment. These models linked the aspect of the environment to the quality of place and livability relating to the built environment, natural resources, natural environment and public realm. There has been limited environmental quality analysis by way of empirical research to investigate the built environmental characteristics in the study area. The study aims to examine the environmental quality of public residential estates in Lekki peninsula, Lagos, Nigeria. The objective is to explore the quality of the built environmental characteristics in the study area.

1.1 Scope of the study

This study did adopt Kamp *et al.* (2003) environmental quality model to investigate the environmental quality of public residential estates focusing on the Public estates from New Town Development Authority (Table1) in Lekki Peninsula in Lagos State.
This is limited to the fully developed public estates due to the fully constructed and almost complete habitation of the estate as well as serving as a yardstick for further research of government residential estates. The study purposively selected three estates namely Abraham Adesanya, Jakande Estate and Lekki Scheme 1 estates. This study is limited to examining the quality of the built environmental characteristics as well as the public realm in the selected residential estates. The study population is captured from New Town Development Authority 2018 (Table 1) from which the sample size is calculated.

Lekki Scheme I, comprising 17,9372 housing units from New Town Development Authority, 2021 was built in 1981 by the government. It is located at approximately (6^0 26’ 38” N 3^0 28’ 12” E) and is bound by three major roads which serve as arteries in and out of the estate. The major roads branch off into smaller streets and close. The estate being a mixed-use development has various types of buildings.

Abraham Adesanya estate comprising 2,258 housing units from New Town Development Authority, 2018 was built in the early 2000 by the government. It is located approximately on (6^0 27’55” N 3^0 34’ 30” E). The Estate is linear and is laid out in the form of broad numbered roads. The roads serve as major arteries in the road network of the Estate, bounding and delineating it into lettered streets. The buildings are predominantly semi-detached bungalows.

Jakande estate comprising 336 housing units from New Town Development Authority, 2021 was built in 1983 and is located at approximately (6^0 27’ 31” N3^0 36’ 07” E). It is a government estate with residents occupying flats in two-storey buildings. The buildings are arranged in a linear form, with the presence of natural and built characteristics and infrastructure. The Estate is laid out in the

form of broad roads, which serve as the major arteries in the road network of the Estate bounding and delineating the Estate. The major arteries in turn branch out into roads and serve as the link between buildings.

Table 1: List of residential Estates in Lekki Peninsula, Lagos State

s/n	Location	Owner	Scheme Title	Classification	Development Status	Year Designed
1	Eti-Osa	Government	Abraham Adesanya Estate	Mixed-use	Fully developed	Early 2000
2	Eti-Osa	Government	Fairmont Garden Scheme	Mixed-use	Developing	2008
3	Eti-Osa	Government	Idera city scheme	Residential	Underdeveloped	2010
4	Eti-Osa	Government	Jakande housing estate	Residential	Fully developed	1983
5	Eti-Osa	Government	Lekki Peninsula Foreshore	Residential	Developing	2001
6	Eti-Osa	Government	Lekki Peninsula Scheme I	Residential	Fully developed	1981
7	Eti-Osa	Government	Lekki Peninsula Scheme II	Residential	Developing	1995
8	Ibeju _Lekki	Government	Abijo GRA Scheme	Residential	Developing	1997
9		Government	Eko Akete estate	Mixed-use	Underdeveloped	
10	Ibeju _Lekki	Government	Iberekodo industrial Scheme	Mixed-use	Underdeveloped	2011

Source: New Town Development Authority (2021)

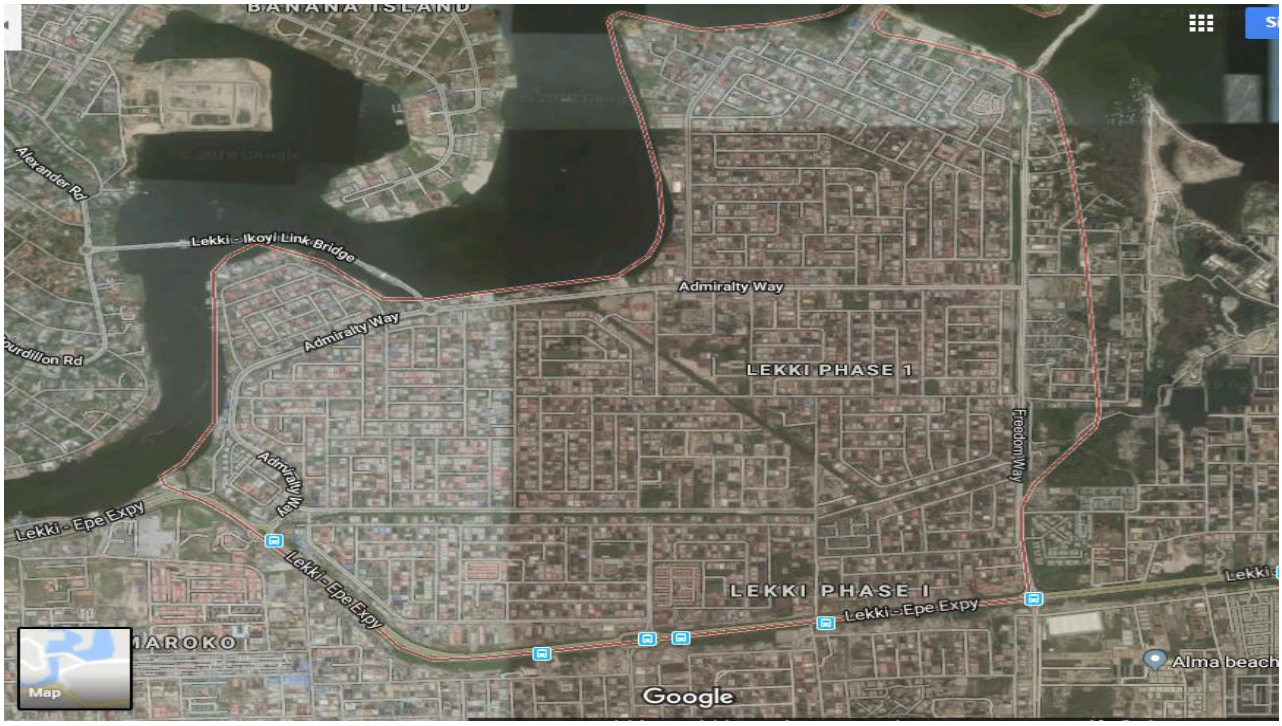


Figure 1.1: Map showing Lekki Scheme 1 Lagos.
Source: Google Maps Imagery (2018)

Figure 1.2: Map showing Abraham Adesanya Estate Lekki Lagos
Source: Google Maps 2018 Imagery

Figure 1.3: Map Showing Jakande Estate Lekki Lagos
Source: Satellite Imagery (2018)

2.0 Literature review

2.1 Understanding Environmental Quality

The concept of environmental quality constitutes all environmental features with phenomena on which residents' existence depends (Onifade, 2021). The importance of improving the quality of life of residents is the first and most important aim of human settlement policy (Mazur *et al.,* 2022). Mbazor (2018), explains that environmental characteristics and conditions of residential estates comprise the major factors that influence the residents' health and overall well-being. The quality of life has to do with a combination of the quality of the environment, which tends to induce in the residents' the feeling of well-being and satisfaction (Onifade, 2021). Development of infrastructure increases diverse environmental quality positively affecting economic growth (Ojo and Amassoma, 2021).

In Nigeria, there has been a continual increase in the urban population. In 1921, 7.8 % of the population lived in urban centres. This rose to 19.3% in 1991, though it is currently more than 75% due to migration in Lagos state (Emodi and Udechukwu, 2021). Lagos State with a rising population has had an increase in residents leading to pressure on the environmental quality of housing (Olotuah, 2016). Research gathered that the Lekki peninsula, t an urban centre that covers parts of Eti-Osa and Ibeju Lekki local government comprising public and private residential estates; this factor being part of the growing strain on residential estates may be of inadequate environmental quality (Durowoju, Edkpay, Popoola and Odiyo, 2018).

Chu *et al.* (2022), explain environmental quality as the result of the quality of composing parts of a given region to include open spaces, natural environment, infrastructure, and physical environment hence the perception of a location as a whole. The affiliation of residential estates and their environmental quality is an essential architectural behavioural question to support complete mental, physical and social well-being (Chu *et al.*, 2022).

2.2 Built Environment

The study of Bird, Ige, Pilkington, Pinto, Petrokofsky, and Burgess-Allen (2022) observed that the built environment is not only a fixed creation shaped by man but includes the infrastructure that supports it. A home perceived as safe and intimate provides major psycho-social benefits. In addition, it enables the development of a sense of identity and attachment as an individual or as a part of a family and provides a space to be oneself. An invasion of external factors or stressors strongly limits this feeling of safety, intimacy, and control, thereby reducing the mental and social function of the home.

Residential estates are mainly characterised by inadequate access to basic services, both social and physical infrastructure (Olotuah, 2016). Olotuah and Bobadoye (2009), advocate that though there are very similar features in various residential forms in Nigeria each tribal group has fashioned its specific distinctive style of residential areas, which is sympathetic to their way of life and their environment. A valuable understanding of their environment is felt by local communities from their local building resources and various methods of putting them to best use. Suffice it to say, that the residential areas will be properly rooted in the socioeconomic, cultural and climatic

situations of the people which originates from their location (Dai and Chen, 2022). Concisely, the built environment in terms of source of annoyance, sanitation, waste disposal and housing quality, comfort will be relevant characteristics to the environment.

2.3 Understanding Residential Quality

Housing is a basic necessity of life that every human being must be provided with (Bashari, Hashim, Samah and Ahmed, 2019)**.** The definition of residential quality means the quality of the internal and external residential building structure (Akinde, 2018). The problems attached to residential quality manifest via poor housing quality and its environment (Bashari, Hashim, Samah and Ahmed,2019). The limited effective policy on socioeconomic characteristics and inefficient infrastructure results in poor residential estates which affects the housing quality (Umeh, Ezeji and Agoha, 2023). Housing quality encompasses the quality of the internal and external structure of a residence and aspects of the internal environment (Mbazor, 2018). The quality of residential estates is an important constituent in the assessment of the built environment within any neighbourhood (Mazur *et al*., 2022). The deficiency in infrastructure such as mechanical services, sanitation, proper sewage and solid waste disposal affects the environmental quality of residential estates (Emodi and Udechukwu, 2021).

Chu *et al.* (2022) explain factors indicating the poor quality of residential estates which are: abnormal room temperature, poor indoor air quality through industrial/chemical fumes, poor sanitation with overflowing bins and semi-solid sewage waste affecting mental health and shorter life span, insecurity of the building structure such as cracks and leakages on the roofs and walls unsafe for living standards, poor shading devices from the outside wall against sunshine, lack of ornamental and green areas in the surrounding to maintain micro-climate, wind-break and to check flooding at the same time. All these should be abated to promote good residential quality.

3.0 Research methods

The triangulation method was adopted. The quantitative approach used three purposively selected estates, Abraham Adesanya, Lekki Scheme 1 and Jakande, estates with 336;17,937 and 2,258 housing units each respectively, which were used as the sample frame. Of these, 7.5% of the total 20,531 housing units were implemented as the sample size for the quantitative approach compared to 5% by Krejcie and Morgan (1970). Systematic random sampling was used to distribute the questionnaires. In the qualitative approach, a random selection of fifteen respondents (heads of households) in each of the three estates was selected to authenticate the quantitative method. The research instruments adopted semi-structured interviews, observational techniques and structured questionnaires.

4.0 Analysis

In the quantitative survey, descriptive statistics and principal component analysis were used. One thousand five hundred forty-two (1542) questionnaires were administered to respondents. The number of respondents who completed the questionnaires was 1429 out of 1542. Jakande's respondents completed 24 out of 26, Abraham Adesanya 154 out of 170 and Lekki Scheme 1,

1,251 questionnaires were returned out of 1,346. The return rate of the questionnaires administered was 92.7%. In the qualitative method, thematic analysis was used.

The mean results (Table 2) showed, that residents moderately agreed with the built environmental characteristics in the public residential estates including available sources of solid waste collection, electrical facilities in good condition, service charges paid for sanitation, presence of structural defects, adequate maintenance of mechanical facilities, presence of noisy areas within and outside the estate, adequate number of bathrooms, presence of environmental cleanliness of the estate grounds, and mechanical facilities are in good state with a mean response rating of 3.98, 3.79, 3.77, 3.54, 3.14, 3.06, 3.04, 3.04, and 2.93 >2.89 (pooled mean).

Table 2: Built Environmental Characteristics in the Study Area

Variable	Mean	SD	Scale	RM	Remark
Available source of solid waste collection	3.98	0.739	4	1.38	High
Electrical facilities are in good condition	3.79	0.791	4	1.31	High
Service charge is paid for the sanitation	3.77	1.330	4	1.31	High
Presence of structural defects	3.54	1.532	4	1.23	High
Adequate maintenance of mechanical facilities	3.14	0.929	3	1.09	High
The presence of noisy areas within and outside the estate	3.06	1.028	3	1.06	High
Adequate number of bathrooms	3.04	0.854	3	1.05	High
Presence of environmental cleanliness of the estate grounds	3.04	0.889	3	1.05	High
Mechanical facilities are in good state	2.93	0.816	3	1.02	High
Adequate number of toilets	2.87	1.221	3	0.99	Low
Adequate maintenance of electrical facilities	2.50	1.124	3	0.87	Low
The existence of incidence of building collapse is evident	2.46	1.189	2	0.85	Low
The frequency of solid waste collection is adequate	2.24	0.591	2	0.78	Low
Good state of plumbing facilities	1.87	0.827	2	0.65	Low
Presence of dislodgement of semi-liquid or liquid waste	1.09	0.453	1	0.38	Low
Pooled Mean	2.89	0.280	3	1.00	Low

Source: Field Survey 2022. n = 1429. SD = Standard Deviation, RM = Relative Mean, Scale: 1 = Strongly Disagree (SD), 2 = Disagree (D), 3 = Moderately Agree (MA), 4 = Agree (A), 5 = Strongly Agree (SA). RM ≥ 1 = High, RM < 1 = Low. Scale Mean = 3.00.

Principal Components Analysis on the quality of the built environmental characteristics in the study area

The built environmental characteristics in the study area were analyzed using exploratory factor analysis (principal component analysis, PCA). Fifteen (15) variables were considered and were analysed individually using PCA. The PCA was carried out based on the varimax rotation method. Only factors having eigenvalue above (1) were considered significant and retained. The cut-off point for item loading was 0.50 and any items below the desired cut-off were not displayed in the results. Before performing principal components analysis, the suitability of data for factor analysis was assessed using KMO and Bartlett's Test.

Table 3: KMO and Bartlett's Test

	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.769
Bartlett's Test of SphericityApprox. Chi-Square	6211.322
df	542
Sig.	.000

(n = 1429).

Table 4: Total Variance Explained

Component Total		Initial Eigenvalues		Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings	
		% of Variance	Cumulative %Total		% of Variance	Cumulative % Total	% of Variance	Cumulative %
1	5.389	35.925	35.925	5.389	35.925	35.925	4.858	32.390	32.390
2	3.442	22.949	58.875	3.442	22.949	58.875	3.419	22.796	55.186
3	1.789	11.925	70.800	1.789	11.925	70.800	1.940	12.935	68.121
4	1.066	7.109	77.908	1.066	7.109	77.908	1.468	9.787	77.908
5	.983	6.554	84.462						
6	.662	4.415	88.877						
7	.555	3.697	92.574						
8	.330	2.202	94.776						
9	.267	1.781	96.557						
10	.195	1.303	97.860						
11	.143	.954	98.814						
12	.069	.463	99.277						
13	.062	.416	99.693						
14	.028	.188	99.881						
15	.018	.119	100.000						
Extraction Method: Principal Component Analysis.									

Inspection of the correlation matrix revealed the presence of significant coefficients of -0.101 and up to 0.898.

KMO and Bartlett's Test

The Kaiser-Meyer-Olkin (Table 3) was 0.769 exceeding the recommended value of 0.50, and Bartlett's Test of Sphericity is statistically significant (p=0.000) at 6211.322 supporting the factorability of the correlation matrix and confirming its suitability for factor analysis

Principal components analysis with the Varimax rotation method revealed the presence of four components with eigenvalues exceeding 1, explaining a total of 32.390%, 22.796%, 12.935%, and 9.787% of the variance respectively; for total eigenvalues of 4.858, 3.419, 1.940, and 1.468. The total variance explained is 77.908%. The four identified components are renamed with the indicated items to constitute the built environmental characteristics in the study area.

Rotated Component Matrix Results Using VARIMAX Method

Based on the rotated Varimax method, the following built environmental characteristics (Table 5) were identified in the residential estates namely: (1) Adequate environmental sanitation (Environmental cleanliness of the estate grounds, Service charge is paid for the sanitation, Electrical facilities are in good condition, Presence of structural defects, Presence of noisy areas within and outside the estate and Incidence of building collapse is evident with factor loadings of .909, .884, .845, -.835, -.769 and -.612 respectively), (2) Adequate mechanical facilities (Mechanical facilities are in good state, Adequate maintenance of mechanical facilities and Available source of maintenance of mechanical facilities with factor loadings of .886, .872, and

.845 respectively), (3) Adequate lavatory (Adequate number of bathrooms, Good state of plumbing facilities and Adequate number of toilets with factor loadings of .841, .788 and .775 respectively), (4) Adequate waste disposal (Dislodgement of semi-liquid or liquid waste, Available source of solid waste collection and The frequency of solid waste collection is adequate with factor loadings of .892, .870 and -.799 respectively).

Table 5: The Rotated Component Matrix

Built Environmental Characteristics	Component			
	1	2	3	4
Environmental cleanliness of the estate grounds	.909			
Service charge is paid for the sanitation	.884			
Electrical facilities are in good condition	.845			
The presence of noisy areas within and outside the estate	-.835			
Presence of structural defects	-.769			
Incidence of building collapse is evident	-.612			
Mechanical facilities are in good state		.886		
Adequate maintenance of mechanical facilities		.872		
Adequate maintenance of electrical facilities		.845		
Adequate number of bathrooms			.841	
Good state of plumbing facilities			.788	
Adequate number of toilets			.775	
Dislodgement of semi-liquid or liquid waste				.892
Available source of solid waste collection				.870
The frequency of solid waste collection is adequate				-.799

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization

Figure 1. The quality of the built environmental characteristics in the study area.

Thematic analysis on constituents of the quality of the built environmental characteristics in the study area

The respondents from public estates (Abraham Adesanya, Jakande and Lekki Scheme 1) said "Yes our number of bedrooms is okay and the present condition of the mechanical and electrical facilities is quite good. Though the service charge is paid for sanitation we still notice that our estate grounds are untidy due to it being a mixed development. "We pay a service charge for sanitation and people clean our surroundings though not as often and properly as we would like. The noise experienced in the estate is very okay though fair outside We are pleased with the number of bathrooms but notice a lot of cracks in our walls. In some instances, some residences were marked harmful for habitation. The plumbing may be okay but poorly maintained which in some cases has affected our toilet use. We noticed dampness on the external walls of our bathrooms and damaged roofs. Commercial activities are all around our estate which constitutes noise in and outside which is near the Lekki -Epe express road with heavy traffic flow. We noticed refuse has been collected though not regularly all the time. That's why the disposal bins seem so untidy at times. We are uncomfortable with the cracks on the walls of our residences. We saw cracks on the external walls of our bathrooms and bedrooms and worried about the stability of our homes.

The coded responses brought about themes: Sources of annoyance, housing quality, sanitation management and waste disposal. The qualitative result of the responses from the public residential estates revealed the importance of housing quality (mechanical and electrical facilities) being relatively good and emphasis on structural defects as well as few incidences of building collapse with physical evidence of cracks and dampness on the walls as well as damaged roofs. These are consistent with the quantitative result. This is graphically illustrated in the NVIVO.

5.0 Discussion

Descriptive Analysis of the Quality of the built environmental characteristics in the study area

The study investigated the built environment in Lekki Peninsula which showed that residents moderately agreed that built environmental characteristics namely housing quality (electrical facilities are in good condition, presence of structural defects, mechanical facilities are in a good state, adequate, maintenance of mechanical facilities and the adequate number of bathrooms), source of annoyance (presence of noisy areas within and outside the estate), sanitation management(service charge is paid for the sanitation, environmental cleanliness of the estate grounds) and waste disposal (available source of solid waste collection).

However, findings showed housing quality (good state of plumbing facilities) as low in the public estates. Furthermore, findings displayed poor housing quality (the presence of structural defects as high in the estates). This shows closer attention is needed to the housing quality of estates in these two aspects as supported by Bashari *et al.* (2019), as planners and designers include these as a significant criterion for evaluating housing quality in line with Akinde (2018) who attributes good quality housing to include adequate space, structural stability and

durability and adequate basic infrastructure.

Inferential Analysis of the Quality of built environmental characteristics in the study area

The result of the PCA grouped the built environmental characteristics in residential estates into factors; Variables were extracted and grouped into four components for the estates. The result identified items under Component 1: Adequate environmental sanitation (Environmental cleanliness of the estate grounds, Service charge is paid for the sanitation, Electrical facilities are in good condition, Presence of structural defects, Presence of noisy areas within and outside the estate and Incidence of building collapse is evident, Component 2: Adequate mechanical facilities (Mechanical facilities are in a good state, Adequate maintenance of mechanical facilities and Available source of maintenance of mechanical facilities, Component 3: Adequate lavatory (Adequate number of bathrooms, Good state of plumbing facilities and Adequate number of toilets, Component 4: Adequate waste disposal (Presence of dislodgement of semi-liquid or liquid waste, Available source of solid waste collection and The frequency of solid waste collection is adequate.

The study showed items in component 1 that occurred namely, *Environmental sanitation, service charge paid for sanitation, electrical facilities are in good condition, presence of structural defects, presence of noisy areas within and outside estate grounds and the existence of incidence of building collapse.* This showed these built environmental characteristics as the most prominent in the residential estates in the Lekki Peninsula. The presence of structural defects and incidence of building collapse are items that are not good housing qualities as they can affect the total health, safety and well-being of the residents. The standpoint of Bird *et al*. (2022) supported that the deplorable housing quality in Nigeria has manifested in structurally unsound and substandard residences. This is substantiated by Emodi and Udechukwu (2021), explaining good housing quality includes adequate space, safety and structural stability.

6.0 Conclusion

The summary of the results showed moderate agreement to the presence of environmental sanitation, service charge paid for sanitation, low frequency of the source of solid waste collection, moderate agreement to the presence of structural defects and the incidence of building collapse are the most significant factors. Building collapse and the presence of structural defects are some of the significant factors showing poor housing quality. Residential estates in the Lekki Peninsula should provide a structurally sound home for the residents' comfort, health and well-being.

7.0 Recommendations

It is suggested that the public residential estates in Lekki Peninsula should provide structurally sound homes paying closer attention to the adequate maintenance of mechanical facilities, and repair of damaged roof structures, and cracks in the walls, for the residents' comfort, health and well-being. The paper affirmed that more attention must be given to the structure of the residences, environmental sanitation and frequency of solid waste collection so as to enhance

the housing quality. These would directly affect the environmental quality of residential estates in the Lekki Peninsula.

References

Akinde, J.O. (2018). A comparative analysis of residential quality estates of public and private estates in an urban centre of Lagos, Nigeria: A case study of Iba Estate in Ojo and Unity Estate in Alimosho. *Journal of geography and regional planning. 11*(4), 46-60. doi:10.5897/JGRP2017.0659

Bashari, S., Hashim, A. H., Sama, A.A. and Ahmed, N. (2019). Residential environmental livability in Nigeria: An overview*. International journal of humanities and social science. 9*(4),11. doi:10.30845/ijhss. v9n4p11

Bird, E.L., Ige, J.O., Pilkington, P., Pinto, A., Petrokofsky, C. and Burgess-Allen, J. (2018). Built and natural environment planning principles for promoting health: An umbrella review. *BMC Public Health.18*, 930. doi:10.1186/s12889-018-5870-2

Chu, M.T., Fenelon, A., Rodriguez, J., Zota, A.R. and Adamkiewicz, G. (2022). Development of a multidimensional housing and environmental quality index (HEQI): application to the American housing survey. *Environmental health. 21*(1),56. doi:10.1186/s12940-022-00866-8

Dai, H.K. and Chen, C. (2022). Air infiltration rates in residential units of public housing estate in Hong Kong. *ScienceDirect. Building and Environment. 219*,109211. doi: 10.1016/j.buildenv.2022.109211

Durowoju, O., Edokpayi, J.N., Poopola, O. and Odiyo, J.O. (2018). Health risk assessment of heavy metals on primary school learners from dust and soil within school premises in Lagos State. Nigeria. *Heavy metals.*74741.doi:10.5772/intechopen. 74741

Emodi, E.E and Udechukwu, E.I, (2021). Quantity of residential housing units as they impact on environmental quality of Enugu, Nigeria. *Iconic Research and Engineering journals. 4* (9), 6-17.

Kamp, I. V., Leidelmeijer, K., Marsman, G. and Hollander, A. (2003). Urban environmental quality and human wellbeing: Towards a conceptual framework and demarcation of concepts; a literature study. *Landscape and Urban Planning.65*(1-2), 5–18.

Krejcie, R.V., and Morgan, D.W. (1970). Determining sample size for research activities. *Educational and psychological measurement. 30*, 607-610.

Mbazor, D.N. (2018). Assessment of housing quality and environmental conditions in selected areas in Akure, Nigeria. *International Journal of Development and Sustainability*.*7* (3), 1049-1061.

Mazur, L., Bac, A., Vaverkova, M.D., Winkler, J., Nowysz, A. and Koda, E. (2022). Evaluation of the quality of the housing environment using Multi-Criteria analysis that includes energy efficiency: A review. *Energies*.*15*(20), 7750. doi:10.3390/en15207750

Ojo, A. E. and Amassoma, D. (2021). Infrastructure development, environmental quality and economic growth in Nigeria. *Journal of Infrastructure Development*.*13*(2), 129-144. doi:10.21203/rs.3.rs-1028066/v1

Ojo, A. and Ojewale, O. (2019). Urbanization and crime in Nigeria. *Palgrave Macmillan.* 1-11. doi:10.1007/978-3-030-19765-0

Olotuah, A.O and Bobadoye, S.A. (2009). Sustainable housing provision for the poor: A review of public sector intervention in Nigeria. *The built and human environment review*. *2*, 51-63.

Olotuah, A.O. (2010). Housing development and environmental degradation in Nigeria. *The built and human environment review. 3*, 42 -48.

Olotuah, A.O. (2016). An appraisal of housing and neighbourhood quality in residential estates in Akure, Nigeria. *Mediterranean Journal of Social Sciences. 7*(3), 424. doi:10.5901/mjss. 2016.v7n3s1p424

Onifade, V. (2021). The effects of residential environmental factors on residents' housing satisfaction in Ogun State, Nigeria. *Ghana Journal of Geography*.*13*(2), 232-258. doi:10.4314/gig. v13i2.9

Boge, F. I. (2021). From Local community to modern conurbation: The development of Lekki Peninsula of Lagos, 1950-1981. *South Asian Journal of Social Sciences and Humanities. 2*(2), 38-53. doi:10.48165/sajssh.2021.2204

Umeh, K.N., Ezeji, K.E. and Agoha, B.O. (2023). The engagement of built-environment professionals, a factor for improving housing transformation in public housing estates in Owerri, Nigeria. *COOU African Journal al of Environmental Research*. *4* (1),1-10.

The Condition of Private Convenience of Residences of Incremental Housing in Ibadan

Jimoh, U. U and Popoola T. M.

Department of Urban and Regional Planning, University of Ibadan, Nigeria
Corresponding Author: jimoluadams@gmail.com

Abstract

The study examines the condition of private convenience on residences of an incremental housing stock in Ibadan. Cross-sectional survey research design was adopted, while both primary and secondary data were utilized. A multi-stage sampling technique was adopted in which eleven (11) Local Government Areas (LGA) constituting, peri-urban and urban areas were delineated. From the eleven (11) Local Government Areas, two (2) Local Government Areas were selected (1 peri-urban area from each LGA). Subsequently, a copy of the structured questionnaire was administered to the household heads in 184 sampled incremental housing in the study area. Furthermore, an observational checklist was used to complement the data. The result shows that the majority (37.5%) of the people in the area, were low-income (₦30,001-₦60,000) earners. About 28.00% indicated that the condition of the toilet was poor. location of private convenience has a significant impact on the health of the residents (F= 0.003). Convenience in incremental housing is adjudged to be poor due to poor planning. Therefore, adequate facilities planning is suggested.

Keywords: *Private Continence, Incremental Housing, Peri-Urban Area, Ibadan.*

1.0 Introduction

Urbanization, among all global phenomena, is one of the oldest that shapes how people live, play and work (Aduwo et al., 2016; Streule et al., 2020). UN-Habitat (2010) declares that more than 50% of the world's population lives in cities and it is envisaged that by the year 2050, 70% of the world's population will be living in cities and this will mostly take place in developing countries. Scholars have reported that Nigeria has been identified as the most populous nation in Africa, with a growing population of over 150 million and over a hundred cities (Oluseyi, 2006; Akintande *et al.,* 2020). Cities, like Ibadan, in the developing nations are experiencing an increase in housing and land needs, owing to an increase in urbanization (Oluseyi, 2006; ADBG, 2022). Rapid urbanization appears to restrict access to the formal land market and exacerbates housing needs, urban poverty, tenure insecurity and the development of squatter settlements (Cohen, 2006; Agbola and Agunbiade, 2009). This is because housing caters to human biological (clean air and water) needs, and psychological needs (satisfaction, contentment, prestige, privacy, choice, freedom, security and social interaction with others, human development, and cultural activities) among others (Olotuah, 2009).

In order to address the housing needs of an ever-increasing restricted housing market, owing to the low-income status of the people and poor marginal propensity for saving, individuals need to embark on progressive building, otherwise known as incremental

housing. Smet (2021) articulated incremental housing as the process by which a shelter is constructed step by step and improved over a period of time in terms of quality and size. This is so common in developing economies, particularly in sub-Saharan Africa, where an average income is less than one dollar (1$) per day. In Ibadan, for example, especially in the peri-urban areas, incremental housing is very common. As the building is in progress, the builders first develop a room or two rooms for the family, then gradually develop or erect a place within or outside the building where their convenience is provided in the building plan (Alabi *et al*., 2021). Due to the non-availability of resources or income, the owner of the building might consider constructing or erecting a temporary shed either with block, plank, clothing or roofing sheet to serve as their place of convenience before the main building is completed.

Convenience may be used to refer to a public toilet in the British parlance. However, by extensional usage particularly in Nigeria, it has generally been used to have the same meaning as a private toilet but distinguished by what type of convenience whether private or public. For ease of understanding, the word in this article is used to refer to convenience as a private toilet which is normally located in the house for domestic use. Given this therefore, convenience can be a small room, used privately for accessing the sanitation fixture for urination and defecation, or a place for bathing, dressing and defecating (Campbell, 2006).

The provision of convenience is crucial for public health and accessing convenience has been referred to as a barometer of civilization (Stanwell-Smith 2010; Wilson and Thomson, 2021). Promoting access to convenience can prevent human faecal pollution, decrease pathogen exposure, and promote good health outcomes in adolescents during growth and development (WHO, 2022). High infant mortality rates, due to household crowding and the non-availability of adequate convenience facilities in most dwellings, inevitably lead to poor health (Hassan, 2000). One basic factor to be considered when considering this state of health is the availability of basic facilities such as bathrooms, kitchens, and conveniences among others in most houses. (Jinad, 2007). The diseases associated with poor sanitation that are, particularly, correlated with poverty and infant mortality, alone account for about 10% of the global burden of disease (Prüss-Üstün *et al*. 2008). At any given time, close to half of the urban populations of Asia, Latin America and Africa, have a disease associated with poor sanitation, hygiene, and water. Of human excreta, faeces are the most dangerous to health (WHO, 2016). There is a wealth of research on the effects of convenience facilities on the health of housing and many have found that toilet accessibility is closely linked to adolescents' health outcomes (Nallari, 2015; Ramani *et al*. 2017; Soeiro *et al.* 2021). For instance, a case study from Bengaluru, India, revealed that adolescent girls who lack access to convenience have to use open defecation, which makes them prone to reproductive tract infections, urinary tract infections, and snake bites (Nallari, 2015).

In addition, the findings from Ramani *et al.* (2017) study in India on school-going adolescents indicated that access to toilets could significantly reduce incidences of diarrhoea. Also, an empirical investigation conducted by Soeiro *et al.* (2021) in Venezuela on menstrual health hygiene issues among adolescents and young women revealed that lack of convenience accessibility

could increase sexual violence and negatively affect the physical and psychological health of young women and female adolescents. Similarly, the study that was carried out by Camenga *et al.* (2019) on the prevention of lower urinary tract symptoms research consortium in the United States revealed that restricted convenience use might significantly influence bladder health among adolescents.

Despite the aforementioned studies, there is still a dearth of empirical investigation on the condition of private convenience on the residences of incremental housing in Ibadan. This is what the study set out to do. The specific objectives are to investigate the condition of private conveniences in the study area and to investigate the effect of private convenience on the residents in the study area.

2.0 Study area

Ibadan is the capital city of Oyo state in Nigeria; the city is located in the Southwestern part of the county. It is located approximately between longitudes 3°53′ and 4°10′ East of the Greenwich Meridian and latitudes 7°22′ and 7°40′ North of the Equator at a distance of some 145 kilometres east of Lagos. Ibadan subsequently became a war camp by 1829 for warriors coming from Oyo, Ife and Ijebu (Mabogunje, 1962). The city is located at an elevation of 234 meters above sea level and it is situated on gently rolling hills running in a Northwest/Southwest direction (Agbola, 2000). The city succeeded in becoming a large empire from around the 1860s to 1890s. Ibadan witnessed rapid growth when it became the Western Province Headquarters in 1939. The built-up area of Ibadan was said to be 38.85sq/km in 1935, 46.40sq/km in 1955, 77.7 sq/km in 1965 and 152.80 sq/km in 1988. By the year 2000, it is estimated that Ibadan covered 400sq/km, out of which the urban local government areas cover about 463.33km². The city of Ibadan is made up of eleven (11) local government areas (LGAs), five (5) of which constitute the urban local governments, while the remaining six (6) form the peri-urban or rural local governments (see Figure 1). The 2006 provisional census figures put the population of Ibadan at 2,550,593 (1,338,659 urban and 1,212,294 rural) (National Population Commission, 2010). Ibadan is characterized by an annual fluctuation of temperature of about 6 °C (Oguntoyinbo, 1994).

Conveniences in the study area, are located separately from the main building and different from each other, based on their income capabilities, but the study majorly focused on those conveniences which are located in incremental housing within the selected area of the study in Ibadan. Rapid urbanization has accelerated the process of uncontrolled expansion of urban areas beyond their physical limits in a process known as sprawling. This is because little or no attention was paid to improving the poor urban planning and housing conditions in the traditional cities. After independence came the boom era, which ushered in rapid occupation of the core area thereby leading to the evolution of unplanned residential neighbourhoods characterised by a lack of adequate access to basic social amenities (Olujimi, 2009)

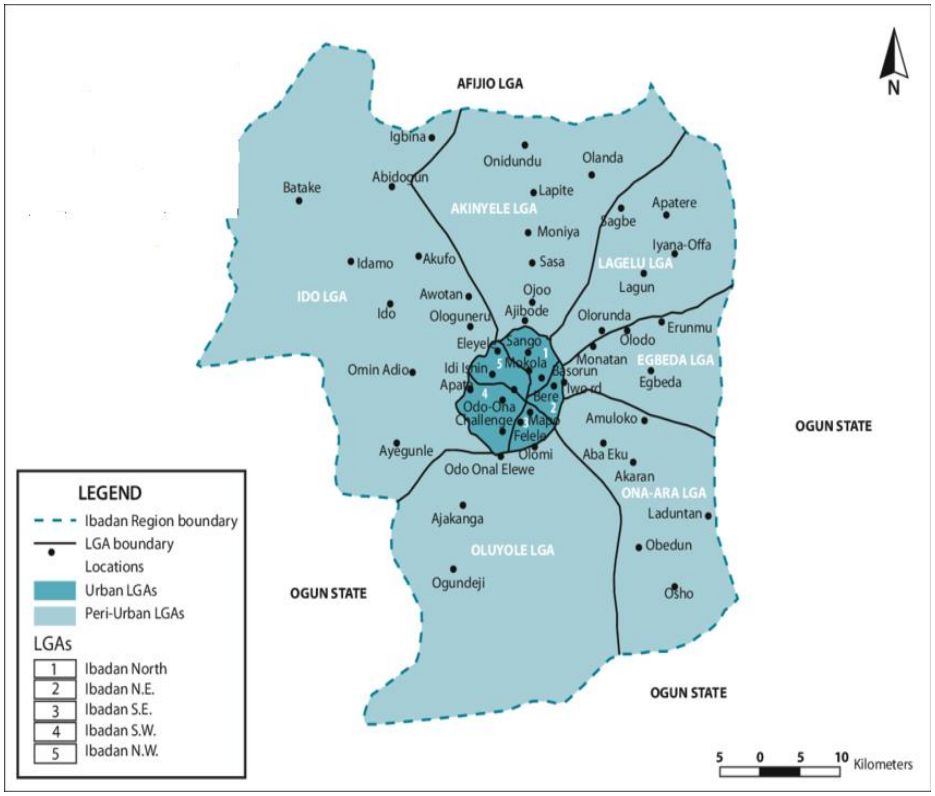


Figure 1: Map of Ibadan in the context of Oyo state
Source: Oyo State Ministry of Land and Survey (2021).

3.0 Methodology.

A cross-sectional survey research design was adopted, while both primary and secondary data were used for the study. A multi-stage sampling technique was adopted in which eleven (11) Local Government Areas (LGA) constituting, peri-urban and urban areas as delineated by Oyo State Ministry of Lands and Survey. From the eleven (11) Local Government Areas, two (2) Local Government Areas were selected, and subsequently, 1 peri-urban area was taken each from the selected LGAs. At the end, a copy of the structured questionnaire was administered systematically to the heads of households in 184 sampled incremental housing units in the study area. The reason for the choice of household head was premised on the fact that they are abreast with the history of housing construction and thereby would be able to give the required information necessary for the study. Issues that were investigated include; socio-economic characteristics, types of buildings, condition of convenience in the incremental housing and the effect of convenience in the incremental houses.

Furthermore, an observational checklist was used to complement the data. The checklist was used primarily to obtain data on the physical attributes of the incremental housing. Both descriptive and inferential (simple regression model) statistics were used to analyze the data at P= less than or equal to 0.05.

4.0 Results and Findings

Socio-Economic Characteristics of the Respondents

This section presents the socio-economic characteristics of the respondents in the study area (Table 1). Concerning the age of the respondents, the majority (28.80%) of the people were between the age range of 46 and 60

years, followed closely, by ages between 61 years and above accounting for 28.26%. The proportion of the respondents who are aged between 31 and 45 years accounted for 26.63%, and the least age range between 18 and 30 which accounted for 16.3%. Regarding the marital status of the respondents, married people accounted for the highest percentage (52.72%) in the distribution, widows/widowers were 21.0%, separated were 14.6%, and singles accounted for the least with 12.5%. On the family size of the respondents, those without children accounted for 11.96%, those between 9-12 were 23.37%, those who were lesser than 5 accounted for 28.26% and those whose family size was between 6-8 constituted the majority, accounting for 36.41%.

Furthermore, an investigation of the occupation structure of the respondents revealed that farmers constituted 17.39%, 20.65% were civil servants, traders were the majority, accounting for 39.67%, while others with different professions (drivers, artisans, company workers etc.) were 22.28%, Regarding, the educational status of the respondents, the study revealed that 15.7% were university graduates, 18.49% had secondary school education, 29.35% were primary school-leavers, while majority (30.98%) of the respondents had no formal education. Moreover, on the income structure of the respondents, it was discovered that those who earned between ₦90,000 and above, were 10.33%, followed by those with an income level of ₦60,001-₦90,000 which accounted for 18.49% respectively. The proportion of respondents whose income was below ₦30,000 accounted for 33.7% while the majority (37.5%) earned between ₦30,001–₦60,000.

This section presents the types of incremental buildings with regard to the convenience attached to them, in the study area. About 13.59% were flats, 17.39% were duplexes, 18.49% were multi-storey buildings while the majority of the buildings were Brazilian (face to face) with (50.54%). Regarding the part of the building that was completed at the time of the study and in ascending order, the building which had only one room completed accounted for 21.20% followed by the building which had two rooms completed accounted for 38.05%, while the majority (40.76%) of the building had other part (kitchen, toilet) of the building completed.

Table 1: **Socio-economic Characteristics of the Respondents**

Socio-economic variables	Variables	Number of Respondents	Percentages	Total
Age group	18-30	30	16.30	**184**
	31-45	49	26.63	
	46-60	53	28.80	
	Above 61	52	28.26	
Marital Status	Single	23	12.50	**184**
	Married	97	52.72	
	Separated	27	14.67	
	Widow/Widower	37	21.00	
Family Size	Less than 5	52	28.26	**184**
	6-8	67	36.41	
	9-12	43	23.37	
	No Child	22	11.96	

Occupation	Civil Servant	38	20.65	**184**
	Trader	73	39.67	
	Farmer	32	17.39	
	Others	41	22.28	
Educational Status	No Formal Education	57	30.98	**184**
	Primary	54	29.35	
	Secondary	34	18.49	
	Tertiary	29	15.76	
Income Status	Below ₦30,000	62	33.70	**184**
	₦30,001 - ₦60,000	69	37.50	
	₦60,001 - ₦90,000	34	18.49	
	Above ₦90,000	19	10.33	

Source: Authors Field Survey (2022)

Taking into consideration the materials used, the buildings that were constructed with bricks had 12.5%, followed by others (wood, roofing pan) which constituted 17.39%, while buildings that were constructed with blocks constituted the majority (70.11%). The condition of the building was also considered in the study area; buildings that were half-plastered accounted for 17.39%, followed by 22.28%, for the buildings that were completely plastered. The unplastered buildings accounted for 29.35%, while the majority (30.99%) of the buildings were partly plastered, either front or side or back. Investigation on infrastructure availability revealed that 48.37% of the buildings had infrastructural facilities such as water, and lights, while those buildings without infrastructural facilities accounted for 52.63%.

Condition of Convenience in the Incremental Building

The section, as data captured in Table 3 presents the condition of convenience in incremental housing in the study area. The Investigation revealed that incremental buildings with conveniences accounted for 51.53% while incremental housing without conveniences accounted for 48.37%. Therefore, more than half of the buildings had conveniences. With regard to the materials with which the conveniences were constructed, it was revealed that 30.97% used corrugated iron sheets for the construction of their convenience, followed by those who used blocks for construction which accounted for 23.37% while others accounted for 13.05%. The majority used wood with 32.61%. This explains the income status of the owner of the building, due to the material used for the construction of the convenience.

Table 2: **Types of Building in the Incremental Building**

Building Characteristics	Variables	Number of Respondents	Percentages	Total
Type of Building	Flat	25	13.59	**184**
	Row (Brazilian Face to Face)	93	50.54	
	Storey Building	34	18.49	
	Others	32	17.39	
Part of the building completed	One room	39	21.20	**184**
	Two room	70	38.05	
	Others	75	40.76	
Material used for the building	Brick	23	12.50	**184**
	Block	129	70.11	
	Others	32	17.39	
Condition of Building	Whole plastered	41	22.28	**184**
	Unplaster	54	29.35	
	Partly Plastered	57	30.99	
	Half Plastered	32	17.39	
Infrastructure Availability	No	89	48.37	**184**

Source: Authors Field Survey (2022)

Furthermore, the investigation was made on the condition of conveniences in the study area. It was observed that 21.74% were in good condition, and 23.37% were in fair condition. Those that were in bad condition accounted for 27.17%, while the majority (27.72%) were in poor condition. Regarding the degree of cleanliness of the convenience facilities in the study area, 16.85% were very clean, 21.20% were clean, 27.72% were dirty, and the majority (34.24%) of the convenience was fairly clean. With respect to the issue of the method used in the defecation in the study area, those whose method of defecation was 'shot put' or open defecation accounted for 13.59%, this was closely followed by 18.48% for those who used water closets. Those who were using the potty accounted to be 26.09% while the majority of the respondents used the squatting method of defecation (41.85%). Moreover, how often the cleaning of the convenience after usage was also investigated. The proportion of the respondents who do not clean their convenience at all accounted for 16.31%, followed by 24.46% by those who do it once a month. Those who clean it once a week accounted for 28.80%, while those who clean their toilet anytime they feel like it constituted the majority (30.44%).

A study was also conducted on the safety of the conveniences during the rainy season or nighttime. About 17.94% of respondents were very safe using their conveniences, 21.74% were safe to use their conveniences, followed by 28.81% were fairly safe to use their conveniences, while the majority (31.52%) were not safe to use their conveniences during nighttime or rainy time because the location of the convenience is not inside the house and it was majorly built with wood and was not covered. Thus, the fear of unknowns in the darkness would deter them from using the conveniences during nighttime.

Table 3: **Condition of Private Convenience in the sampled Incrementally Developed Building**

Investigated Variables	Variables	Number of Respondents	Percentages	Total
Availability of Private toilet	Available	89	48.36	
	Unavailable	85	46..64	**184**
Classification of toilet	Toilet without water	114	61.96	
	Toilet with water	51	27.72	**184**
	No response	19	10.33	
Material used in the construction of the toilet	Wood	60	32.61	
	Concrete Block	43	23.37	
	Roofing Pan	57	30.97	**184**
	Others	24	13.05	
Condition of the toilet	Good	40	21.74	
	Poor	51	27.72	
	Fair	43	23.37	**184**
	Bad	50	27.17	
Level of cleanliness of the toilet	Very clean	31	16.84	
	Clean	39	21.20	
	Fairly clean	63	34.24	**184**
	Unclean/Dirty	51	27.72	
Method of usage of the toile	Sitting on it	34	18.48	
	Squatting	77	41.85	
	Using of potty	48	26.09	**184**
	Others	25	13.59	
Frequency of toilet cleanliness	Once a week	53	28.80	
	Once a month	45	24.46	
	Anytime	56	30.44	
	Others	30	16.31	
Perceived level of safety of toilet	Very safe		17.94	
	Safe		21.74	
	Fairly safe		28.81	
	Unsafe		31.52	

Source: Authors Field Survey (2022).

5.0 Effect of Convenience on the Incremental Building

As presented in Table 4, the investigation of the effects of convenience in incremental housing was made. This was to document whether the respondents had encountered any form of toilet disease due to the use or lack of toilet facilities. More than half (50.54%) of the respondents had encountered one sickness or the other. Concerning the type of disease diagnosed, 24.46% were diagnosed with gonorrhoea, 25.00% were diagnosed with cholera, and 25.54% were diagnosed with diarrhoea, constituting the majority. The results validate the work of Ramani *et al.* (2017). When asked how the disease was being treated in the study area, the majority (32.24%) depended on herbal medicine, 32.07% depended on self-medication, less than one quarter (19.02%) depended on orthodox medicine, while 14.67% placed their treatment on faith-based (spiritual means through traditional or religious houses). The next was how often they went for treatment

when they were sick, 13.04% of the respondents were every month, 18.48% were twice a year and 17.94% were yearly. A majority (50.54%) of the people never went for treatment. Finally, issues on the measures put in place to stop the spread of disease in the study area were investigated. About 20.11% went for medical check-ups. Those who were enlightened by their family members constituted 26.63%. Some who believe that rearing animals or caging them to stop the spread of disease accounted for 25.54%, while the majority (27.72%) engaged in toilet cleansing

5.0 Discussion

Regarding the socio-economic characteristics of the respondents, the results imply that the population within the active age group has the capability to have savings due to their involvement in one form of occupation or the other, thereby making it possible for them to embark on gradual housing. Besides, some members could take facilities or loans to embark on building construction, since most of the credit facilities may not be enough to build in one movement, it became necessary to embark on the gradual construction of their houses (World Bank 2020). The high incidence of married people in the study area is a reflection of their need for accommodation to keep their families (Agbola and Agunbiade, 2009), while the large sizes of families with corresponding low income negatively impact the saving for housing, which explains, the observed reason of incremental housing. (Agbola and Agunbiade, 2009).

.

Table 4: Effects of Convenience in the sampled Incrementally Developed Building

Investigated Variables	Variables	Number of Respondents	Percentages	Total
Have you encountered any form of diseases	Yes	89	48.36	**184**
	No	85	46..64	
Type of disease exposed	Diarrhea	47	25.54	**184**
	Cholera	46	25.00	
	Gonorrhea	45	24.46	
Method of treatment adopted owing to the toilet disease infection or exposure	Herbs	63	34.24	**184**
	Consulting of doctor	35	19.02	
	Self-medication	59	32.07	
	Others	27	14.67	
Frequency of medical check-up	Monthly	24	13.04	**184**
	Twice a year	34	18.48	
	Yearly	33	17.94	
	Never gone before	93	50.54	
Measure put in place to prevent or stop the spread of disease and infection	Family sensitization	49	26.63	**184**
	Toilet cleaning	51	27.72	
	Medical check-up	37	20.11	
	Others	47	25.54	

Source: Authors Field Survey (2022).

On the occupational structure, the results imply that, since the majority of the respondents were traders, it is possible that the little profit margin made, could be invested into the gradual construction of building of their own. The study is supported by Adeyeni *et al*. (2016). On educational status, there is always a correlation between illiteracy and poverty, where access to credit facilities may be difficult, thereby using little annual savings to embark on gradual construction. Regarding the income, it implies that the amount of monthly income earned by the majority may not be sufficient to complete a building project in one movement, as a result of the prevailing market price of building materials. Hence there is a need for progressive housing. The work is also validated by Adeyeni *et al*. (2016).

Furthermore, an investigation of the conditions of convenience in the incremental building shows that the observed predominance of the Brazilian type of building can be attributed to its cheapness and ease of construction compared to other types of buildings; this is buttressed by Olayiwola (2012). The result is a reflection of the low-income status of the people. Despite the gradual process involved in the construction, almost half of the respondents could not complete the conveniences. This aspect may also be attributed to available funds and the priority given to which part of the building. It is not impossible to see such people resort to open defecation. This implied that other parts of the building developed incrementally were used for other purposes (Smet, 2021).

With respect to the conditions of conveniences in the incremental housing, the predominance of poor conveniences in the study area has a direct link to the poor level of income of the respondents. This consequently has implications on the health of the people, since poor convenience facilities will promote toilet diseases (WHO, 2022). The majority of the respondents could not plaster their convenience, because the owners of the building were low-income earners. This concurs with the work of Adeyeni *et al.* (2016) where it was observed that developers could not afford to plaster all the buildings at once. The same is true of the kind of blocks used.

The use of local materials like locally made blocks was premised on how easy it is to get and how cheap in terms of construction work, and also given the fact that the respondents were low-income earners (Adeyeni *et al.* 2016). Classification of convenience based on water facility availability was also considered in which the majority of the conveniences investigated had no water. The implication is that it will make it difficult for users to flush after usage. The effects may even be more in the dry season, a situation that has some negative consequences on the health of the respondents (WHO, 2022).

With respect to the effect of convenience on the residents, there is a direct correlation between dirty conveniences and diseases, especially where there is a high occupancy ratio coupled with a poor maintenance culture, the spread of the disease may be more severe, having a negative effect on health (WHO and UNICEF 2021).

The implication of the higher percentage of respondents using other methods of defecation apart from water closets was that, they have a higher probability of contracting diseases. This is corroborated by WHO (2019). Any

toilet left unclean after use will become a breeding site for agents of disease, thereby having health implications for the users (WHO and UNICEF 2021). The scenario can be attributed to the low-income status of the respondents as earlier mentioned in this study and the importance given to the facility in the building process (Adeyeni *et al.* 2016).

Continual diagnosis of toilet diseases is an indication of the negative effects of the type of convenience that is prevalent in the study area. By extension, this also accounts for why the respondents were engaged in all forms of treatment other than orthodox medicine, thereby relying on natural herbal medicine due to their low-income status. The assertion validates the work of Adeyeni et al. (2016). The result suggests why most respondents have not been able to trace their diseases to the use and types of convenience facilities in relation to cleaning the toilet.

Table 5: **Output Table for Inferential Analysis**

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	.000	1	.000	.003	.960a
Residual	17.826	182	.098		
Total	17.826	183			

Source: Authors Fieldwork (2022)

Hypothesis Testing

The Hypothesis which states that private conveniences in incremental houses do not have an effect on the health of the residents was set up (see Table 5). The data were transformed into dummy variables for ease of recognition by the SPSS package. By using numerical values of the regression coefficient “r” taking the values between -1< r < +1 to validate the hypothesis, whether there is a significant relationship between the two variables. The significant relationship of F= 0.003 is a strong value, which is far from 1. The implication is that; private convenience has a strong tendency of causing disease that could affect the people living in the incremental housing in the study area.

6.0 Conclusion and Recommendation

Evaluation of private conveniences of the residents of incremental housing in Ibadan has been found to have a negative impact on the respondents. This is evident in the number of diseases associated with private conveniences in incremental housing (diarrhea, cholera, and gonorrhea). It is recommended that effective planning design and monitoring of approved building plans in the peri-urban area should be enhanced by the Local Planning Authority, for the people in the study area in order to have a better quality of life and to be free from various kinds of diseases. The solutions provided include the construction of private conveniences for their conveniences, they should also disengage in open defecation, improving of sanitation environment, cleanliness of their private convenience, regular cleaning after usage, using non-contaminated materials for their conveniences, consulting health practitioners regularly in order to check their health status.

References

Adeyeni, G., Olayiwola, L. and Oladehinde, G. (2016). Challenges to Incremental Housing Development in Ibadan Municipality, Nigeria, *Asian Research Journal of Arts & Social Sciences, 1*(4), 1–10.

Aduwo, E., Edewor, P. and Ibem, E. (2016). Urbanisation and Housing for Low-Income Earners in Nigeria: A Review of Features, Challenges and Prospects, *Mediterranean Journal of Social Sciences, 7*(3S1), 347–357.

Agbola, T. and Agunbiade, E. (2009). Urbanisation, slum development and security of tenure: the challenges of meeting Millennium Development Goal 7 in Metropolitan Lagos, Nigeria. In A. de Sherbiniin, A. Rahman, A. Barbieri, J.C. Fotso, & Y. Zhu (eds.) *Urban Population-Environment Dynamics in the Developing World: Case Studies and Lessons Learned*. Town of publisher? Committee for International Cooperation in National Research in Demography: page numbers?

Akintande, O., Olubusoye, O., Adenikinju, A., and Olanrewaju, B. (2020). Modeling the determinants of renewable energy consumption: Evidence from the five most populous nations in Africa, *Energy, 206*, 117992.DOI?

Alabi. M., Babalola, T. and Popoola, A. (2021). Tenure insecurity and incremental housing development in the peri-urban interface of Ibadan, Nigeria. *CIDADES, Comunidades e Territórios*. 43(Dec/2021), 185-206. DOI: 10.15847/cct.21000

Angoua ELE, Dongo K, Templeton MR, Zinsstag J, and Bonfoh B. (2018). Barriers to access improved water and sanitation in poor peri-urban settlements of Abidjan, Coˆte d'Ivoire. *PLoS ONE,* 13 (8). 2018. doi: 10.1371/journal.pone.0202928

Camenga DR, Brady SS, Hardacker CT, Williams BR, Hebert-Beirne J, and James AS. (2019). The prevention of lower urinary tract symptoms research consortium. U.S. adolescent and adult women's experiences accessing and using toilets in schools, workplaces, and public spaces: *Int J Environ Res Public Health*.;16, 3338.

Campbell, L. (2006). Historical Linguitics: An introduction, 2nd ed., Cambridge: MIT Press, p.263, ISBN 978-0-262-53267-9.

Cohen, B. (2006). Urbanisation in developing countries: Current trends, future projections, and key challenges of sustainability, *Technology in Society, 28*(6), 63–80.

Hasan A. (2000). Housing for the poor: Failure of formal sector strategies, Karachi: City Press. 263–98.

Jinad, A.M. (2007). *Understanding the Basics of Housing*: (A Book of study notes for students in Tertiary Institution), Jos University Press.

Mulenga JN, Bwalya BB, Kaliba-Chishimba K. (2017). Determinants and inequalities in access to improved water sources and sanitation among the Zambian households. International Journal of Development and Sustainability, 6(8), 746–762. 2017.

Nallari A. (2015). All we want are toilets inside our homes!" The critical role of sanitation in the lives of urban poor adolescent girls in Bengaluru. India Environ Urban, 27(1), 73–88.

Olotuah O.A. (2009). Demystifying the Nigerian urban housing question. Inaugural Lecture Series 53, Federal

University of Technology, Akure, Nigeria.

Oluseyi, F. (2006). Urban Land Use Change Analysis of a Traditional City from Remote Sensing Data: Case of Ibadan Metropolitan Area, Nigeria, *Humanity & Social Sciences Journal, 1*(1), 42–64.

Olujimi, J. (2009) evolving a planning strategy for managing urban sprawl in Nigeria. *Journal of Human Ecology* 25 3201-208

Prüss-Üstün A, Bos R, Gore F, Bartram J. (2008) Safer water, better health ; costs, benefits and sustainability of interventions to protect and promote health. Geneva: World Health Organization.

Ramani SV, Frühauf T, Dutta A. (2017). On diarrhoea in adolescents and school toilets: insights from an Indian village school study. J Dev Stud. 2017;53(11):1899–914.

Smets P. (2021). Housing finance trapped in a dilemma of perceptions: Affordability criteria for the urban poor in India Questioned. *Housing Studies*. 14(6).

Soeiro R, Rachel L and Costa L. (2021). Period poverty: menstrual health hygiene issues among adolescent and young Venezuela Migrant Women at the Northern Western Border of Brazil. *Reprod Health*, (18): 238

Stanwell-Smith R. (2010). Public toilets down the drain? Why privies are a public health concern. Public Health, 124(11):613–6.

UN-Habitat. (2010). *State of the world's cities 2010/2011: Bridging the urban divide*. Nairobi: United Nations Human Settlements Programme/Earthscan.

World Health Organization (WHO 2022). Estimates of global burden of disease. Available at http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/

World Health Organization (2016). World Health Organization releases country estimates on air pollution exposure and health impact. Geneva: World Health Organization.

World Health Organization. (2019). Sanitation. Accessed May 3rd, 2021 https://www.who.int/news-room/fact-sheets/detail/sanitation.

World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) (2021). Progress on household drinking water, sanitation and hygiene 2000–2020: five years into the SDGs. Geneva: World Health Organization

Virtual Reality: Modernizing Real Estate Marketing Business With 360 Virtual Circuits in Nigeria

Oyewole Clement Oyesomo[1]., Oyewale Joseph Oyedeji[1]. and Kazeem Bolayemi Akinbola[2]

[1]Bells University of Technology, Ota, Ogun State, Nigeria
[2]Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria
Corresponding Author: oyesomos@gmail.com

Abstract

The study assessed virtual reality and how its application can modernize the real estate marketing business in the era of globalization and post-COVID-19 syndrome in Lagos State. The specific objectives of the study include-, identifying the current real estate marketing practice among estate surveyors and valuers in the study area, awareness and barriers to the adoption of virtual reality and users' perception of virtual reality applications in real estate businesses. The study population was Estate Surveyors and Valuers operating in Lagos State and the sampling technique employed was a simple random technique. Data gathered were analyzed using a descriptive approach and results were represented using tables and a 5-point Likert scale. The study revealed that estate surveyors and valuers in the study area market their properties using the traditional strategy, most importantly, the use of banners, distribution of property fliers and social media. It was also gathered that the key barriers to the application of virtual reality were lack of awareness, application cost-in-use and the fear of unacceptability among prospective clients. Based on the findings, it is recommended that the application of virtual reality as a marketing mechanism should be embraced in Estate Surveying and valuation practice as it has an inherent benefit of helping to enhance workers' ease of getting tasks done, such as virtual tours and property showcase in, in the midst of post-COVID-19 syndrome and globalization. Estate surveyors and valuers should embark on rigorous public awareness and enlightenment on virtual reality in order to onboard prospective clients who are not aware of the application and software. This is necessary in order to build public confidence in its genuineness

Keywords *Virtual reality, Compute-Aided Simulation, Traditional Approach, Marketing Tool, Estate Surveying and Valuation.*

1.0 Background to the study

All over the world, partly due to the advancement of technological breakthroughs, especially as it is being witnessed in the most recent times, the business of real estate marketing has evolved, of course, this cannot be outrightly divorced from the momentum of the fourth industrial revolution (Nieradka, 2019), on the other hand, the trend is being fuelled by the emergence of the global health crises as emasculated by the 2020's COVID-19 pandemic outbreak (Lockdown and movement restriction), all of which have changed the medium of marketing and ways of getting tasks executed have changed drastically across different sectors of the economy. For example, a

series of technological platforms, which have nuanced themselves in the versions of augmented reality, skype, zoom, Google Meeting and of course virtual reality, among other applications, are all becoming increasingly prominent as tools for promoting business ventures and meetings virtually.

Sulaiman, Abdul-Aziz, Bakar, Halili and Azuddin, (2020), observed that traditional real estate marketing strategies, such as; site visits, digital photography, 2D video slideshows, drone photography, and video, are no longer unilaterally effective given the current market conditions, demands and realities. The traditional approach to marketing real estate products- land and landed properties, in the phase of different environmental factors, such as; pandemics, globalization and technological advancements, has been regarded as time-wasting, relatively costly and most often inconvenient to parties who are geographically distanced (Felli et al., 2018). Nilsson (2000) stated that amid the challenges associated with traditional real estate marketing tools, there is a need to integrate computerized media and information technologies in the real estate business, such as virtual reality.

Barak, Perlamn and Sack (2013) corroborated this assertion by identifying virtual reality as a relatively new technology that is making waves across different sectors of the economy. The software makes use of computer-simulated environs and represents its spectres in 3D formats, which could be an array of objects that are being found as either incidents or fields which grants people a sort of mutualism around which a real situation revolves, through the involvement of individual's senses (Barak, Perlamn and Sack, 2013). The authors avowed that in many industries and sectors- movie industry, military aviation and gaming industry, virtual reality and other virtual technology inclined software are the upcoming big things and the situation is not all that different from the real estate, architectural and construction industry (Barak, Perlamn and Sack, 2013).

Bleize and Antheunis (2019) opined that the application of virtual reality for marketing real estate products, - land and landed properties, can enhance the positive attitude of prospective clients if used appropriately. The technology aims at lending support for real estate businesses through what is largely referred to as teleporting, a prism that captures clients /people from anywhere directly to the property that has been listed for sale, lease or rent, whilst helping the client to save time and ease the pressure of physical inspection and money (Deaky and Parv, 2018). Studies have specified that through virtual reality software, users can be immersed in a virtual experience and world via a head-mounted device (HMD) that entails the use of headphones, controllers and other supportive devices that enable its users to steer through the virtual experience seamlessly (Barnes, 2017; Pennington and Bolton, 2019).

Hassanein (2020), described that Virtual reality is one of the top ten important technology trends identified by Gartner for 2019 that is helping to enhance worker's ease of getting tasks done, promoting health and safety in different industries. Pennington and Bolton (2019) noted that its application in the real estate business will be a paradigm shift from the traditional approach of physical inspection of sites to computer-aided simulation that offers its users and operators real-life experience in the comfort of their homes. This corroborates the assertion of Georgiou *et al* (2019), who described that the application of virtual reality in the real estate sector can

significantly help address traditional real estate marketing problems, such as time wastage. Also, in the words of Juan (2018), the software enhances and increases the odds that a client will purchase or rent a listed property having viewed what the property looks like virtually. This is evidenced in the United States of America where 77% of property buyers preferred to have a Virtual reality tour instead of a physical inspection during and after the pandemic (Coldwell Banker Real Estate LLC, 2018).

Hence, in developed nations of the world, for instance, the United States of America and the United Kingdom, the application of virtual technology has received a wide audience in the real estate sector among practitioners given its significance. However, the reason for its low adoption among real estate practitioners/estate surveyors and valuers in developing nations, most importantly Nigeria, is still yet unknown due to the paucity of data in the field. Thus, the current study attempts to address the problem by ascertaining the current marketing practice among Estate Surveyors and Valuers, barriers/reasons for the low adoption of virtual reality for real estate marketing business, users' perception of virtual reality applications in real estate marketing business and ways by which the application of virtual reality can be used to modernize and revolutionize real estate marketing business in Nigeria.

2.0 Literature review

2.1 An Overview of Virtual Reality and Its Application in the Built Environment

Virtual reality is a method that creates a computer-simulated environment by using hardware as well as software components. Whyte (2002), noted that virtual reality is a cutting-edge technology that visualizes a significant amount of complex information, it supports its users' interaction and navigation with virtual objects in a synthetic or visual environment. The ability to navigate makes it possible to travel around the characteristics of a virtual world with ease.

Real estate, construction, healthcare, gaming, military, educational institutions and manufacturing industry, and defence, among others, are diverse industries in which virtual reality has been applied (Xu and Zheng, 2021). It is one of the key technologies that can enhance property viewing and inspection, construction safety, efficiency and site risk mitigation (Xu and Zheng, 2021, Georgiou and Nikolaou 2020), and its areas of application in the real estate business field comprises; planning, visualization, collaboration, safety and construction equipment management (Xu and Zheng, 2021)

Rowlinson (2004), with the idea of virtual reality as its foundation, designed a safety tool that leveraged the knowledge of real safety professionals to take pre-emptive action. Lucas, Thabet and Worlikar (2008) in their study emphasized the critical advantages of "cognitive learning" connected with virtual reality usage above the conventional methods carried out in schoolrooms in the specific context of safety training for equipment operators. The study's results corroborate Le *et al.*'s (2014) assertion that "collaborative virtual reality has an abundance of potential in practical safety learning, as well as combined effort between trainees and improving their efficiency and quality. In response to this, Getuli *et al*. (2020) defended this assertion by noting that by seeing the scenario of people who are participating in an immersive visual reality simulation of a building site for safety training purposes, the trainees

are encouraged to work together positively.

A virtual environment simulation-based training program was designed by Zhao e*t al*. (2009) to educate trainees about the electrical risks associated with building sites. The result was supported by the argument made by Goulding *et al*. (2012) that virtual reality technology peaks construction employees by simulating potential issues that could arise on-site due to different kinds of negligence via computer simulation beforehand. In their study, Guo *et al.* (2012) concluded that virtual reality has a wide range of applications in the building and construction industry. These applications include a three-dimensional training facility with interactive motions that foster creativity, immersion, and interaction; they also help create an immersive environment that can take the place of a physical setting and offer practical exercises involving appropriate worker/workforce interactions (Delgado, Oyedele, Demian, and Beach, 2020).

A study by Barak, Perlman, and Sacks (2013), revealed that virtual reality exposure kept students focused throughout the whole training period, while traditional training caused trainees to lose focus after an hour. Pedrol et al. (2016), in their study, found that when virtual reality technology is compared to traditional paper-based training, virtual-inclined training has a considerably larger impact on trainees' "understanding, knowledge, and grasp of safety concept." Therefore, in order to enhance the trainees' capacity to recognize potential hazards in energy sources, Chen et al. (2013) created a virtual environment software that combined Building information modelling with 2-dimensional imagery.

Jeelani et al. (2020) discovered that immersive training experiences speed up users' learning processes and recognized the effectiveness of using simulated training procedures for construction practitioners. The study also found that when participants were interviewed, they acknowledged and stated that virtual reality was a "highly engaging and realistic experience" and that it had assisted them in managing occupational hazards related to construction through simulation before engaging in actual construction work.

The review of the literature above has critically presented the overview of virtual reality and some areas of its application in the built environment, particularly in the real estate construction industry. Hence, the adoption of virtual reality in the real estate industry would revolutionize the existing practice by leading to tremendous and unprecedented improvement and growth of the real estate business as documented in other sectors where it has been applied. Maintaining the happiness and satisfaction of clients are the basic concerns of any business. Map System (2023) reported that if a Virtual reality application is judiciously implemented in the real estate business, it would transform the real estate traditional sector functions.

2.2 **Application of Virtual Reality in Real Estate Business**

Virtual reality applications have been frequently used in real estate in the developed worlds, such as the United States of America and the United Kingdom because they allow marketers to provide potential customers with the most realistic experience of a product, service, or location without actually having them there (Kholim, Anis, Siti and Fatin, 2023). According to Wang *et al*. (2014), the key to enticing customers to buy real estate and boosting real estate

sales is giving them access to virtual reality (VR) walkthroughs of properties that are still under construction. The most popular marketing strategy that was used by virtual reality to obtain brand experiences in 2017 was the virtual tour (Kholim, Anis, Siti and Fatin, 2023). This claim demonstrates how virtual reality photography supported the real estate industry in areas where mental imagery, also known as the perceptual representation of non-verbal information in memory, was prevalent (Kim *et al.,* 2020).

Virtual Reality is gaining prominence in the real estate sector through virtual staging and tours. The need for virtual reality in the real estate business became a necessity in modern dispensation as a result of the traditional approach, physical inspection of properties, not meeting up with the present state of globalization and post-COVID-19 demand (Afzal *et al*., 2021). Virtual reality can be seen as a powerful communication and marketing tool in the real estate sector. With the application of virtual reality in the real estate sector people can easily evaluate, experience and interact with real estate products-land, brick and mortar before leasing, renting or purchasing them (Bleize and Antheunis, 2019). Sihi (2018) in his study reported the encouraging impact that the application of virtual reality has on the home-buying process. The study revealed that parties in a real estate business- home buyers and property realtors were able to conclude transactions with utmost convenience irrespective of their geographical space (Sihi, 2018).

The application of virtual reality is not only limited to the cases of renting, leasing, and purchasing properties in the real estate business. Juan *et al* (2018) indicated that visualization of houses or construction operations in the development stage or under construction is possible, particularly, for houses sold off-plan through sell then build housing delivery model. This was corroborated by the study of Hou and Wu (2020), where the authors accentuated that virtual reality assists potential buyers in making more informed decisions as regards the purchase, usage, change and reconstruction decisions that are connected to their properties through an immersive environment. Hence, the area of applicability of virtual reality in the real estate marketing business is discussed below as extracted from the literature.

2.2.1 Virtual Property Showcasing and Tour

The selling, leasing, renting or purchasing of real estate either for personal or corporate needs takes a lot of effort and patience. With virtual reality, it is possible for clients or people to virtually visit listed properties without leaving their base or homes and still get the real feelings as if they were physically present there. This is achievable by positioning cameras throughout an apartment or a building and filming a scene from various angles; with this, a full presence illusion is produced. Today, potential buyers can study their future houses by immersing themselves in high-resolution virtual worlds by taking virtual tours online. Customers can also interact with virtual objects and observe how they function (Georgiou, 2019). Hence, to give prospective buyers a remote tour of the property, virtual tours can be offered on a real estate listing or website. This is especially helpful for purchasers from outside the area who might not be able to see the home in person before making a purchase.

2.2.2 Staging Properties Virtually

The virtual staging of properties is another way virtual reality may be used

in the real estate business. Real estate agents, property managers, and investors in rental and sales properties are just a few of the parties that can benefit. Some clients frequently search for fully equipped apartments. When inspecting a property that is empty versus one that is completely furnished, the experiences are very different. The latter gives off the impression of a luxurious home that any person would like. Sales may therefore double if virtual reality makes it a reality. The actual staging costs a lot of money and time.

2.2.3 Presentation of Properties Online

Traditional clients often inspect or visit listed properties for sale or to let once. Hence, their decision is often based on a single visit and sometimes they are unable to properly inspect the properties thoroughly the way they should, perhaps, they could be worried about other issues on leaving the subject property. With virtual reality, millions of people or clients can view or inspect the same properties virtually without disturbing or knowing each other. This is made possible through the use of guided tours or interactive virtual tours. Guided tours, it is more of traditional promotional videos which could be fully virtual or in the form of 360-degree videos, while interactive tours, use 3D tours and allow properties to be seen and viewed virtually at the time of the day.

2.3 Categorization of Virtual Reality Immersion

Nikolic (2007) categorized virtual reality immersion levels into three and they are identified and discussed below:

2.3.1 Full-Immersive Virtual Reality Platform-

This model offers users a 360-degree perspective of the simulated virtual environment. A full immersion is simple to accomplish by using a head-mounted display (HMD). The Cave Automatic Virtual Environment (CAVE) is the method that enables a fully immersive experience in the engineering, construction, and real estate industries. According to Nikolic (2007), a fully immersive system offers a 1:1 scale recreation and a strong sense of presence.

2.3.2 Semi-Immersive VR Platform

This system/model creates a partly virtual reality environment and it is referred to as projection-based virtual reality. This is very close to fully immersive virtual reality, however, projectors and huge displays are used to offer viewers a sensation of partial immersion.

2.3.3 Non-Immersive VR Platform

This virtual reality, sometimes referred to as desktop virtual reality, features a three-dimensional scene that can be seen through a graphics monitor and navigated by a mouse. The likelihood and cheap cost of adoption are the system's main benefits. Autodesk Navisworks is one example of such a model. In order to verify properties, visualize construction and property events, improve communication and collaboration with various property market participants, review designs, and easily complete transactions, virtual reality can be used (Hassanein, 2020). According to Hassanein (2020), the advantages of virtual reality include increased safety, cost savings, risk reduction, and the facilitation of effective stakeholder engagement.

Table 1: Comparison between the conventional marketing approaches and Virtual reality

SN	Description	Conventional (Site visit, Digital photography, 2D, Video Slideshow, Drone, Photo and Video	Virtual Reality
1	Accessibility	It is costly, limited time and time-consuming as physical visit is often required.	It is mobile friendly, socially sharable and accessible 24/7 subject to the comfort of prospective buyers/renters' home
2	Visual Capture	Physical inspection necessary	Easy to Do it yourself with the application of High mounted device in case of full immersion or controlled through the use of a mouse and other physical device made available for property viewing
3	Detail information	Limited information	Full measurement and labelling
4	Visual Experience	Limited viewpoint- you can only see the part the realtor wants you to see e.g. video recording and drone	Self-tour and maximum reality.

Source: Suleiman et al. (2020)

2.4 Comparison between Conventional Real Estate Marketing and Virtual Reality

Conventional real estate marketing techniques have been in use for a very long time by real estate brokers and property agents as a medium and strategy for marketing their properties for sale, short-let or renters. The traditional marketing techniques rely on the use of magazine, brochure, newspaper, television advert, radio advertising, site visit, digital photography, 2D video presentation, drone photo and video among others. In comparison with traditional methods, Sulaiman et al (2020) affirmed that virtual reality technology provides a better function with high ability as a new way to marketing properties in the real estate industry in terms of accessibility, visual capture, specific information and visual experience. Table 1 presents the summary of comparison between the conventional approaches with virtual reality.

3.0 Research methods

Data for the study were gathered via a mixed survey approach that employed the use of structured questionnaires and interviews. The study was conducted among practising Estate Surveyors and Valuers operating in Lagos State, being a statutory profession in charge of real estate agency practice in Nigeria. Since the study is centred on real estate marketing and the applicability of virtual reality as a tool for real estate marketing, the selected respondents were deemed appropriate and relevant in providing the needed data to achieve the objectives of the study. The study examined the current property marketing practice among Estate Surveyors and Valuers, barriers/reasons for the low adoption of

virtual reality, users' perception of virtual reality applications in real estate marketing business, and areas of applicability of virtual reality in real estate marketing business in the study area. The population of the respondents in the study area is depicted in Table 2.

Table 2: Study Population

SN	Study Population		Source
	N	N	
Estate Surveyors and Valuers	`421	280	NIESV Firm Directory, 2016-2023

In determining the sample size, the model of Frankfort Nachmias 1996 was employed.

$$n = \frac{Z^2 * p * q * N}{e^2 * (N - 1) + (Z^2 * p * q)}$$

Where:

Z: Area under a normal curve

p: Estimated proportion of population

q: 1-pe: Margin of error

Out of the 280 questionnaires that were administered to the practising Estate surveying firms in Lagos State, a total of 149 (53.21%) of the administered questionnaires were retrieved and found useful for analysis. The simple random sampling technique was employed and the questionnaires were administered to one Estate Surveyor and Valuer per firm in order to prevent repetition of data and results, while also giving equal opportunity to other members of the population. The questionnaire comprised a five-point Likert scale (Where 1 has a low score, 2= slightly high 3= somewhat high, 4= high and 5 extremely high). The data gathered were analyzed using descriptive statistics using frequency tables, mean and relative important index to depict the relative importance of each variable.

4.0 Results and Discussion

This section revealed the result of the study based on data gathered through the administered questionnaires. It unravels information as regards the sampled Estate Surveying and Valuation firms, pertinent background information of the respondents as well as the presentation of results that are germane towards achieving the specific objectives of the study.

4.1 Profile of Estate Surveyors and Valuers

The background profile of the respondents is depicted in tables 3-6, while the imperative information to achieving the objectives of the study is presented in tables 7- 11.

Table 3: Years of Operation of Estate Surveying Firms

In years	Frequency	%
Less than 3years	1	0.67%
Above 3years less than 6years	4	2.68
Above 6 less than 9years	19	12.75
Above 9 less than 12years	56	37.58
Above 12years	69	46.30
Total	149	100.0

Source: Field Survey (2023)

The number of years that the sampled estate surveying and valuation firms have been in operation in the real estate space is presented in Table 3. As shown in the table, 0.67% of the firms have been in operation for less than 3 years, 2.68% of the firms for above 3 years and less than 6 years, and 12.75% for above 6 years and less than 9 years. Also, 37.58% for above 9 and less than 12 years old, while the highest proportion of the firms, 46.30%, have been in operation for above 12 years. This result indicates that the majority of the firms have been in operation for a reasonable period of years which is an indication that responses gathered from the firms will be germane to actualizing the purpose of the study.

Table 4 presents the distribution of the firms by core practice. As shown in the table, 5.36% of the total firms are into real estate agency practice only, 7.38% of the firm's core practice is property and facility management and an estimated 2.01% firm's core practice is valuation. Meanwhile, an estimated 0.67% is into property development, while a majority of the firms, 84.56% are into general real estate practices. This means that most of the firms engage in all aspects of the estate surveying and valuation

profession which include but are not limited to real estate agency, valuation, property management and feasibility and viability studies.

Table 4: Distribution by Firm's Operation

Firm Practice	Frequency	Percentage
Real Estate Agency	8	5.36
Property and Facility Management	11	7.38
Valuation	3	2.01
Development	1	0.67
General Real estate practice	126	84.56
Total	149	100.0

Source: Author's Survey (2023)

The educational qualification of the respondents is presented in Table 5. As shown in the table, 14.09% of the respondents were diploma certificate holders, 73.82% were either holders of Higher National Diploma certificate or Bachelor of Science and an estimated 12.08% were holders of Master's degree. Furthermore, none of the respondents had a Master of Philosophy or a Doctorate certificate. Nevertheless, based on the presented information, it can be said that the respondents are learned persons whose responses can be relied upon. This is based on the assumption that they understand the imperativeness of research of this nature.

Table 5: Distribution of Respondents by Educational Qualification

Educational Qualification	Frequency	Percentage
Diploma	21	14.09
HND/BSc	110	73.82
Masters	18	12.08
M.Phil./ PhD	0	0.00
Total	149	100.0

Source: Field Survey (2023)

The professional affiliation of the respondents is depicted as follows in Table 6: 14.09% of the total respondents were student members of the Nigeria Institution of Estate Surveyors and Valuers, an estimated 34.22% are either graduate or professional members, and the highest proportion of the respondents were associate members of Nigeria Institution of Estate Surveyors and Valuers. The remaining 8.0% of respondents were fellows of the institution. Hence, based on the foregoing, the highest proportions of the respondents are professionals affiliated with NIESV, the professional institution of Estate Surveying and Valuation practice in Nigeria.

Table 6: Professional Affiliation of Respondents

Professional Qualification	Frequency	Percentage
Student member of NIESV	21	14.09
Probationer/Graduate member	51	34.22
Associate of NIESV	65	43.62
Fellow of NIESV	12	8.0
Total	149	100.0

Source: Author's Survey (2023)

4.2 Marketing Strategies Employed by Estate Surveying and Valuation Firms

In order to ascertain the marketing strategies that Estate Surveying and Valuation firms in Lagos State employ in marketing their real estate products, For-Sale and To-Let, the respondents were asked pertinent questions and the results are presented in Tables 7 and 9.

Table 7 displays the marketing strategies employed by Estate surveyors and valuers for their real estate products- To Let, in the study area. The result revealed that the use of banners/signage and billboards is the most used traditional marketing medium by Estate Surveyors and Valuers in the study area with a relative importance index of 4.73. This is an act of mounting To-Let banners, billboards and signage on the subject property as a means of publicizing the property to the locals where the property is situated. This corroborates the findings of Olukolajo et al. (2015), where the authors posit that billboards and signage are the most used traditional marketing medium for both To-Let, To-Lease and For-Sale properties by Estate Surveyors and valuers. The second most used marketing strategy is the distribution of soft and hard copies of property bulletins and fliers with other estate surveying firms, property firms and estate agents with a significant relative important index of 4.27. This marketing approach could be said to have been in existence as long as the profession itself and it allows for collaboration and networking between other colleagues in the area of joint transaction and letting. Social media and the use of short videos rank as the third most used medium of marketing among the practising estate surveyors and valuers in the study area with a high relative importance index of 4.21. The use of this medium has become popular as a marketing strategy across the world as a very fast way of disseminating information and advertising to larger audiences in respective of their geographical location. Also, a fairly significant proportion of the estate surveying firms in the study area adopt online property marketing agencies, that is, the use of branded agency outlets. This ranked fourth with a relative importance index of 3.51. Also, as shown in the table, the use of newspaper, radio and television as a marketing strategy ranks among the least used mediums alongside virtual reality with a relative importance index of 1.44 and 1.21 respectively. The low adoption of newspaper advertising, radio and television could be due to its short shelf life and the high cost associated with its usage. The study of Olukolajo et al. (2015) corroborates this finding by reporting that newspaper, radio and television are among the rarely used marketing strategies by professional Estate Surveyors and Valuers. Meanwhile, the reason for the low adoption of virtual reality in the study area is captured in Table 10.

Table 8 shows the strategies employed by estate surveying and valuation firms in the study for marketing properties for sale. The study revealed a slight difference between the preferred marketing strategies for To-Let and For-Sale properties as shown in Tables 7 and 8 respectively.

The reason for these differences could be attributed to the capital intensiveness, complexity and nature of each transaction in terms of ease of liquidity. Hence, social media is the most used tool for marketing For-Sale properties by

Table 7: Medium of Marketing Property for Letting by Estate Surveying Firms

Marketing Strategy	V.O	O	F.O	N.O	N.V.O	Weight =EFX	RII=EFX /EF	Rank
Use of Banners/sign boards and signage	132	7	3	4	1	706	4.73	1st
Fliers, photography And Bulletins	99	18	9	20	3	637	4.27	2nd
Social Media, Short Videos e.g Facebook	76	15	10	17	31	535	3.59	3rd
Online property marketing outlet e.g JIJI	73	12	15	17	32	524	3.51	4th
Publishing in Newspaper and Advertising through Radio and Television	25	20	21	34	116	216	1.44	5th
Virtual reality applications e.g 3.D	5	20	6	14	135	180	1.21	6th

Source: Field Survey (2023)

Table 8: Methods of Marketing Property for Sale

Marketing Strategy	V.O	O	F.O	N.O	N.V.O	Weight =EFX	RII=EFX /EF	Rank
Use of Social Media e.g. Facebook, Instagram.	119	19	3	5	3	693	4.69	1st
Use of Banners	115	20	3	1	10	676	4.53	2nd
Online property marketing media e.g using property marketing outlets	86	46	9	1	7	50	4.39	3rd
Distribution of property fliers and bulletins	62	48	9	5	25	564	3.78	4th
Virtual reality application e.g. 3.	12	48	14	15	60	384	2.58	5th
Publishing in Newspaper and use of Radio and Television Advert	6	5	14	34	90	250	1.67	6th

Source: Field Survey (2023)

The scale used for rating is represented as follows: V.O- Very Often (5), O - Often (4), F.O – Fairly Often (3), N.O- Not Often (2), N.V.O Not Very Often (1)

by estate surveyors and valuers in the study area as it ranked first with a relative importance index of 4.69. This could be a result of the need to a reach wider audience because of the capital intensiveness and illiquidity nature of real estate investment. Next to this is the traditional use of banners with a relative importance index of 4.53, closely followed by the use of property marketing outlets with a significant relative importance of 4.39. Findings also revealed that the use of property fliers and property bulletins (Distribution to different property companies) ranks fourth with an RII of 3.78. Meanwhile, it can also be seen that virtual reality ranks among the least used marketing tools with a low RII of 2.58, while the use of newspaper, radio and television adverts recorded a very high insignificant RII of 1.67. The barriers and reasons for the low adoption and implementation of virtual reality among practising estate surveyors and valuers are captured in Table 10.

Virtual reality as earlier stated is a relatively new technology that creates a simulated environment for its operators and users by offering them a virtual experience. The technology has been in

use in developed markets such as the United States and the United Kingdom for marketing properties and showcasing (Coldwell Banker Real Estate LLC, 2018 Juan, *et al*. 2018) but is relatively not in use in Nigeria. Hence, this section unravels the level of awareness of Estate Surveyors and Valuers in the study area apropos the application of virtual reality.

In order to establish the level of awareness of Estate Surveyors and valuers in the study area apropos the application of virtual reality in the real estate marketing business, the respondents were asked paramount questions in this regard and the result is shown in the above table 9. It can be seen that 20.81% of the respondents indicated a high level of awareness of the application of virtual reality as a real estate marketing tool, and also 19.49% of the respondents indicated a very high degree of awareness. Meanwhile, 13.42% indicated a moderately high awareness level with virtual reality applications and 46.30% indicated a very low level of awareness. Based on the foregoing, the result of the study as shown in Table 9 affirmed a relatively low level of awareness of the application of virtual reality in real estate marketing business in the study area. This was corroborated by an interview and the reason for its low awareness among the estate surveyors and valuers in the study area was attributed to the newness of the application/tool as well as lack of knowledge of its benefit in real estate marketing business.

Table 10 examined barriers and reasons for the low adoption of virtual reality among Estate Surveyors and Valuers in the study area. The two most significant barriers or reasons for the low adoption of virtual reality were a lack of its knowledge and benefits with a relative importance index of 4.91 and a high cost of financing the application, in terms of procurement, installation and overall life cycle costing, ranks second with relative importance index of 4.23. Similarly, fear of unacceptability of the application by prospective clients ranks third with a significant relative importance index of 3.89, fear of delay in concluding deals with the application ranks fourth with a relative importance index of 3.22, while power issues rank fifth with a relative 3.09. Furthermore, another significant barrier and reason for the low adoption of virtual reality is the respondents' doubt about its accuracy and usage in handling complex property tasks with the relatively important index of 3.04 as well as the quality of property profile for sale or letting also recorded significant relative importance index of 3.04 and both occupying sixth position. Meanwhile, secrecy in terms of discreteness of property transactions in cases where property owners do not want the general public to know their decision to sell their properties as well as unreliable internet issues were both recognized as insignificant barriers and reasons for the low adoption of virtual reality for real estate marketing business in the study area with low relative importance index of 1.38 and 1.17 respectively.

Table 9: Awareness of Virtual Reality Applications among Real Estate Practitioners

Awareness Level	Frequency	**Percentage**
Very High	29	**19.49**
High	31	**20.81**
Moderately High	20	**13.42**
Low	69	**46.30**
Total	149	**100.0**

Source: Authors' Survey, 2023

Table 10: Barriers to Adoption of Virtual Reality Application in Real Estate Business in Lagos State

Barriers	**V.S**	**S**	**F. S**	**N.S**	**H.I**	**Weight=EFX**	**RII=EFX/EF**	**Rank**
Lack of knowledge among practitioners	128	15	2	1	2	710	4.79	1st
Cost of financing the application	82	48	4	2	13	631	4.23	2nd
Fear of unacceptability of the application by clients for property viewing and showcasing	68	39	14	15	13	581	3.89	3rd
Fear of not being able to conclude deals on time or at all	38	40	14	32	25	4.81	3.22	4th
Power issues	38	33	13	35	30	38	3.09	5th
Accuracy in complex task	29	40	14	40	26	454	3.04	6th
Quality of Property profile for sale or letting	29	40	14	39	27	455	3.04	6th
Secrecy of Property Sales	5	8	2	11	123	208	1.38	7th
Internet issues in Nigeria	2	1	2	11	133	133	1.17	8th

Source: Authors' Survey, 2023

The scale used for rating is represented as follows: VS- Very Significant (5), S- Significant (4), F.S- Fairly Significant (3), N.S- Not Significant (2), H.I- Highly Insignificant (1

The findings from Table 10 were corroborated by the interview. It was gathered from the respondents that lack of detailed knowledge among practitioners' fear of its acceptability among end users / prospective clients and the cost of financing and operating virtual reality software and hardware were critical problems and barriers to its adoption. This corroborates their high ranking as key barriers to the adoption of virtual reality. These findings were consistent with Ebeh's (2007) study which identified cost, health-related issues and applicability as challenges of virtual reality training in Nigeria. Also, responses from the interview further affirmed that the power problem in Nigeria is a major barrier to its adoption. Nigeria's power supply is intermittent and not steady,

Table 11: **User's Perception of Virtual Reality Application in Real Estate Marketing**

User's Perception	Strongly Agree-5	Agree-4	Fairly Agreed-3	Disagree-2	Strongly Disagree-1	Weight=EFX	RII=EFX/EF	Rank
The creation of experiences is greatly enhanced by virtual reality technology.	59	49	10	11	20	563	3.77	1st
Virtual reality generates highly realistic sensations	42	46	30	11	20	526	3.53	2nd
The images produced by VR equipment are incredibly realistic.	39	44	30	13	23	514	3.44	3rd
Viewing properties via virtual reality application can influence your purchase decision	30	39	34	13	33	467	3.13	4th
Virtual reality is more useful in the gaming industry compared to the real estate industry	9	20	23	38	59	329	2.20	5th
Virtual reality has no advantage over 2D videos	1	21	20	25	82	281	1.88	6th
Virtual reality will increase fraudulent activities in real estate agency	3	21	15	25	85	279	1.87	7th

Source: Field Survey (2023)

while virtual reality application requires a 24/7 power supply to make them accessible any time of the day. The interviewee noted that a break in transmission with a prospective client during a virtual tour could negatively affect the likelihood of consummating a transaction. However, it was gathered that the discreteness of sales transactions and poor internet services are the least significant barriers to virtual reality adoption.

Table 11 examined users/estate surveyors and valuers' perception of virtual reality applications as a real estate marketing tool and the result shows a positive rating among its users. It can be seen that the respondents indicated that the creation of real-life experiences is greatly enhanced by virtual reality technology. This ranked first with a significant relative importance index of 3.77 and this is closely followed by virtual reality being highly rated to generate realistic sensations and feelings with a relative importance index of 3.53. The study further revealed that the respondents indicated that the images produced by virtual reality equipment are incredibly realistic (RII-3.44) and viewing properties via virtual reality application can greatly influence the positive decision to buy or lease a property due to its immersive nature and reality with relative importance index of 3.13. Meanwhile, findings as shown in Table 11 also revealed that the respondents/users disagreed that virtual reality is more useful in the gaming industry compared to real estate. This recorded a low relative importance index of 2.20 and ranked 5th, while the respondents also strongly disagreed that the application of virtual reality has no advantage over 2D videos with a relative importance index of 1.88 ranking sixth. Also, the respondents strongly disagreed that the application of virtual reality will increase fraudulent activities in the real estate marketing business with a low relative importance index of 1.87 and it ranked as the least on the table taking the seventh position.

The findings in Table 11 were corroborated by an interview. It was revealed by the respondents that virtual reality is capable of creating enhanced visual experiences and realistic sensations. This affirmed its relevance and importance in the real estate marketing business and this finding is in consonance with Nieradka's (2020) study, which reported that the software has a great likelihood of creating the experience and realistic version of reality for its users. Thus, from the foregoing, it can be said that virtual reality has great potential in the real estate marketing world if implemented completely.

5.0 Conclusion and Recommendation

The study examined virtual reality and its application in the real estate marketing business among practising Estate Surveyors and Valuers in Lagos State. The current study has admixed to the existing body of knowledge by ascertaining the current marketing practice, awareness and barriers to the adoption of virtual reality as well as the practitioners/users' perception of virtual reality in Lagos State. It was gathered that the estate surveyors and valuers, in the study area often market their properties via the traditional approach: hanging of banners, distribution of fliers and use of social media. It was also gathered that the practitioners rarely use virtual reality as a marketing tool and the key barriers to its adoption were lack of awareness, cost-in-use and fear of unacceptability by the market. The study also revealed that though the

level of awareness of virtual reality among the real estate practitioners in the study area is relatively low and still at the infancy stage, the practitioners still recognise its potential.

This study concludes that there is a need for estate surveyors, valuers and other real estate professionals to revolutionize the real estate marketing industry by adopting the application of virtual reality as practised in order sectors of the economy such as the gaming industry, oil and gas, and aviation industry in order to offer prospective clients (purchaser or renters), immersive and real-life experience at their comfort zones. This approach can be blended with traditional/conventional marketing in order to facilitate the ease of doing business.

Hence, with reference to the findings of this study, the following are recommended:

i. Real estate professionals should adopt virtual reality technology as a new approach and strategy to real estate marketing. With the application of virtual reality in the real estate business, real estate professionals/estate surveyors and valuers can simplify the process of home tours, improve the experience of potential buyers, reduce time spent on traffic and aid ease of doing business, while increasing turn-over rate.

ii. Nigeria Institution of Estate Surveyors and Valuers in collaboration with the Estate Surveying and Valuation Board of Nigeria should organize periodic seminars, conferences and workshops aimed at enlightening and training members on the benefits and and application of virtual reality in real estate business.

iii. Estate surveyors and valuers should embark on rigorous public awareness and enlightenment on virtual reality in order onboard prospective clients who are not aware of this application and software. This is necessary in order to build public confidence on its genuineness.

iv. The study also recommends a blend of both traditional and modern marketing technology in order to aid market penetration and satisfy peculiarity of each prospective client in terms of socio-economic and intrinsic characteristics.

v. Further research should be done in similar fields that haven't been thoroughly explored yet, such as augmented reality, mixed reality, and the use of laser scanning in the building and real estate industries.

Reference

Afzal, M. Shafiq, M.T. Jassmi, and H.A. (2021). Improving construction safety with virtual- design construction technologies – a review. *Journal of Information Technology in Construction,* 26, 319-340

Sacks, R., Perlman, A., and Barak, R. (2013). Construction safety training using immersive virtual reality. *Construction Management and Economics*, *31*(9), 1005-1017.

Barnes, S. (2016) Understanding Virtual Reality in Marketing: Nature, Implications and Potential. Available at: https://ssrn.com/abstract=2909100

Bleize, D. N., and Antheunis, M. L. (2019). Factors influencing purchase intent in virtual worlds: a review of the literature. *Journal of Marketing Communications*, *25*(4), 403-420.

Chen, A, Golparvar-Fard, M. and Kleiner, B. (2013). 'Design and development of Saves: A construction safety training of augmented virtual environment for hazard recognition and severity identification. *Computer. Civil. Engineering*. 2013, 841–848

Coldwell Banker Real Estate (2018). Virtual Reality Poised to Revolutionize Home Buying -Survey Results of the 2018 Coldwell Banker Real Estate Smart Home Marketplace Survey January 2018 Coldwell Banker Real Estate LLC

Deaky, B. A., and Parv, A. L. (2018, August). Virtual Reality for Real Estate–a case study. In *IOP Conference Series: Materials Science and Engineering* (Vol. 399, No. 1, p. 012013). IOP Publishing.

Davila Delgado, J. M., Oyedele, L., Beach, T., and Demian, P. (2020). Augmented and virtual reality in construction: drivers and limitations for industry adoption. *Journal of construction engineering and management*, *146*(7), 04020079.

Ebeh, R. (2007). Virtual Reality Training: Prospect and Challenges for Nigerian Industrial / Organizational Psychologists. *Nigeria Journal of Contemporary Psychology*, 1-6.

Frankfort-Nachmias, C. (1996) Research Methods in the Social Sciences. Aukland: Hodder Arnold Ltd

Felli, F., Liu, C., Ullah, F., and Sepasgozar, S. (2018, September). Implementation of 360 videos and mobile laser measurement technologies for immersive visualisation of real estate & properties. In *Education Building Professionals for the Future in the Globalized World*, (pp. 294–305), *Proceedings of the 42nd AUBEA Conference, Singapore* (Vol. 1).

Georgiou, K., and Nikolaou, I. (2020). Are applicants in favour of traditional or gamified assessment methods? Exploring applicant reactions towards a gamified selection method. *Computers in Human Behavior*, *109*, 106356.

Georgiou, M. (2019) VR Applications: Modernizing your Real Estate Business with 360 Virtual Tours & More.

Getuli,V., Capone, P. and Bruttini, A (2020). Planning, management and administration of HS contents with BIM and VR in construction: an implementation protocol," *Engineering, Construction and Architectural Management*: 10.1108/ECAM-11-2019 0647

Goulding, J., Nadim, W., Petridis, P. and Alshawi, M (2012). Construction industry offsite production: A virtual reality interactive training environment prototype. *Advance Engineering Informatics*, 26(1), 103–116.

Guo, H. L., Li, H., Chan, G. and Skitmore, M. (2012). Using game technologies to the safety of construction plant operations. Accident Analysis and Prevention, 48, 204–213.

Hassanein, A. (2020). Application of Virtual Reality in Construction Management and Control. *International Master of Science in Construction and Real Estate Management.* Joint Study Programme of Metropolia UAS and HTW Berlin

Hou, H. and Wu, H. (2020), "Technology for real estate education and practice: a VR technology perspective", Property Management, 38(2), 311-324**.**

Juan, Y. K., Chen, H. H., and Chi, H. Y. (2018). Developing and evaluating a virtual reality-based navigation system for pre-sale housing sales. *Applied Sciences*, *8*(6), 952.

Kholim, S. Anis, S.S, Siti, H.R and Fatin, N.H (2023). The Implementation of Virtual Reality (VR) Technology in Real Estate Industry. *Journal of the Malaysian Institute of Planners*, 21(3), 255-265

Kim, M. J., Lee, C. K., and Jung, T. (2020). Exploring consumer behaviour in virtual reality tourism using an extended stimulus-organism-response model. *Journal of Travel Research, 59*(1), 69-89.

Jeelani, I., Han, K., and Albert, A. (2020). Development of virtual reality and stereo-panoramic environments for construction safety training. *Engineering, Construction and Architectural Management*, *27*(8), 1853-1876.

Lucas, J. Thabet, W. and Worlikar, P (2008). A VR-Based Training Program for Conveyor Belt Safety. *Journal of Information Technology in Construction*, 13(2008), 381– 407

Map System (2023) How Real Estate Business Benefits from Virtual Reality.

Nikolić, D. (2007) *Evaluating relative impact of virtual reality components detail and realism on spatial comprehension and presence*. Master's Thesis, the Pennsylvania State University, USA

Nilsson, B. (2000). Internationalizing the Curriculum. In P. Crowther *et al*. (Eds.), *Internationalization at Home: A Position Paper* (pp. 21-28)

Nigeria Institution of Estate Surveyors and Valuers Directory (2016). Registered firms directory

Nieradka, P. (2019). Using virtual reality technologies in the real estate sector. *Annales Universitatis Mariae Curie-Skłodowska, Sectio H Oeconomia*, *53*(2), 45-53.

Olukolajo, M.A, Ojo, B. and Akinwande, D.O (2015). Assessment of the use of social media in real estate transactions in Lagos State market. *America Journal of Economics, Finance and Management*, 2, 63-68

Pedro, A., Le, Q. T., and Park, C. S. (2016). Framework for integrating safety into construction methods education through interactive virtual reality. *Journal of professional issues in engineering education and practice*, *142*(2), 04015011.

Pennington, B., and Bolton, S. (2019). Buyer's Guide: Digital Health and Safety Training Solutions. Retrieved from: https://www.verdantix.com/report/buyer-s-guide-digital-health-and-safety-training-solutions

Sacks, R. Perlman, A. and Barak, R. (2013) Construction safety training using immersive virtual reality," *Construction Management and Economics,* 31(9), 1005-1017

Rowlinson, S. (2004). *Construction Safety Management Systems.* Routledge.

Sihi, D. (2018). Home Sweet Virtual Home: The use of virtual and

augmented reality technologies in high involvement purchase decisions, Journal of Research in Interactive Marketing, 12(4), 398-417.

Sulaiman, M. Z., Aziz, M. N. A., Bakar, M. H. A., Halili, N. A., and Azuddin, M. A. (2020, December). Matterport: virtual tour as a new marketing approach in the real estate business during the pandemic COVID-19. In *International Conference of Innovation in Media and Visual Design (IMDES 2020)* (pp. 221-226). Atlantis Press.

Wang, J., Wang, X., Shou, W., and Xu, B. (2014). Integrating BIM and augmented reality for interactive architectural visualisation. *Construction Innovation*, *14*(4), 453-476.

Whyte, J. 2002. Industrial applications of virtual reality in architecture and construction*. Journal of Information Technology in Construction* (ITcon), 8(4), 43-50.

Xu, Z., and Zheng, N. (2020). Incorporating virtual reality technology in safety training solution for construction site of urban cities. *Sustainability*, *13*(1), 243.

Zhao, F., Chen, L., Ma, H., and Zhang, W. (2018). Virtual reality: A possible approach to myopia prevention and control?. *Medical hypotheses*, *121*, 1-3.

Appraisal of the nature and characteristics of road traffic speed breakers in Osogbo, Osun State, Nigeria

Ibrahim, R.B[1], Adedotun, S.B[1], Ogundahunsi, D.S. [1], Adeosun,J. [2], Adebiyi, R. [1], and Oyerinde, I[1].

[1]Department of Urban and Regional Planning, Osun State University.
[2]Department of Building, Osun State University
Corresponding Author: rafiu.ibrahim@uniosun.edu.ng

Abstract

This study examines the condition of speed breakers in the selected major, distributor and service roads; the volume of traffic as well as the road user's perception of the effects of speed breakers. Data utilized for this study were obtained from nine (9) randomly selected roads out of the identified 13 roads. A total of 55 speed breakers were examined for the study. The random sampling procedure was utilized to administer questionnaires to vehicle operators and commuters. The data collected were analyzed using descriptive statistics of frequency and percentage. Analysis of Variance was used to examine the differences in the design and characteristics of speed breakers in the selected roads. The results revealed that speed humps were the only type of speed breaker installed in the study area but they were of different shapes. All fifty-five (55) speed breakers examined were made of asphalt except one found at Salvation Army School which was made of rubber. The longest speed hump was found on a major road; in close proximity to the Osun State House of Assembly, Abeere (Stadium-Lameco Road) measuring 16.91m while the shortest one was found on a service road; at Suzzy Junction (Suzzy Road) measuring 7.00m. The findings from Analysis of Variance (ANOVA) revealed that there was statistically significant variation in the design and characteristics of road traffic speed breakers in Osogbo at $p<0.05$ confidence level. The study recommends amongst others proper maintenance of road traffic speed breakers, provision of stormwater drainage on the roads, use of smart speed breakers and use of standards for speed breakers design and installation.

Keywords *Road Traffic, Speed Breaker, Bumps, Humps, Asphalt.*

1.0 Introduction

Transportation from time immemorial according to Nieuwenhuijsen (2020) has been the heart of planning that connects people to different locations of their choice in any geographical setting. Transportation has indeed encouraged interactions to take place among humans and has also enabled the movement of people, goods, information, services and other basic elements to any needed location within human settings (Porru *et al*., 2020). Jean-Paul (2021), ascertained that due to its extensive use of infrastructure, the transport sector is an important component of the economy and a common vehicle for development. This is even more so in a global economy where opportunities have been increasingly related to the mobility of people and freight, including information and communication technologies (Zannat and Choudhury, 2019).

The relevance of speed to a road's degree of safety cannot be overstated. Road accidents are the most dreaded thing that can happen to road users, despite the fact that they occur frequently. According to Choudhary *et al.* (2018), overspeeding is the leading cause of fatal accidents as it increases the likelihood of an accident and the severity of injury sustained in the event of an accident. Vehicles travelling at a higher speed are more likely to be involved in an accident than those travelling at a lower speed, and the severity of the collision will also be greater in the case of faster vehicles. A car travelling at a high speed will have a higher impact on collision, resulting in more injuries (World Health Organization, 2014). Speed is a major contributing factor to road accidents; and the relationship between speed and road accidents and between speed and the severity of accidents are well documented (Goniewicz et al., 2016).

Measures to slow down traffic should be taken in the interest of vehicle and environmental safety. Calming devices are the simplest and most conventional method of traffic speed control (vehicle speed reducers known as speed breakers). According to Abdulmawjoud et al. (2021), a speed breaker is a type of traffic calming device that is useful for smooth movement and is one of the most effective ways to reduce road accidents and improve road user safety. The measures are intended to make it more difficult for a vehicle to speed or to make the driver feel some discomfort when driving over them at high speeds (U.S Department of Transportation, 2019).

Speed breakers are devices that are erected to allow pedestrians to commute safely by reducing vehicle speed (Chukwugozi, 2014). They are widely regarded as the most effective and cost-effective method of reducing speeding and protecting pedestrians from speed-related incidents (Archer et al., 2008). They are self-controlling and are sometimes referred to as "Sleeping Traffic Officers" (Salau, Adeyefa and Oke, 2004). They can be installed whenever the authority that has jurisdiction over the roads or streets believes that they are necessary and appropriate for the situation. Out of the various traffic calming approaches including chicanes, rumble strips, and speed cushions, road humps are generally utilized in several countries for decreasing the severity and the frequency of crashes, and for improving the local environment (Nordiana et al., 2020).

When used alone, traffic signs and other visual traffic control devices, particularly speed control signs, have been found to be less effective. However, when utilized in conjunction with actual traffic calming devices such as speed breakers, their performance can be greatly improved. Varying types of roads are designed for different levels of speed, which cars must adhere to in order for the roadway system to function properly. It is common practice to offer various control methods to guarantee that the required speeds are maintained. These improvements can help to enhance traffic flow while also improving safety and convenience. The existing literature on road traffic speed breakers predominantly covers general aspects of traffic calming measures and their impact on road safety. However, a comprehensive and detailed investigation focusing specifically on the nature and characteristics of road traffic speed breakers in Osogbo, Osun State, Nigeria is notably absent. This geographical region presents unique socio-economic and infrastructural dynamics that warrant a dedicated empirical analysis of speed breakers' design, functionality, and their

implications for road safety within this locale. Thus, this study endeavours to bridge this gap by providing a nuanced understanding of road traffic speed breakers in Osogbo, thereby contributing empirical insights that can inform policies and practices concerning the installation and management of these traffic calming devices in this specific context.

2.0 Literature review

The effectiveness of traffic calming techniques has been widely discussed in the field of transportation and road safety. Asefa et al. (2020) investigated the efficacy of speed bumps on a rural two-lane roadway in Ethiopia. The study's findings indicate that speed reducers have been shown to decrease crashes in high-income environments. However, their usefulness may have been hindered due to inadequate design for the specific kind of highway, inconsistent location, insufficient labelling and repair, as well as inadequate coordination among stakeholders. In their study, Raghupathi and Vedagiri (2021) assessed the effectiveness of several traffic calming techniques, including speed bumps, speed humps, speed tables, and rumble strips, on residential streets in Mumbai City. The research found that, despite the implementation of numerous speed reduction measures, the urban roadways in the city remain susceptible to road safety issues. The velocity of automobiles, even inside residential streets, is seen to exceed acceptable levels, with the exception of areas equipped with speed-slowing devices. Korr et al. (2019) conducted a study to analyse the effects of speed humps on Indian roads. This research demonstrates that the implementation of speed bumps has a significant impact on speed profiles, trip time, distance, and percentile speed. The research also observed that although they effectively decrease vehicle speed, they also lead to significant adverse effects, including passenger discomfort and higher running expenses for vehicles.

In Nigeria, Chukwugozi (2014) conducted a study to investigate the impact of speed bump installations on the main roads in Ondo, located in the southwestern region of the country. The data indicates that the construction of speed bumps had a negative impact on the road traffic accident trend in most of the examined routes, with just a few exceptions. The results also indicate that most participants are against the installation of speed bumps due to their detrimental effects on vehicles, human health from collisions, increased risk of criminal activities for road users, and reduced traffic flow on the chosen routes. In a study conducted by Ndoke (2014), the author investigated the effectiveness of road humps as a traffic calming measure on several main highways in the city of Minna. It was discovered that the humps effectively serve as traffic-calming devices on the roadways where they are installed. However, it was also observed that the humps have a pronounced propensity to degrade rapidly. The traffic humps were also discovered to have significantly decreased the frequency of accidents on the roads where they are built.

Collectively, these studies emphasise the correlation between various speed calming methods, their influence on vehicle behaviour, and road safety, and the diverse responses and consequences found in different geographical locations. The efficacy of speed barriers, such as ripples, mounds, and other traffic calming interventions, is contingent upon their configuration, positioning, and contextual variables. These studies emphasise that the efficacy of roads may be compromised due to improper design for certain road

types, erratic placement, lack of maintenance, and poor stakeholder cooperation. Despite the use of several speed mitigation strategies, metropolitan roadways often remain susceptible in terms of road safety. Automobiles often surpass acceptable speeds, particularly on roads without efficient speed reduction measures, hence significantly increasing the likelihood of accidents and dangers. The implementation of speed humps has a substantial impact on the speed patterns of vehicles, as well as their travel duration and distance covered. Although they efficiently decrease speed, they have drawbacks such as passenger discomfort and higher running expenses.

3. Materials and Methods

3.1 The Study Area

Osogbo is a city located in Osun state, Southwestern Nigeria with coordinates7˚46'N 4˚34'E. Lying along the Osun River, it is situated on the railway line from Lagos and at the intersection of roads from Ilesa, Ede, Ogbomosho, and Ikirun. The town is served by a local airport. It became the capital city of Osun State in 1991. Osogbo city seats the Headquarters of both Osogbo Local Government Area (situated at Oke Baale Area of the city) and Olorunda Local Government Area (situated at Igbonna Area of the city). It is about 88 kilometres by road northeast of Ibadan. It is also 108 kilometres (67 mi) by road south of Ilorin and 108 kilometres (67 mi) northwest of Akure. Osogbo shares boundaries with Ikirun, Ilesa, Ede, Egbedore, Ogbomosho and Iragbiji and is easily accessible from any part of the state because of its central nature. It is about 48 km from Ife, 32 km from Ilesa, 46 km from Iwo, 48 km from Ikire and 46 km from Ila-Orangun. The map of Osogbo is indicated in Figure 1, while the road map is shown in Figure 2.

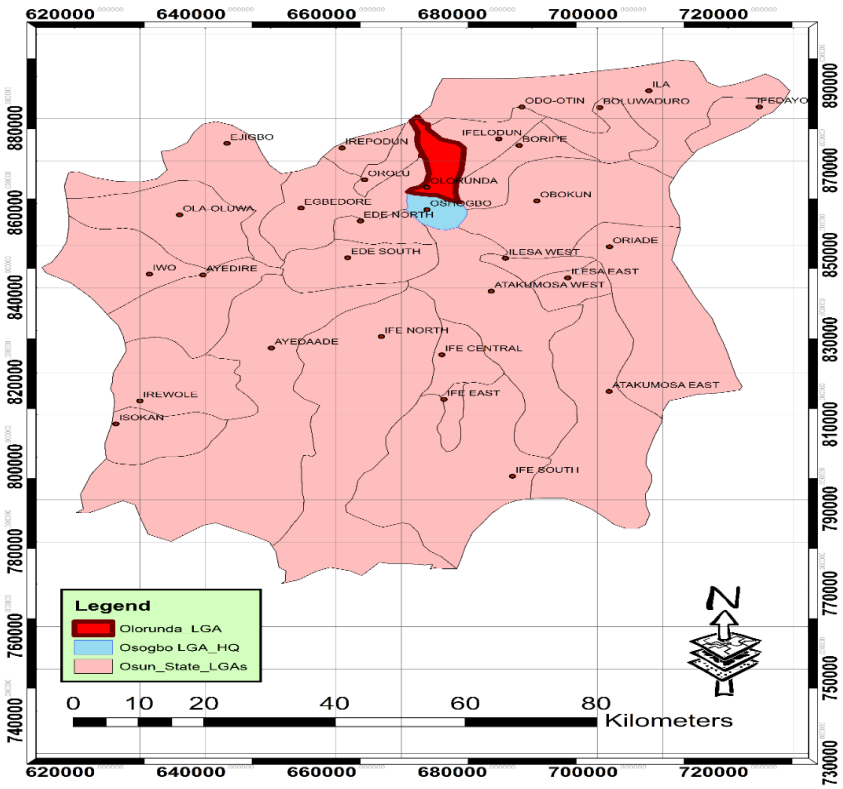


Figure 1: Map of Osun state indicating Osogbo and Olorunda Local Government Areas
Source: URP, GIS Laboratory, UNIOSUN (2022)

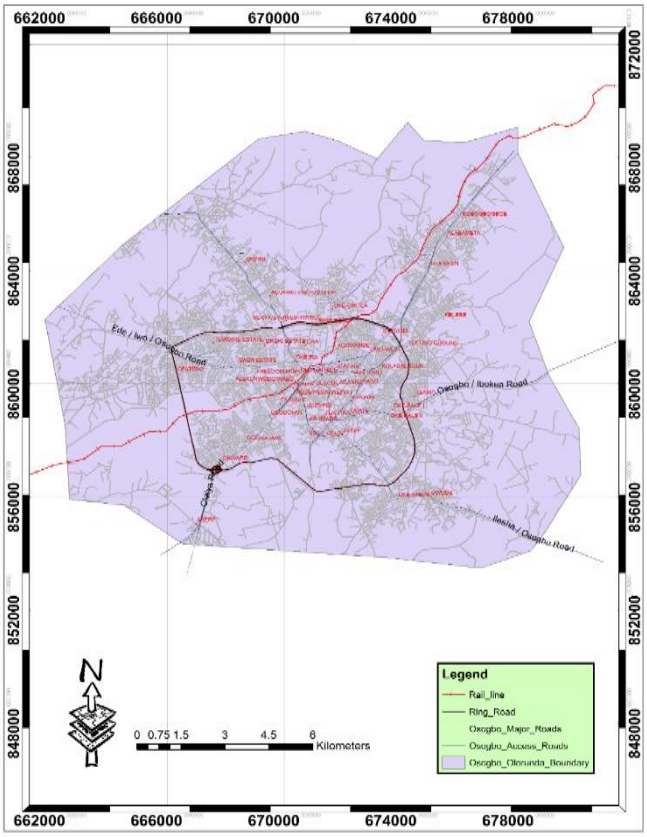


Figure 2: Road map of Osogbo
Source: URP, GIS Laboratory, UNIOSUN (2022)

3.2 *Method of Data Collection and Analysis*

The study area comprised major roads, distributor roads, and service roads within Osogbo, Osun State, Nigeria, forming the sampling frame for the road study. A total of 13 roads were identified. To select a representative sample, a random sampling technique using balloting was employed, resulting in the selection of 9 roads from the identified pool. Details of the selected roads, along with the count of speed breakers on each road, are provided in Table 1. For data collection related to road users' perspectives, an accidental sampling technique was utilized to administer questionnaires to individuals who were willing to participate. This technique was suitable as it allows researchers to gather data from individuals who are readily available and willing to participate (Dhivyadeepa, 2015).

The collected data encompassed various aspects, including the design and characteristics of speed breakers, condition assessment of speed breakers, the volume of traffic observed on roads equipped with speed breakers, perception of road users regarding the effects of speed breakers on road conditions, vehicles, and overall road user experience. Descriptive analysis was employed to assess the design, condition, and traffic volume associated with speed breakers. Additionally, Analysis of Variance (ANOVA) was utilized to investigate potential differences in the design and characteristics of speed breakers among the selected roads.

Table 1: Identified roads for the study and number of speed breakers

Roads Identified		**Selected Roads**	**Number of speed breakers**
Major	Olaiya - Abere	Selected	14
	Ilesa Garage		
	Ayetoro - Stadium		
	Stadium – Lameco	Selected	13
Distributor	Alekuwodo	Selected	3
	Capital	Selected	4
	Rinsayo		
	Ojaoba - Station	Selected	2
	Odiolowo -Isale Osun	Selected	10
Service	Oke Arungbo	Selected	2
	Station Road-Oluode	Selected	3
	Suzzy junction	Selected	4
	Halleluyah Estate		
Total	13	**9**	**55**

Source: Authors' Fieldwork, (2022)

4. Research Findings

4.1 Design, characteristics and condition of available speed breakers in the study area

In this section of the study, an attempt was made to examine the design, characteristics and condition of available speed breakers in Osogbo. The parameters used in this assessment were: the types of speed breakers, number of speed breakers, characteristics like length, height, width, material, shape and condition of speed breakers.

Table 2 reveals that the Olaiya-Abeere Road, extending from Dream Centre Church, Ogooluwa, to the State Government of Osun Secretariat, Abeere, encompasses fourteen speed breakers. These speed breakers, all constructed as asphalt speed humps, serve to regulate traffic speed along the two-lane road, each lane measuring 17.00m in width. Observations revealed a diversity in the design characteristics of the speed humps. While all are categorized as speed humps, they exhibit distinct variations in dimensions. For instance, the longest speed hump, found near the House of Assembly in Abeere, spans 16.91m, contrasting with the shortest at Dream Centre Church, Ogooluwa, measuring 7.13m in length. The width ranged from the widest speed hump opposite Dream Centre Church (3.35m) to the narrowest at Federal Mortgage Bank (0.85m). The variations in length and width of the speed humps may influence their effectiveness in controlling vehicle speed and ensuring road safety. For instance, longer and wider speed humps might better deter speeding vehicles, especially in areas with higher traffic density. The dimensions and shapes of these speed humps directly affect traffic flow and driver behaviour. Factors such as abruptness, height, and width might impact vehicle deceleration and driver comfort, potentially affecting overall traffic patterns and road safety measures.

Table 3 presents an evaluation of thirteen-speed breakers positioned along Stadium-Lameco Road, stretching from St. Leo's Catholic Nursery & Primary School, Ring Road, to Demist Oil, Lameco.

Table 2: Design, characteristics and condition of speed breakers along Olaiya-Abeere Road

S/N	Location of speed breaker	Type of speed breaker	Material of speed breaker	Length (m)	Width (m)	Height (m)	Shape of speed breaker	Condition of speed breaker
	Dream Centre Church, Ogooluwa	Speed hump	Asphalt	7.13	3.20	0.03	Flat-topped	Smooth
	Dream Centre Church, Ogooluwa	Speed hump	Asphalt	7.13	1.55	0.03	Flat-topped	Smooth
	Opposite Dream Centre Church, Ogooluwa	Speed hump	Asphalt	9.90	3.35	0.03	Flat-topped	Smooth
	Osamdo House, Ogooluwa	Speed hump	Asphalt	9.90	1.41	0.03	Flat-topped	Smooth
	Ataoja High School	Speed hump	Asphalt	9.32	1.50	0.06	Parabolic	Smooth
	Ataoja High School	Speed hump	Asphalt	9.32	1.50	0.06	Parabolic	Smooth
	Federal Mortgage Bank	Speed hump	Asphalt	10.55	0.85	0.06	Parabolic	Smooth
	Federal Mortgage Bank	Speed hump	Asphalt	10.55	0.85	0.06	Parabolic	Smooth
	Opposite House of Assembly, Abeere	Speed hump	Asphalt	8.85	2.55	0.06	Parabolic	Smooth
.	Opposite House of Assembly, Abeere	Speed hump	Asphalt	9.36	2.55	0.06	Parabolic	Smooth
.	House of Assembly, Abeere	Speed hump	Asphalt	11.26	2.55	0.06	Parabolic	Smooth
.	House of Assembly, Abeere	Speed hump	Asphalt	16.91	2.52	0.06	Parabolic	Smooth
.	Opposite State Secretariat, Abeere	Speed hump	Asphalt	13.54	2.55	0.06	Parabolic	Smooth
.	Opposite State Secretariat, Abeere	Speed hump	Asphalt	12.10	2.55	0.06	Parabolic	Smooth

Source: *Authors' Fieldwork, (2022)*

Table 3: Design, characteristics and condition of speed breakers along Stadium-Lameco Road

S/N	Location of speed breaker	Type of speed breaker	Material of speed breaker	Length (m)	Width (m)	Height (m)	Shape of speed breaker	Condition of speed breaker
1.	St. Leo's Catholic Nur & Pry School, Ring Road	Speed hump	Asphalt	12.92	0.73	0.08	Parabolic	The existence of potholes at the foot
2.	Buketi Food Canteen, Ring Road	Speed hump	Asphalt	12.94	0.96	0.08	Parabolic	The existence of potholes at the foot
3.	Buketi Food Canteen, Ring Road	Speed hump	Asphalt	7.36	1.09	0.08	Parabolic	The existence of potholes at the foot
4.	Islahudeen Junction, Ring Road	Speed hump	Asphalt	11.29	1.95	0.08	Parabolic	The existence of potholes at the foot
5.	Opposite AP Filling Station, Ring Road	Speed hump	Asphalt	9.65	0.71	0.08	Parabolic	Smooth
6.	Opposite AP Filling Station, Ring Road	Speed hump	Asphalt	8.61	0.83	0.08	Parabolic	Smooth
7.	Oke-oniti Junction Ring Road	Speed hump	Asphalt	13.63	0.74	0.08	Parabolic	The existence of potholes at the foot
8.	Allah's Favour & Mercy House, Ring Road	Speed hump	Asphalt	9.55	0.85	0.08	Parabolic	The existence of potholes at the foot
9.	Allah's Favour & Mercy House, Ring Road	Speed hump	Asphalt	9.65	0.91	0.08	Parabolic	The existence of potholes at the foot
10.	Opposite Demist Oil, Lameco	Speed hump	Asphalt	9.60	1.20	0.03	Parabolic	Smooth
11.	Opposite Demist Oil, Lameco	Speed hump	Asphalt	11.70	1.20	0.03	Parabolic	Smooth
12.	Opposite Demist Oil, Lameco	Speed hump	Asphalt	11.30	1.20	0.03	Parabolic	Smooth
13.	Opposite Demist Oil, Lameco	Speed hump	Asphalt	11.75	1.20	0.03	Parabolic	The existence of potholes at the foot

Source: *Authors' Fieldwork, (2022)*

This roadway comprises two lanes, each lane measuring 13.00m in width, and is equipped with speed humps entirely constructed using asphalt material. Despite all being speed humps of parabolic shape, significant variations in dimensions and conditions were observed among the evaluated speed breakers. The length ranged from the longest at Oke-oniti Junction, Ring Road (13.63m) to the shortest at Buketi Food Canteen, Ring Road (7.36m). Similarly, the width varied, with the widest hump at Islahudeen Junction, Ring Road (1.95m) and the narrowest opposite AP Filling Station (0.71m). Out of the thirteen-speed humps surveyed, only five were noted to be in a smooth condition, while the remainder exhibited potholes, affecting their functionality and potentially compromising road safety measures. Variations in dimensions and the presence of potholes have significant implications for traffic regulation and road safety. The varying conditions of speed humps may impact vehicle deceleration, driver behaviour, and overall road safety measures.

Table 4 outlines the locations and characteristics of potholes in the immediate vicinity of speed breakers along Stadium-Lameco Road. The surveyed road section, housing eight-speed humps, exhibited a total of twenty-two potholes. Additionally, the road was observed to feature an open drainage system. The potholes displayed various shapes and dimensions. The widest pothole, measuring 6.45m in width, was identified around the speed hump at Oke-oniti Junction Ring Road, while the narrowest, spanning 0.60m, was situated near St. Leo's Catholic Nursery and Primary School, Ring Road. In terms of depth, the deepest pothole was detected around Oke-oniti Junction, whereas multiple potholes measured 0.02m in depth, were found at different locations. The substantial presence of twenty-two potholes within the vicinity of the speed humps signifies a critical concern for the smooth flow of vehicular traffic. Potholes pose a significant threat to road safety and can potentially impede smooth vehicular movement

Table 4: Incidence of potholes at the immediate surrounding of speed breakers along Stadium-Lameco Road

S/N	Location of speed breaker	Type of speed breaker	Shape of pothole	Depth of pothole (m)	Wideness of pothole (m)
1.	St. Leo's Catholic Nur & Pry School, Ring Road	Speed hump	Irregular Irregular Circular	0.08 0.08 0.02	2.42 2.10 0.60
2.	Buketi Food Canteen, Ring Road	Speed hump	Circular	0.02	0.62
3.	Buketi Food Canteen, Ring Road	Speed hump	Irregular	0.13	2.03
4.	Islahudeen Junction, Ring Road	Speed hump	Irregular	0.17	2.88
5.	Oke-oniti Junction Ring Road	Speed hump	Irregular Spherical	0.21 0.07	6.45 5.23
6.	Allah's Favour & Mercy House, Ring Road	Speed hump	Spherical Spherical Spherical Spherical Irregular	0.04 0.06 0.06 0.17 0.12	1.11 0.80 1.70 2.71 2.66

			Irregular	0.07	1.30
7.	Allah's Favour & Mercy House, Ring Road	Speed hump	Irregular Spherical Irregular Irregular Irregular	0.07 0.121 0.12 0.12 0.05	2.18 1.45 5.38 2.24 1.13
8.	Opposite Demist Oil, Lameco	Speed hump	Irregular Irregular Irregular	0.03 0.02 0.02	1.50 0.88 0.74
	Total number of potholes = 22				

Source: Authors' Fieldwork, (2022)

Table 5 illustrates the evaluation of ten-speed breakers positioned along Odiolowo-Isale Osun Road, commencing from Oluomo Group of Schools, Odiolowo, and concluding at Bodmas Olaniyan Ventures, Isale Osun. This roadway consists of two lanes, each with a width measuring 11.00m, housing a total of 10 speed breakers. The surveyed speed breakers were exclusively asphalt-made speed humps, differing in shape and displaying various dimensions. Despite all being categorized as speed humps, they exhibited diverse characteristics in length, width, and height. The observed speed humps varied significantly in their physical dimensions. The length ranged from 9.77m at Olutimehin Grammar School, Isale Osun, to 11.00m at Oluomo Group of Schools, Odiolowo. Similarly, the width varied, with the widest at Opposite Olutimehin Grammar School, Isale Osun (2.98m) and the narrowest at several locations in Odiolowo (1.47m). Notably, all surveyed speed humps were observed to be in good condition, characterized by a smooth surface. The diverse characteristics of these speed humps emphasize the necessity for standardized design and dimensions to ensure consistent and effective traffic calming measures.

Table 6 showcases an evaluation of two-speed breakers situated exclusively at the front of Libofary Filling Station, Popo, along Ojaoba-Station Road. This road section comprises a single lane, with a measured width of 10.00m, housing a total of two speed breakers. Both surveyed speed breakers were identified as asphalt-made speed humps, sharing identical shapes and conditions. They were observed to have uniform width, height, and shape, differing only in their respective lengths. The speed breakers displayed consistent characteristics in terms of width and height, with variations solely in their lengths. Despite these variations, all speed humps were noted to be in good condition, featuring a smooth surface.

Table 7 depicts an evaluation of four-speed breakers positioned along Capital Road, spanning from Capital Junction to Faridah Shopping Complex. This road comprises two lanes, each measuring 9.00m in width, housing a total of four-speed breakers. All observed speed breakers on Capital Road were identified as asphalt-based speed humps, sharing a consistent parabolic shape. Despite their uniform design, they exhibited variations in dimensions, specifically in terms of length, width, and height. The speed humps showcased diverse characteristics concerning their dimensions, encompassing variations in length, width, and height. However, despite these differences, all speed humps were noted to be in good condition, displaying a smooth surface.

Table 5: Design, characteristics and condition of speed breakers along Odiolowo-Isale Osun Road

S/N	Location of speed breaker	Type of speed breaker	Material of speed breaker	Length (m)	Width (m)	Height (m)	Shape of speed breaker	Condition of speed breaker
1.	Oluomo Group of Schools, Odiolowo	Speed hump	Asphalt	11.00	1.87	0.13	Parabolic	Smooth
2.	H.R Communication Phone & Accessories, Odiolowo	Speed hump	Asphalt	9.90	1.47	0.03	Flat-topped	Smooth
3.	Khemmy Collections Unisex Boutique, Odiolowo	Speed hump	Asphalt	9.90	1.47	0.03	Flat-topped	Smooth
4.	Supreme Cleaners, Odiolowo	Speed hump	Asphalt	9.90	1.47	0.03	Flat-topped	Smooth
5.	Alhaja Olanrewaju Restaurant, Odiolowo	Speed hump	Asphalt	9.90	1.47	0.03	Flat-topped	Smooth
6.	Opposite Next Standard Boutique, Odiolowo	Speed hump	Asphalt	9.90	1.90	0.03	Flat-topped	Smooth
7.	Olutimehin Grammar School, Isale Osun	Speed hump	Asphalt	9.77	1.58	0.03	Flat-topped	Smooth
8.	Olutimehin Grammar School, Isale Osun	Speed hump	Asphalt	10.75	1.64	0.03	Flat-topped	Smooth
9.	Opposite Olutimehin Grammar School, Isale Osun	Speed hump	Asphalt	10.27	2.98	0.06	Flat-topped	Smooth
10.	Bodmas Olaniyan Ventures, Isale Osun	Speed hump	Asphalt	9.90	2.75	0.06	Flat-topped	Smooth

Source: Authors' Fieldwork, (2022)

Table 6: Design, characteristics and condition of speed breakers along Ojaoba-Station Road

S/N	Location of speed breaker	Type of speed breaker	Material of speed breaker	Length (m)	Width (m)	Height (m)	Shape of speed breaker	Condition of speed breaker
1.	Libofary Filling Station, Popo	Speed hump	Asphalt	10.70	1.80	0.08	Parabolic	Smooth
2.	Libofary Filling Station, Popo	Speed hump	Asphalt	10.50	1.80	0.08	Parabolic	Smooth

Source: Authors' Fieldwork, (2022)

Table 7: Design, characteristics and condition of speed breakers along Capital Road

S/N	Location of speed breaker	Type of speed breaker	Material of speed breaker	Length (m)	Width (m)	Height (m)	Shape of speed breaker	Condition of speed breaker
1.	Capital Junction	Speed hump	Asphalt	8.32	1.03	0.35	Parabolic	Smooth
2.	Capital Junction	Speed hump	Asphalt	8.72	1.03	0.35	Parabolic	Smooth
3.	Capital Junction	Speed hump	Asphalt	8.38	1.05	0.35	Parabolic	Smooth
4.	Faridah Shopping Complex	Speed hump	Asphalt	8.76	1.05	0.35	Parabolic	Smooth

Source: Authors' Fieldwork, (2022)

Table 8: Design, characteristics and condition of speed breakers along Alekuwodo Road

S/N	Location of speed breaker	Type of speed breaker	Material of speed breaker	Length (m)	Width (m)	Height (m)	Shape of speed breaker	Condition of speed breaker
1.	Salvation Army School, Alekuwodo	Speed hump	Asphalt	10.32	2.35	0.06	Parabolic	Smooth
2.	Salvation Army School, Alekuwodo	Speed hump	Rubber	10.32	0.90	0.03	Parabolic	Worn out Partial removal

Table 8 illustrates an evaluation of three-speed breakers situated along Alekuwodo Road, all located at Salvation Army School. This road segment encompasses two lanes, each measuring 10.00m in width, accommodating a total of three-speed breakers. The observed speed breakers on Alekuwodo Road were identified as speed humps, differing in their composition. While two-speed humps were made of asphalt, the third one was constructed from rubber. Despite this material difference, all speed humps shared a common parabolic shape. The speed humps exhibited variations in their dimensions—length, width, and height—despite having a consistent design. The asphalt-made speed humps were noted to be in good condition, maintaining a smooth surface. However, the rubber speed hump showed signs of wear and partial removal from the road, indicating a compromised condition.

4.2: Volume of traffic on the roads with speed breakers in the study area

The volume of traffic on the selected major, distributor and service roads with speed breakers in Osogbo was assessed. The types of vehicles that plied the roads and volumes of traffic among others were used for evaluation.

Different types of vehicles that plied the study area according to the field survey were presented in Figure 1. According to Figure 1, motorcycles (54.95%) were the predominant means of movement in the area. Private cars (19.87%) and minibuses (17.86%) were also on the high usage while passenger buses (4.97%) were also significant. Private buses (0.69%), trucks/vans (1.44%), and tricycles (0.18) had low usage. Others (0.04%) like trailers and tankers had the least percentage.

4.2.1. Vehicle composition

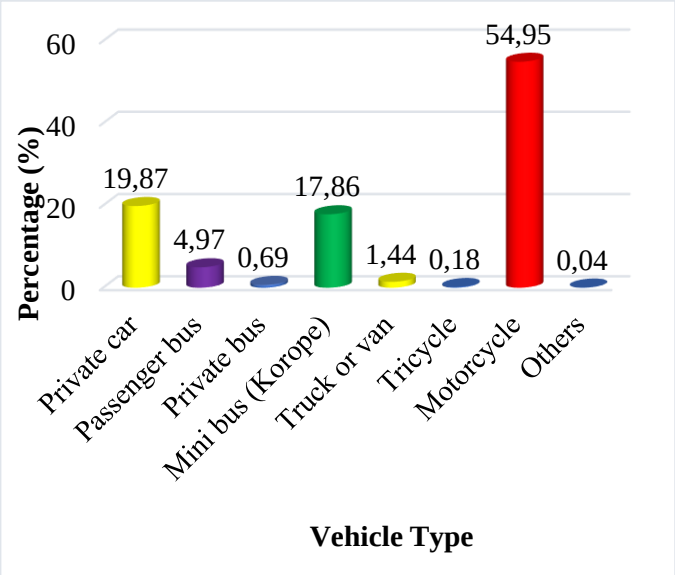


Figure 1: Vehicle composition in Osogbo
Source: Authors' Fieldwork, (2022)

4.2.2. Traffic Count at Olaiya-Abeere Road

The summary of traffic counts as shown in Table 9 indicated that vehicles that plied the distributor road in one week were higher (151,712) than that of the major road (140,177) and that of the major road was higher than that of the service road (62,511). It was also observed that motorcycles, private cars, and minibuses (korope) were the most dominant modes of transportation in Osogbo.

4.2.2.1: Average Volume of Traffic

The average Volume of traffic at the selected Major, Distributor and Service Roads in Osogbo as shown in Table 11 reveals that Ojaoba – Station Road recorded the highest volume of traffic at morning peak with 5,710 vph (45.2%). Station Road – Oluode was found to have the lowest volume of traffic with 1,337 vph (10.6%) at morning peak. For the afternoon peak, Olaiya – Abeere Road recorded the highest volume of

traffic with 20885 vph (49.0%). This was followed by Ojaoba – Station Road with vph 14,513 (34.1%) and the least volume of traffic occurs in Station Road – Oluode with 7181 vph (16.9%) at afternoon peak.

4.3: Perceptions of road users on the effects of speed breakers on the road, vehicles and road users in the study area

Under this sub-section of the study, an attempt was made to examine the perceptions of road users on the effects of speed breakers on the road, vehicles and road users in the study area.

Table 11 shows the number of respondents who were vehicle owners. The table reveals that on the major roads, 50.0% of respondents were vehicle owners while 50.0% do not own a vehicle. On distributor roads, 63.5% of respondents were vehicle owners while 36.5% do not own a vehicle and on service roads, 79.1% of respondents were vehicle owners while 20.9%% do not own a vehicle. Altogether, 64% of the total respondents across all roads were vehicle owners while 36.0% do not own any vehicle.

Table 9: Summary of Traffic Counts in the selected Major, Distributor and Service roads in Osogbo

S/N	Types of vehicles	Major Road	Distributor Road	Service Road
	Private car	39124	23232	8080
	Passenger bus	14876	2618	102
	Private bus	1637	669	126
	Minibus (Korope)	33690	28840	777
	Truck or van	3959	1003	152
	Tricycle	308	216	106
	Motorcycle	46446	95123	53168
	Others	137	11	0
	Total	**140177**	**151712**	**62511**

Source: Authors' Fieldwork, (2022)

Table 10: Average Volume of Traffic at Major, Distributor and Service Roads in Osogbo

S/N	Road Name	Morning Peak (7-8 am)		Afternoon Peak (4-5 pm)	
		VPH	% of total	VPH	% of total
1.	Olaiya – Abeere	5582	44.2	20885	49.0
2.	Ojaoba – Station Road	5710	45.2	14513	34.1
3.	Station Road – Oluode	1337	10.6	7181	16.9
	Total	12629	100	42579	100

Source: Authors' Fieldwork, (2022) VPH= Vehicle Per Hour

Table 11: Vehicle ownership of respondents

Road Type		Vehicle ownership		Total
		Yes	No	
Major Road	F		22	44
	% of Row	.0	50.0	100.0
	% of Column	.4	37.9	27.3
Distributor Road	F		27	74
	% of Row	.5	36.5	100.0
	% of Column	.6	46.6	46.0
Service Road	F		9	43
	% of Row	.1	20.9	100.0
	% of Column	.0	15.5	26.7
Total	F	3	58	161
	% of Row	.0	36.0	100.0
	% of Column	0.0	100.0	100.0

F= Frequency, %= Percentage
Source: Authors' Fieldwork, (2022)

Table 12: Type of vehicle owned by vehicle owners

Road type		Type of vehicle owned							Total
		Bus	Minibus	Car	Motorcyce	Tricycle	Lorry	Truck	
Major road	F	1	4	8	11	1	0	1	26
	% of Row	3.8	15.4	30.8	42.3	3.8	0.0	3.8	100.0
	% of Column	16.7	16.0	26.7	28.2	10.0	0.0	25.0	22.6
Distributor road	F	3	19	13	13	1	1	3	53
	% of Row	5.7	35.8	24.5	24.5	1.9	1.9	5.7	100.0
	% of Column	50.0	76.0	43.3	33.3	10.0	100.0	75.0	46.1
Service road	F	2	2	9	15	8	0	0	36
	% of Row	5.6	5.6	25.0	41.7	22.2	0.0	0.0	100.0
	% of Column	33.3	8.0	30.0	38.5	80.0	0.0	0.0	31.3
Total	F	6	25	30	39	10	1	4	115
	% of Row	5.2	21.7	26.1	33.9	8.7	0.9	3.5	100.0
	% of Column	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

F= Frequency, %= Percentage
Source: Authors' Fieldwork, (2022)

Table 13: Respondent's Perception of the Condition of the Speed Breakers

Road Type		Condition of the speed breaker					Total
		Excellent	Good	Fair	Poor	Very poor	
Major road	F	7	28	9	0	0	44
	% of Row	15.9	63.6	20.5	0.0	0.0	100.0
	% of Column	29.2	31.5	19.6	0.0	0.0	27.3
Distributor road	F	9	44	20	1	0	74
	% of Row	12.2	59.5	27.0	1.4	0.0	100.0
	% of Column	37.5	49.4	43.5	100.0	0.0	46.0
Service road	F	8	17	17	0	1	43
	% of Row	18.6	39.5	39.5	0.0	2.3	100.0
	% of Column	33.3	19.1	37.0	0.0	100.0	26.7

Total	F	24	89	46	1	1	161
	% of Row	14.9	55.3	28.6	0.6	0.6	100.0
	% of Column	100.0	100.0	100.0	100.0	100.0	100.0

X^2= 10.321, df=8, P>0.05= 0.243 F= Frequency, %= Percentage
Source: Authors' Fieldwork, (2022)

Table 12 shows the types of vehicles owned by respondents who were vehicle owners. The table reveals that motorcycle owners accounted for the highest percentage (33.9%) of respondents across the study area. This was followed by car owners, (26.1%), minibus (21.7%), tricycle owners (8.7%), bus owners (5.2%), truck owners (3.5%) and lorry owners (0.9%) accounted for the least percentage of vehicle owners in the study area.

It was observed from Table 13 that 15.9% of respondents indicated that speed breakers on major roads were in excellent condition while 63.6% reported that speed breakers on major roads were in good condition and 20.5% indicated that the condition of speed breakers on major roads was fair. This indicates that the majority of the speed breakers on the major roads were in good condition. From the table, it was also revealed that 12.2% of respondents indicated that speed breakers on distributor roads were in excellent condition while 59.5% maintained that speed breakers on distributor roads were in good condition, 27.0% indicated that the condition of speed breakers on distributor road was fair while 1.4% declared that the condition of speed breakers on distributor road is poor. This indicates that the majority of the speed breakers on the distributor roads were in good condition.

Likewise, it was discovered that 18.6% of respondents indicated that speed breakers on service roads were in excellent condition, 39.5% indicated that speed breakers on service roads were in good condition, 17 39.5% maintained that it was fair while 2.3% remarked that it was very poor. This indicates that the majority of the speed breakers on the service roads were in good condition. The chi-square statistics reported for the analysis show that there is no significant difference in the responses of respondents on the condition of speed breakers in the study area: X^2= 10.321, df=8, P>0.05= 0.243.

Table 14 showcases the varied reasons for installing speed breakers across major, distributor, and service roads. Approximately 26.7% of respondents cited the aim to reduce accidents as a prime motive for speed breaker installation, while 6.8% mentioned regulating traffic. Only 0.6% highlighted reducing accident fatalities as a specific reason. Moreover, 15.5% indicated that speed breakers were installed to enhance pedestrian safety, and the most prevalent reason, cited by 50.3% of respondents, was to lower vehicle speed. The data suggests that the primary purpose behind speed breaker installation across these roads was to reduce vehicle speed. This action not only contributes to diminishing accidents related to excessive speed but also plays a significant role in reducing collision fatalities and enhancing pedestrian safety.

Table 14: Reason for the installation of speed breaker

Road type		Reason for the installation of speed breaker(s) on this road					
		To reduce accident	To regulate traffic	To reduce accident fatality	To improve safety for pedestrians	Reduction of vehicle speed	Total
Major Road	F	13	4	0	3	24	44
	% of Row	29.5	9.1	0.0	6.8	54.5	100.0
	% of Column	30.2	36.4	0.0	12.0	29.6	27.3
Distributor	F	17	4	0	13	40	74
Road	% of Row	23.0	5.4	0.0	17.6	54.1	100.0
	% of Column	39.5	36.4	0.0	52.0	49.4	46.0
Service	F	13	3	1	9	17	43
Road	% of Row	30.2	7.0	2.3	20.9	39.5	100.0
	% of Column	30.2	27.3	100.0	36.0	21.0	26.7
Total	F	43	11	1	25	81	161
	% of Row	26.7	6.8	0.6	15.5	50.3	100.0
	% of Column	100.0	100.0	100.0	100.0	100.0	100.0

F= Frequency, %= Percentage
Source: Authors' Fieldwork, (2022)

Table 15: Ratings of the Negative Effects of Speed Breakers in Osogbo

S/N	Negative effects	Rating					NR (f)	SWV	MWV	Rank
		5	4	3	2	1				
	Damage to vehicle	45	216	138	68	18	161	485	**3.01**	**3rd**
	Decrease in vehicle life span	15	144	144	82	33	161	418	**2.61**	**8th**
	Damage to the engine and suspension of components	65	116	147	64	38	161	430	**2.67**	**7th**
	Deterioration of vehicle bottom	105	152	141	46	32	161	476	**2.97**	**5th**
	Wear and tears and brakes and tyres	55	144	126	68	38	161	431	**2.68**	**6th**
	Fuel consumption level	10	160	129	34	59	161	392	**2.43**	**10th**
	Additional cost to operators	40	116	102	44	68	161	370	**2.31**	**12th**
	Decrease in overall efficiency of vehicles	0	144	144	92	19	161	399	**2.48**	**9th**
	Environmental impacts	85	76	102	76	53	161	392	**2.43**	**11th**
.	Headache	50	256	96	54	27	161	483	**3.00**	**4th**
.	Back pain	120	256	81	38	27	161	522	**3.24**	**1st**
.	Neck pain	115	216	72	84	18	161	505	**3.14**	**2nd**
.	Damage to road	65	104	51	54	78	161	352	**2.19**	**13th**
									35.16	

Mean of ∑ MWV/n= 35.16/13 = 2.70
Source: Authors' Fieldwork, (2022)

Table 15 presents the ratings of the negative effects caused by speed breakers in the surveyed area, utilizing a Likert scale to gauge the extent of these effects. Respondents attributed various degrees of impact using the scale: very high (5), high (4), fairly high (3), low (2), and very low (1). The RWV (Rating Weight Value) was computed by summing the product of the total responses per variable and their corresponding weight assigned in the scale.

The analysis of the ratings revealed that back pain had the highest mean weighted value of 3.24, signifying a substantial occurrence of back pain due to speed breakers in Osogbo. Following this, neck pain obtained a mean weighted value of 3.14, and other prominent negative effects included damage to the vehicle (3.01), headache (3.00), deterioration of the vehicle bottom (2.97), and wear and tear of brakes and tyres (2.68), among others, indicating a descending order of the severity of negative effects caused by speed breakers in the area. Chukwugozi's (2014) findings align with the observed occurrences of neck and back pain due to speed breakers. This correlation emphasizes the need for measures to mitigate these health concerns associated with road features like speed breakers.

The overall mean value of respondents' ratings regarding the negative effects of speed breakers amounted to 2.70. This suggests that, on average, respondents identified the negative impact of speed breakers to be relatively high in the surveyed area. This situation, though concerning, is crucial to address as these negative effects not only impact road users' health but also lead to increased expenses. Hence, there is a pressing need to mitigate these negative effects and improve the installation of future speed breakers to minimize their adverse impact.

Table 16 reveals the ratings of the positive effects of speed breakers in the study area. The Likert scale was used to weigh the degree of negative effects of speed breakers. This is done by attaching values of weight to the different degrees of responses as shown: very high (5) high (4) fairly high (3) low (2) very low (1). The RWV (Rating Weight Value) was obtained by summing up the product of the total number of responses to each variable and the weight attached to each rating i.e. (a x 5) + (b x 4) + (c x 3) + (d x 2) + (e x 1). The mean used in the course of computation was also obtained by summing up the SWV and dividing it by the total number of variables, 161. From Table 17, it was observed that reduction of vehicle speed has the highest mean weighted value of 4.63. This implies that the reduction of vehicle speed due to speed breakers was high in Osogbo. It's interesting to note that Chukwugozi's (2014) findings might resonate with the positive effect of speed breakers in reducing vehicle speed. This correlation reinforces the intended purpose of speed breakers—to slow down vehicles and enhance safety This situation was followed in decreasing order by safety improvement for pedestrians which had a mean weighted value of 4.24, reduction of accidents (4.23); and reduction in the severity of injury during a collision (4.02); indicating decreasing level of positive effects of speed breakers in the study area. Likewise, the overall mean value of responses to the rate of negative effects of speed breakers as obtained from the respondents was 4.28. This shows that the mean responses of the respondents were above average indicating that the rate of positive effects of speed breakers was very high in the study area.

Table 16: Ratings of the Positive Effects of Speed Breakers in Osogbo

S/N	Positive effects	Rating					NR (f)	SWV	MWV	Rank
		5	4	3	2	1				
	Safety improvement for pedestrians	305	336	33	8	1	161	683	**4.24**	**2nd**
	Reduction of accidents	290	364	15	12	1	161	682	**4.23**	**3rd**
	Reduction in severity of injury during a collision	235	324	69	18	1	161	647	**4.02**	**4th**
	Reduction of vehicle speed	550	176	18	0	1	161	745	**4.63**	**1st**
									17.13	

Mean of ∑ MWV/n= 17.13/4 = 4.28
Source: Authors' Fieldwork, (2022)

Table 17: ANOVA of differences in the design and characteristics of speed breakers

		Sum of Squares	Df	Mean Square	F	Sig.
Type of speed breaker	Between Groups	0.000	8	0.000	0.000	0.000
	Within Groups	0.000	46	0.000		
	Total	0.000	54			
Material of speed breaker	Between Groups	0.583	8	0.073	2.368	0.032
	Within Groups	1.417	46	0.031		
	Total	2.000	54			
Shape of speed breaker	Between Groups	14.352	8	1.794	21.964	0.000
	Within Groups	3.757	46	0.082		
	Total	18.109	54			
Condition of speed breaker	Between Groups	7.693	8	0.962	2.642	0.018
	Within Groups	16.744	46	0.364		
	Total	24.436	54			

Source: Authors' Fieldwork, (2022)

4.3 Research Hypothesis: There is a significant difference in the design and characteristics of speed breakers in the study area.

Table 17 demonstrates the ratings concerning the positive effects attributed to speed breakers in the surveyed area, using a Likert scale to evaluate these effects. Respondents used a scale including very high (5), high (4), fairly high (3), low (2), and very low (1) to assess the extent of these effects. The RWV (Rating Weight Value) was calculated by summing the product of the total responses per variable and their corresponding weight on the scale. This helped determine the mean weighted value for each positive effect. The analysis showed that the reduction of vehicle speed obtained the highest mean weighted value of 4.63, indicating a substantial reduction in vehicle speed due to speed breakers in Osogbo. Following this, safety improvement for pedestrians garnered a mean weighted value of 4.24, a reduction in accidents

(4.23), and a reduction in the severity of injury during collisions (4.02), indicating a descending order of the positive effects of speed breakers in the area.

The overall mean value of respondents' ratings regarding the positive effects of speed breakers was 4.28. This suggests that, on average, respondents perceived the positive impact of speed breakers to be very high in the surveyed area. Notably, these positive effects included significant improvements in pedestrian safety, a reduction in accidents, minimized severity of injuries during collisions, and a substantial decrease in vehicle speed, emphasizing the beneficial aspects of speed breaker installations in the area.

5. Discussion of Findings

The findings presented in this section encapsulate a comprehensive examination of road traffic speed breakers in Osogbo, Osun State. Through meticulous observation, data collection, and analysis, this study sought to unravel the issues surrounding the design, conditions, and effects of speed breakers within this study area.

5.1 Design and Characteristics of Speed Breakers

The observed diversity in speed hump dimensions highlights the importance of tailored designs for effective traffic control. Longer and wider speed humps exhibited a greater potential to deter speeding vehicles, particularly in high-density traffic areas. Notably, the condition of speed breakers significantly influences their functionality. While the majority were in good condition, instances of wear, potholes, or partial removal compromised their effectiveness in regulating traffic and ensuring road safety. This aligns with Asefa *et al.*'s (2020) findings, which emphasized that the effectiveness of speed reducers, although known to reduce collisions, can be affected by several factors, hindering the overall effectiveness of speed breakers in ensuring road safety and regulating traffic flow. Addressing the diverse conditions of speed breakers, especially potholes and wear, is paramount to enhancing road safety (Raghupathi and Vedagiri, 2020). Korr *et al*. (2019) posited that maintaining and standardizing speed hump designs can mitigate safety risks and improve overall traffic regulation. The study further emphasized standardized dimensions for speed breakers which could ensure consistent traffic calming measures. Uniform design across roads might optimize their efficiency in controlling traffic speed. Standardized speed breaker dimensions could play a pivotal role in ensuring consistent traffic calming effects across diverse road sections. Consistent design would streamline traffic regulation and safety measures. The study's emphasis on standardised dimensions echoes the importance highlighted by Shwaly *et al*., (2018) reinforcing the notion that proper adherence to installation standards is crucial for the optimal functionality of speed breakers in traffic regulation.

5.2 Traffic Composition and Volume

The prevalence of motorcycles as the primary mode of transport indicates the need for accommodating road infrastructure. Motorcycles' dominance suggests their influence on traffic flow and safety involving speed breakers. While motorcycles are prevalent, private cars and mini-buses contribute significantly to traffic. Lower usage by other vehicles like passenger buses, trucks/vans, and tricycles suggests diverse dynamics for different vehicle types. With the prevalence of motorcycles, road infrastructure must

accommodate this mode of transport effectively. This includes optimizing speed breaker designs to ensure their effectiveness for motorcycles, considering their dominance on these roads. Chepchieng *et al*. (2012) echoed similar sentiments regarding the prevalence of motorcycles in urban transport. Their study emphasized how urban transport policies, including regulations, parking availability, and policies on motorcycle trade, significantly impact the prevalence of motorcycles in towns.

The traffic count indicates a higher volume on distributor roads than on major roads and a further decline on service roads. Motorcycles, private cars, and mini-buses were the predominant modes of transportation in Osogbo, influencing overall traffic patterns. Different roads experienced varying traffic volumes during peak hours. For instance, Ojaoba – Station Road had the highest morning peak traffic, while Olaiya – Abeere Road recorded the highest during the afternoon peak. This disparity implies varied traffic dynamics during different hours on different roads. Salisu and Oyesiku (2020), examining traffic surveys in Ogun State, similarly found higher traffic volumes on distributor roads compared to major roads, with further declines on service roads. Their study also highlighted the predominance of Car/SUV vehicular types on Nigerian roads. They also observed varying peak periods between different roads, emphasizing the need to consider distinct traffic patterns on different roads and at different times for effective traffic management and infrastructure planning.

5.3 Reasons and Effects of Speed Breakers

According to the study, the predominant reason for installing speed breakers across roads was to reduce vehicle speed (50.3%). Other motives included enhancing pedestrian safety (15.5%) and reducing accidents (26.7%). In a study by Damsere-Derry *et al*. (2019) in Ghana, traffic calming measures aimed to lower vehicular speeds and subsequently reduce both the frequency and severity of pedestrian injuries in built-up areas. Similarly, Arbogast *et al*. (2018) emphasized the installation of speed humps as a means to decrease vehicle speeds, thereby contributing to reducing pedestrian injuries and accidents. Respondents identified back pain (3.24) and neck pain (3.14) as the most severe negative effects of speed breakers, followed by vehicle damage (3.01) and headaches (3.00).

Chukwugozi's study in Ondo Southwestern Nigeria (2014) also found that the majority of participants did not support speed bump installations due to their negative implications, particularly the damage to vehicles and the adverse impact on human health, including causing back and neck pains. Speed breakers were perceived to have a significant positive impact on reducing vehicle speed (4.63), improving pedestrian safety (4.24), and reducing accidents (4.23). These ratings indicate high perceived benefits from speed breaker installations. This underscores the necessity for a nuanced approach to speed breaker design and placement to balance safety considerations and mitigate adverse impacts on road users' well-being. Addressing these findings can pave the way for enhanced road safety and infrastructure planning in Osogbo.

6. Contribution to knowledge and opportunity for further research

The conducted research on the nature and characteristics of road traffic speed breakers in Osogbo provides valuable insights into their impact on road safety,

vehicular conditions, and the perceptions of road users. It contributes significantly to the existing knowledge by highlighting several crucial aspects. It evaluates the condition of speed breakers across different road types, offering a snapshot of their state. This analysis could guide maintenance efforts or inform future installations to improve road safety without causing excessive wear on vehicles. Furthermore, the study comprehensively assesses both the positive and negative impacts of speed breakers on road users and vehicles. It delves into the effects on vehicle wear and tear, potential health implications for passengers, and the broader implications on road safety. By gathering perceptions from respondents, the research offers a glimpse into how speed breakers are viewed by those directly affected. This perception analysis can help policymakers understand public sentiment towards these road features.

Opportunities for further research in this area include conducting longitudinal studies to assess the prolonged effects of speed breakers on roads, vehicles, and users' health could offer a more comprehensive understanding of their impacts over time. Comparing the effectiveness and impacts of various types of speed breakers (asphalt, rubber, etc.) on road safety, traffic flow, and vehicle maintenance can also help identify the most efficient options. Exploring driver behaviours in response to speed breakers and their influence on accident rates, vehicular wear, and pedestrian safety can further provide insights into how drivers adapt and react to these road features.

7. Conclusion and Policy Issues

It was observed from the research findings that the only type of speed breaker installed on roads in the study area were speed humps with variations in their characteristics in terms of length, width and height. They also differ in the types of material they are made of, shape and condition. Furthermore, motorcycles, private cars, and minibuses (korope) were established as the most dominant modes of transportation in Osogbo. Back pain occurrence due to the installation of speed breakers on the road of Osogbo was noted to be a high disadvantage. While reduction of vehicle speed had the highest advantage. Findings from Analysis of Variance (ANOVA) revealed that there was statistically significant variation in the design and characteristics of road traffic speed breakers in Osogbo at $p<0.05$ confidence level.

Based on the findings of the study, the following recommendations were made: to ensure the sustainability of these installed speed breakers, it is recommended that the installed devices should be properly maintained. Stormwater drainage should be provided along roads in order to minimize the rate of potholes being developed. Standard measurement of speed breakers should be followed and perhaps reviewed too for installation of speed breakers in the future. The government should install signage systems to create awareness for road users which could further enhance the safety of road users. To minimize the negative effects of traditional speed breakers like speed humps and bumps, smart speed breakers may be initiated such as automated 3-D painting speed breakers, BIV (Intelligent Speed Bump, Acti-bump anti-speeding systems, etc.

References

Abdulmawjoud, A. A., Jamel, M. G., and Al-Taei, A. A. (2021). Traffic flow parameters development modelling at

traffic calming measures located on arterial roads. *Ain Shams Engineering Journal*, *12*(1), 437-444.

Arbogast, H., Patao, M., Demeter, N., Bachman, S., Devietti, E., Upperman, J. S., and Burke, R. V. (2018). The effectiveness of installing a speed hump in reducing motor vehicle accidents involving pedestrians under the age of 21. *Journal of Transport and Health*, *8*, 30-34.

Archer, J., Fotheringham, N., Symmons, M., and Corben, B. (2008). The impact of lowering speed limits in urban and metropolitan areas. Monash University: Accident Research Centre.

Asefa, N., Yang, H. S., Kahsay, Z. H., Hassen, A., and Gebrehiwot, T. G. (2020). Effectiveness of transverse speed reducers and exploring factors contributing to road traffic crashes on a rural two-lane highway: A mixed methods study.

Choudhary, P., Imprialou, M., Velaga, N. R., and Choudhary, A. (2018). Impacts of speed variations on freeway crashes by severity and vehicle type. *Accident Analysis & Prevention*, *121*, 213-222.

Chepchieng, J., Kyalo, D., and Mulwa, A. (2012). The influence of urban transport policy on the growth of motorcycles and tricycles in Kenya.

Chukwugozi, R., P. (2014). 'Is Speed bumps Installation Panacea for Road Traffic Crash Prevention?" An Evaluation of Selected Civil Engineering Journal Vol. 4, No. 6, June, 2018 1221 Major Routes in Ondo, Southwestern Nigeria." IOSR Journal of Humanities and Social Science (IOSR-JHSS), 19.5(2014): pp 79–98.

Damsere-Derry, J., Ebel, B. E., Mock, C. N., Afukaar, F., Donkor, P., and Kalowole, T. O. (2019). Evaluation of the effectiveness of traffic calming measures on vehicle speeds and pedestrian injury severity in Ghana. *Traffic injury prevention*, *20*(3), 336-342.

Dhivyadeepa, E. (2015). *Sampling techniques in educational research*. Lulu. com.

Goniewicz, K., Goniewicz, M., Pawłowski, W., and Fiedor, P. (2016). Road accident rates: strategies and programmes for improving road traffic safety. *European journal of trauma and emergency surgery*, *42*, 433-438.

Jean-Paul, R. (2021). Constraints in the Canadian Transport Infrastructure Grid. *The School of Public Policy Publications (SPPP)*, *14*.

Korr, R. K., Molugaram, K., Bonala, A., and Thabassum, S. (2019). Impact analysis of speed humps on Indian roads. *Journal of the Eastern Asia Society for Transportation Studies*, *13*, 2073-2090.

Ndoke, P. N., James, O., and Kolo, S. S. (2014). Road Humps as Traffic Calming Device on Urban Roads.

Nieuwenhuijsen, M. J. (2020). Urban and transport planning pathways to carbon neutral, liveable and healthy cities; A review of the current evidence. *Environment International, 140*, 105661.

Nordiana Mashros, Muhammad Faizudin, Aztri Y.K, Sitti Asmah, Norhidayah A.H and Nor Zurairahetty, (2020). Evaluating the Effectiveness of Road Humps in Reducing Vehicle Speed: Case Study of a University Campus. International Journal of Advance Engineering and Research Development, 10(2), 814-820

Porru, S., Misso, F. E., Pani, F. E., and Repetto, C. (2020). Smart mobility and public transport: Opportunities and challenges in rural and urban areas. *Journal of traffic and transportation engineering (English edition)*, *7*(1), 88-97.

Raghupathi, K., and Vedagiri, P. (2020). Investigation of Effectiveness of Traffic Calming Measures on Urban Streets under Mixed Traffic Conditions. *Transportation Research Part A: Policy and Practice*, 00067-6.

Salau, T. A., Adeyefa, A. O., and Oke, S. A. (2004). Vehicle speed control using road bumps. Transport - 2004, Vol XIX, No 3, pp. 130 - 136.

Salisu, U. O., and Oyesiku, O. O. (2020). Traffic survey analysis: implications for road transport planning in
.

Nigeria. *LOGI–Scientific Journal on Transport and Logistics*, *11*(2), 12-22.

Shwaly, S., Amal, A. A., and Zakaria, M. H. (2018). Public evaluation of speed humps performance and effectiveness. *Civil Engineering Journal*, *4*(6), 1206-1222.

U.S. Department of Transportation (2019). Traffic Calming to Slow Vehicle Speeds.
World Health Organization. (2014). Road safety-speed. Retrieved from http://www.who.int/ violence injury prevention.

Zannat, K. E., and Choudhury, C. F. (2019). Emerging big data sources for public transport planning: A systematic review on current state of art and future research directions. *Journal of the Indian Institute of Science*, *99*(4), 601-619

Spatial Analysis of Journey-to-School by Secondary School Students in Minna, Nigeria

Akande, O[1]., Adeleye B. M[1], Musa, H.D[1]., Medayese, S. O. [1], Odumosu, Yemi[2]., and Morenikeji, Wole[1]

[1]Department of Urban & Regional Planning, Fed University of Tech., Minna, Nigeria.
[2]Department of Surveying and Geoinformatics, Federal University, Oye Ekiti, Ekiti.
Corresponding Email: banji.adeleye@futminna.edu.ng

Abstract

Education infrastructure planning is an integral part of society amidst the rapid urbanisation experienced in Nigerian cities. This study analysed the Journey-to-School of public and private secondary school students in Minna, Nigeria. The study's objectives were to examine the spatial analysis of public and private secondary schools and the distance covered by the students from home to school in Minna. Quantitative data were collected from 8422 students in 107 schools comprising 20 public and 87 private secondary schools. Data collected were corroborated with geographic information analysis. The study reveals that the average distance covered (2.70km) by students attending public schools is more than the distance covered (2.07km) by students attending private secondary schools. The study further reveals that 53.19% of the students in public schools travel more than 2 km to school daily, but with the inclusion of private schools, the percentage of students travelling above 2 km to school daily was reduced by 10%. The study concludes that the cluster and the random distribution in private and public secondary schools are indications of poor education infrastructure planning. The study, therefore, recommends proper education infrastructure planning and that public schools should be provided in neighbourhoods where students travel more than 5 km daily to access secondary education

Keywords: *Spatial Analysis, Home-School Distance, Journey-to-School, Public Schools, Private Schools*

1.0 Introduction

Location and allocation principles are of great importance in facilities planning. They help determine the optimal quantity and location of facilities that will ensure maximum utilisation and distance minimisation. Insufficient supply of schools can lead to a lack of education opportunities for students and longer travel distances, while too many schools in one area can result in low enrolment rates, underutilisation and resource wastage. Longer home-school distances have been shown to have an impact on students. It has been found to lead to increased transportation costs **(**He and Giuliano 2018)**,** increased commuting time (Idowu, 2016)**,** and decreased student academic performance (Mhiliwa, 2015).

By 2030, all girls and boys in Nigeria are expected to have acquired complete, free, equitable and quality primary and secondary education (United Nations, 2015.). This requires the establishment of schools in the right quantity, quality, cost and distribution in order to be accessible to the citizens irrespective of their economic status. However, studies (Tarkhnishvili et al., 2022; United Nations

Educational Scientific and Cultural Organization, 2021) have shown that public authorities are not able to supply enough schools, hence the emergence of private schools to fill in the gap, but at a cost. As comprehensively documented by Day et al. (2014), there is moderate strength evidence that private schools tend to be more expensive than state schools in terms of both school fees and hidden costs such as uniforms and books. However, because of the perceived higher quality of outcomes, parents who can afford the cost are prepared to enrol their children in these private schools. As noted by OECD (2012), one reason could be that parents believe that these schools offer a better education, an environment more conducive to learning, additional resources, and better policies and practices, and advantaged parents are more informed or aware of the differences in quality across schools.

Different researchers have examined the various dimensions of home-school distance from various angles. Mantovan et al. (2021) examined the home-school distances and the percentage of students who choose schools farther from their homes in Milan, Italy. They found that there is almost no difference in school proximity between native and immigrant-origin students. However, native students are more likely to attend schools that are farther from their homes. The analysis only considers students in the final year of lower secondary education.

In another study, Oneya and Onyango (2021) examined the perceived effect of distance-related variables on students' academic performance in community secondary schools in Rorya District, Tanzania. The study found that long distances travelled by students have negative effects on their academic performance. It leads to reduced teacher-student contact time, as students spend more time travelling to and from school. The sample size of 87 respondents may not be fully representative of the entire population of stakeholders in community secondary schools in Rorya District. The study relies on self-reported perceptions of school stakeholders, which may be subject to biases and inaccuracies.

In Nigeria, the spatial distribution and proximal model of secondary educational facilities in Oyo State, Nigeria's Ibadan South West, are the main focus of a study by Agbabiaka et al. (2020). With a higher concentration of schools in some wards than others, the results showed a dispersed pattern of school distribution. In general, according to their findings, the secondary schools' locations were found to meet UNESCO requirements for school placement. The research was dependent on self-reported information from students and school administrators, which could have included errors or biases. Adewuyi et al. (2022) conducted a study in the same city that revealed school clustering in certain areas of Ibadan and fewer schools in other parts. The study also found that students' mental abilities, academic participation, academic performance, communication with teachers, and feelings of insecurity during travel are significantly impacted by the distance they travel.

Aule et al. (2023) studied how accessible secondary schools are in various parts of Benue State. The study used geostatistical analysis. To examine the spatial distribution of schools and their proximity to populated areas, the researchers employed Geographic Information System (GIS) techniques. The study discovered that

different regions of Benue State had varying degrees of accessibility to secondary schools. A further finding of the analysis was that there was an uneven distribution of schools, with a higher concentration of schools in some areas than in others. Even though this study is extensive, with 8422 questionnaires administered in 120 secondary schools, distance estimation was based on students' perceptions. GPS only captured the school's location. The approaches used by the studies reviewed show that the average nearest neighbourhood analysis was not considered in determining the spatial distribution of schools. This gap was filled in this study; against this background; this study aims at analysing the Journey-to-School by Secondary School Students in Minna, Niger State. The specific objectives considered for this study are:

I. To examine the spatial analysis of public and private secondary schools in Minna;
II. To examine the distance covered by secondary school students from home to school.

2.0 Methodology

The study area was divided into 39 sub-units based on the existing neighbourhoods of Minna to ensure adequate coverage of schools. A Questionnaire prepared on Open Data Kits (ODK) was used as the instrument for data collection. The ODK was preferred because it automatically captures the coordinates of points of interest. The Purposeful sampling technique was adopted because the class sizes were unknown and there is a vast variation in the number of students per class between private and public schools. At least five students were interviewed in each class from Junior Secondary School 1 to 3 to Senior Secondary School 1 to 3. The questionnaire asked about the gender of students, the mode of travel to school, and the neighbourhood in which their houses were located. The coordinates of the schools were automatically captured, while the coordinates of the neighbourhood centres where the students' homes are located were captured from Google Earth during office work. The longitude and latitude coordinates were converted to Eastings and Northings, and thereafter, the origin and destination coordinates were converted to distances. Data were collected from 107 schools and responses were received from, 8871 students in the 107 schools identified. After data cleaning, 8,422 responses were accepted for analysis. This total may vary due to missing information on one or two of the variables.

The threshold distance of 2km was adopted as the ideal travel distance for a secondary student (Duze, 2011; Kanayochukwu et al., 2020**)**. To this effect, a buffer of a 2km radius was created around the private and public secondary schools to ascertain the neighbourhoods in which secondary school students travel beyond the 2km mark.

2.1 Ethical consideration

Consent was sought from the school principals before the students could participate in the research. The identity of students who participated in this research was protected; no student was coerced to participate in the research.

3.0 Data Analysis

3.1 Descriptive analysis

A total of 20 public and 87 private secondary schools in operation were found in the comprehensive survey carried out in the city of Minna, central Nigeria. Table 1 reveals that 52.16% of the respondents in both public and private secondary schools were males while 47.84% of students were female in both private and public secondary schools. The number of students from sampled Classes one to six that is, Junior Secondary 1 (JS 1) to Senior Secondary 3 (SS 3) varied from 1,052 in SS3 to 1,633 in JS 1 as shown in Table 1

3.2 Mode of Journey-to-School

The majority of the students (42.0%) undertook the journey to school on foot, the second highest mode of transport was the tricycle as 2582 (30.7%) students used the mode. The choice of tricycles by 30.7% of the students can be attributed to the acceptance of tricycles as a mode of transportation in all Nigerian cities (Adeyemi and Yusuf, 2019). The study reveals that 1689 (20.0%) of the students use motorcycles due to the opinion that the mode is fast. This perception was also shared by Igwe and Osisioma, (2023) who opined that motorcycles are fast at accessing roads and getting to one's destination in time. Other modes of transportation used by the students in the study area were private cars (4.6%), school buses (1.6%), taxis (0.1%) and bicycles (1.0%). The students' modes of transportation are explained in Figure 1.

Table 1: Sample population by Gender and School Type

Variable		Counts	% of Total
Gender	Female	4029	47.84 %
	Male	4393	52.16 %
Class	JSS 1	1633	19.39 %
	JSS 2	1624	19.28 %
	JSS 3	1580	18.76 %
	SS 1	1351	16.04 %
	SS 2	1182	14.03 %
	SS 3	1052	12.49 %

Source: Authors analysis, 2023

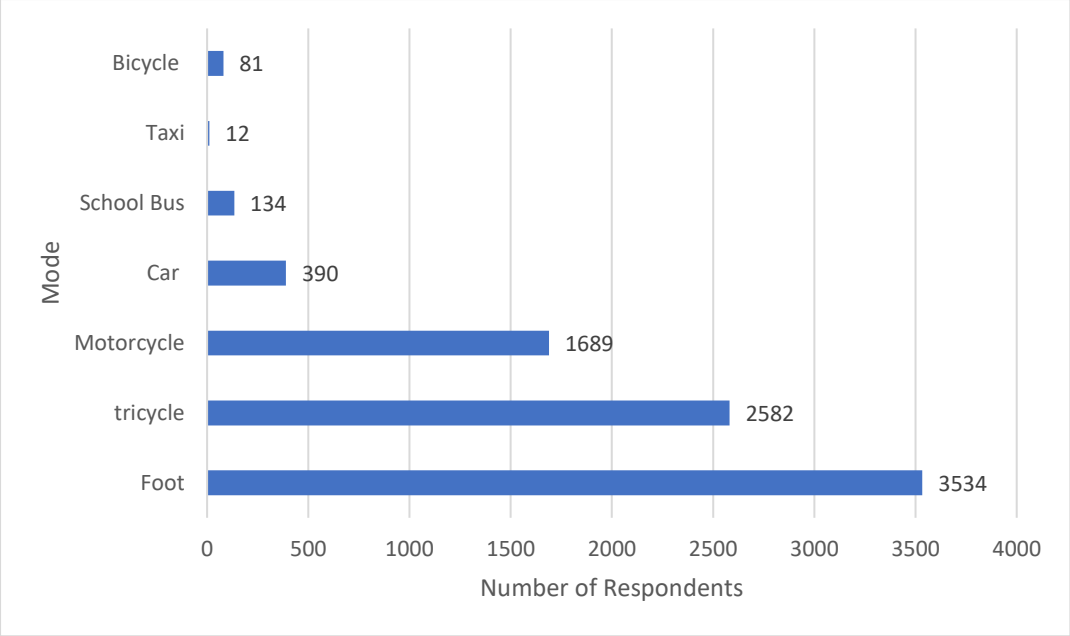


Figure. 1: Mode of Journey-to-School
Source: Authors analysis, 2023

3.3 Data Analysis

Spatial Analysis of Secondary Schools in Minna

In explaining the spatial analysis of secondary schools in Minna the relationship between the secondary schools and bus stops, and the distance travelled to School by Gender in Minna was ascertained. Figure 2 depicts the service area of the bus stops within a five-minute drive in Minna. The study shows that the majority of the public secondary schools (14; 70%) were within five minutes travel time to the bus stop, while six secondary schools were outside the five minutes travel time distance from the bus stop. Similarly, the majority of the private secondary schools (54; 62%) were within five minutes travel time to the school, while 33 (38%) were outside the minimum five minutes travel time from the bus stop. This implies that students who travel by mechanical means (tricycle, taxi, school bus) may have to make part of their trip on foot for more than five minutes before getting their mode.

Pooling all the students together, the median distance travelled by male respondents from home to school was estimated to be 1.43 km per trip which was found to be lower than that of the female students (1.55km) as shown in Table 2. This difference was not found to be statistically significant (U=8,664,254.5, p=.096).

3.4 Spatial Variation of Distance Travelled by Secondary School Students in Minna

The spatial variation of distance travelled in the study area by respondents who attend public secondary school is presented in Figure 3. The result reveals that respondents who reside in Talba Estate, Gurara, Nyikangbe, Kpakungu, Barkin Sale, Sahuka Kahuta, Chanchaga, and Gbeganu travel above 5km from their home to the school. The lengthy travel distance embarked upon by the respondents in these

neighbourhoods can be attributed to the lack of public secondary schools within their neighbourhoods (See Figure 3).

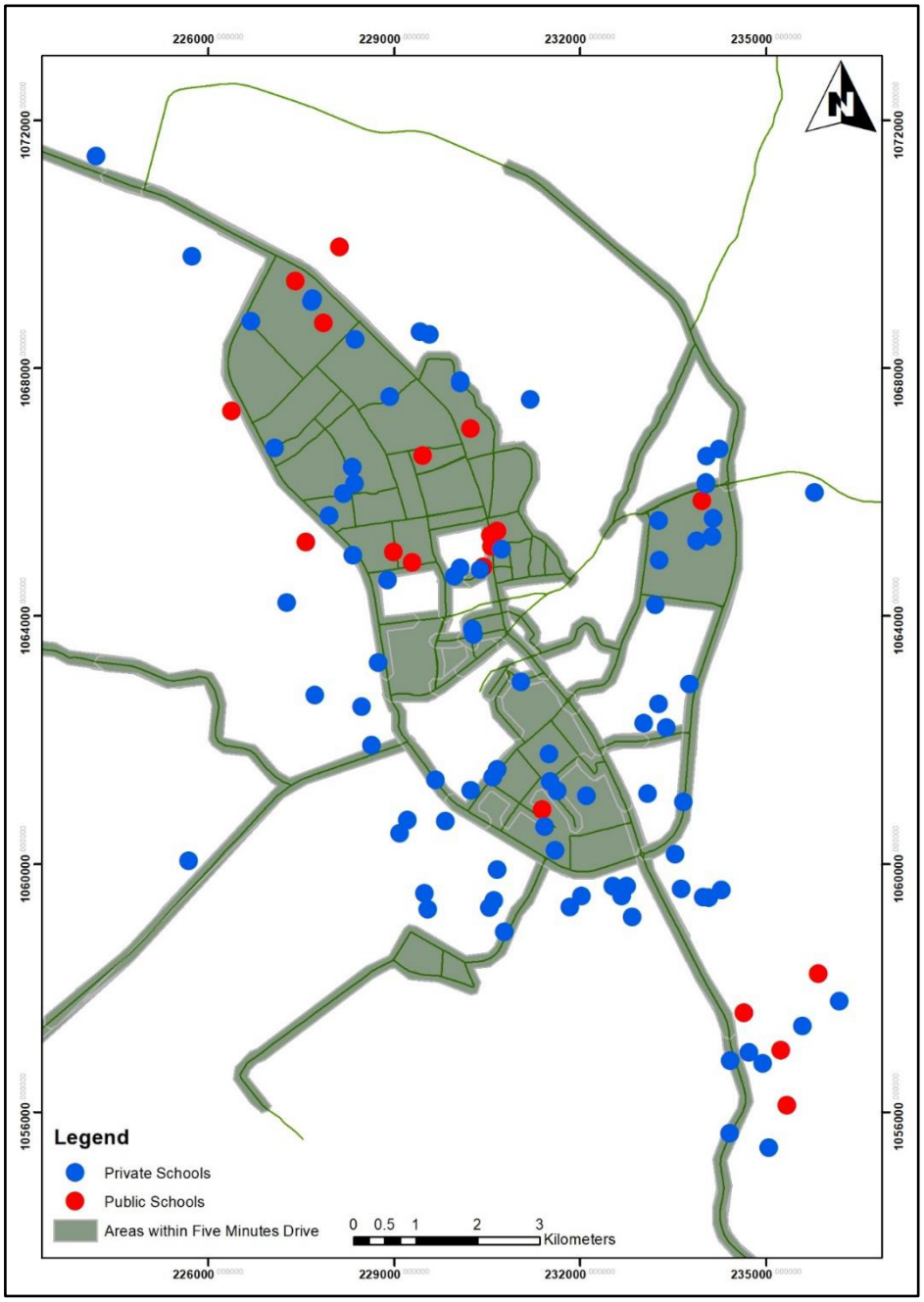


Figure 2: Service area map showing areas within 5mins driving distance from schools
Source: Authors Analysis, 2023

Table 2: Gender and travel distance to school

	Gender	N	Median	SD	Minimum	Maximum
Distance	Female	4029	1.5514	2.2768	0.0138	14.9066
	Male	4393	1.4286	2.2627	0.0248	19.4215

Source: Authors field survey, 2023.

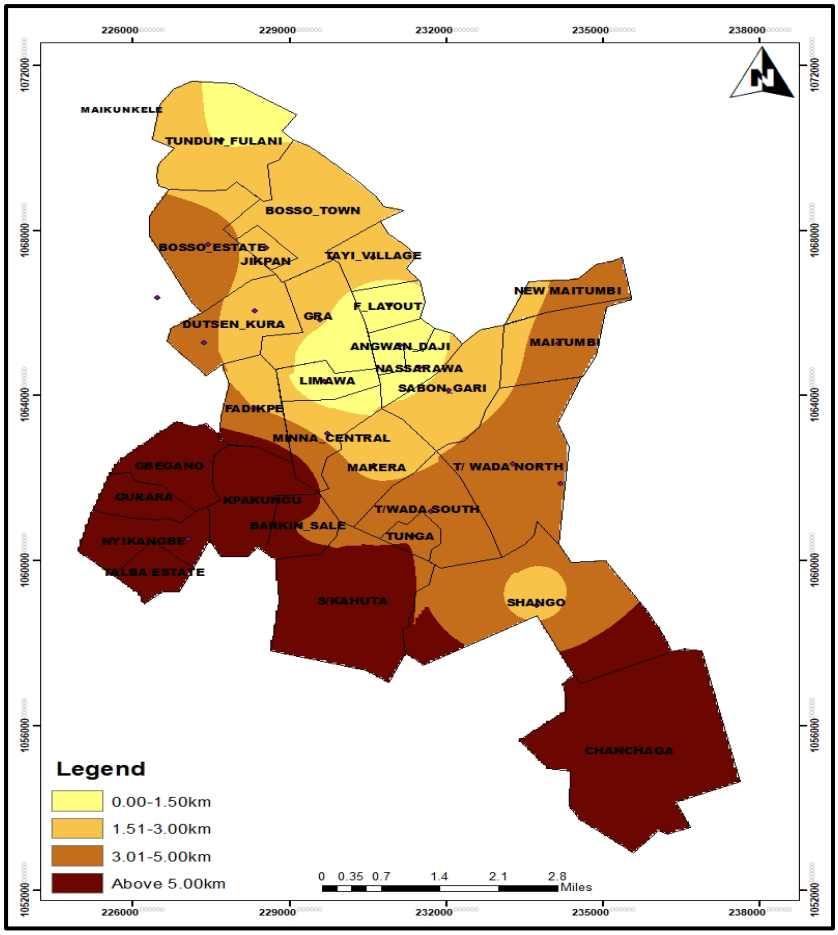


Figure 3: Public School Trip Length
Source: Authors Analysis (2023)

Respondents who take a daily trip of less than 1km daily from their homes to school are those who reside close to the public secondary schools. These respondents were located in Limawa, F-Layout, GRA, and Angwan Daji.

The buffer analysis (2kms) further reveals that only the residents in GRA, F-Layout, Bosso Town, Bosso Estate, Tunga, Jikpan, Dusten Kura Gwari, Dusten Kura Hausa, Fadikpe, and Maitumbi that would travel less than 2km daily from their home to school daily (Figure 4). This shows that students who live in the fringe neighbourhoods travel more distance to attend secondary school education compared to their counterparts who live in the city core where there is a greater concentration of public schools.

The Average Nearest Neighbour Analysis for the spatial distribution of the public secondary schools in the study area reveals a random distribution pattern with a Nearest Neighbour ratio of 1.1199 and a Z score of 1.0259 (see Figure 5). This shows that no distinct effort was deployed in the distribution of public secondary schools across the city (Minna), that is, the schools were randomly distributed across the study area.

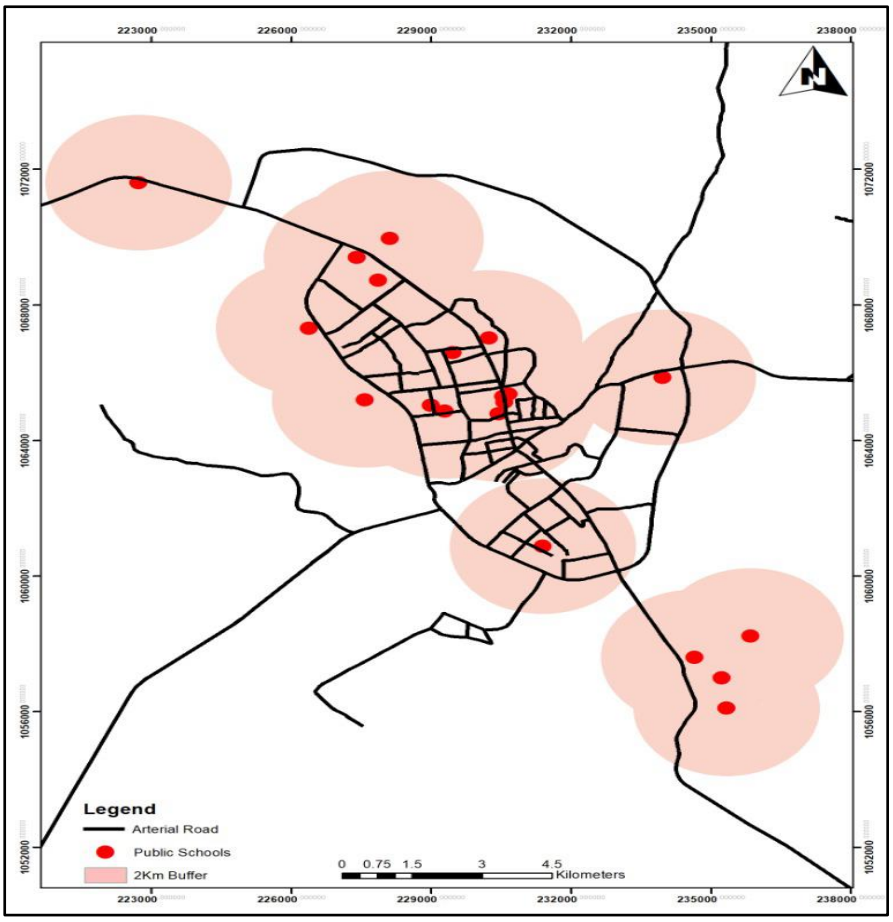


Figure 4: 2kms buffer of Public Secondary Schools in Minna
Source: Authors Analysis (2023)

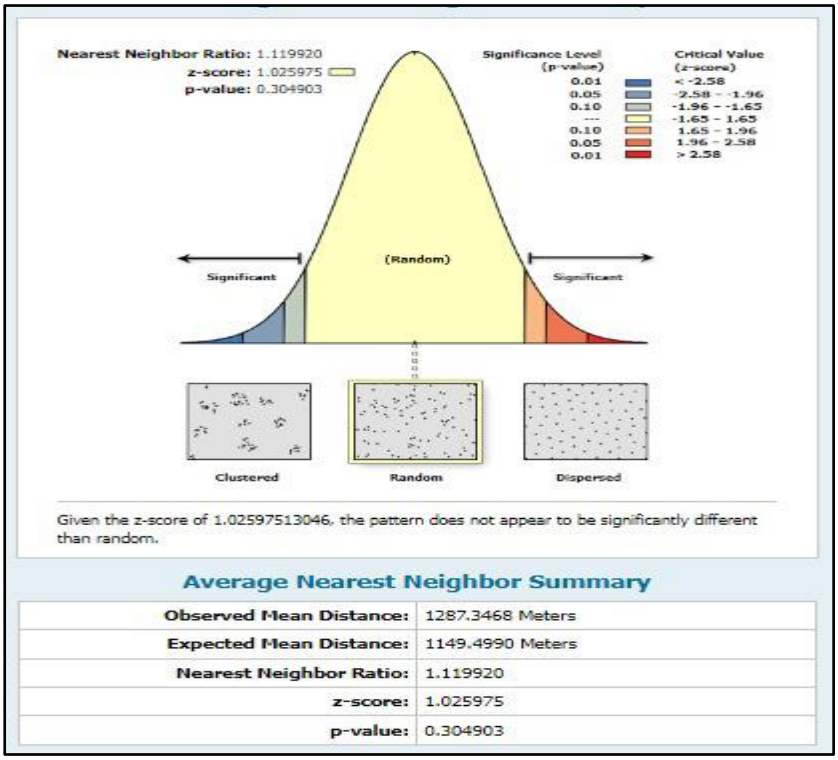


Figure 5: Summary of Average Nearest Neighbours of Public Secondary Schools
Source: Authors Analysis (2023)

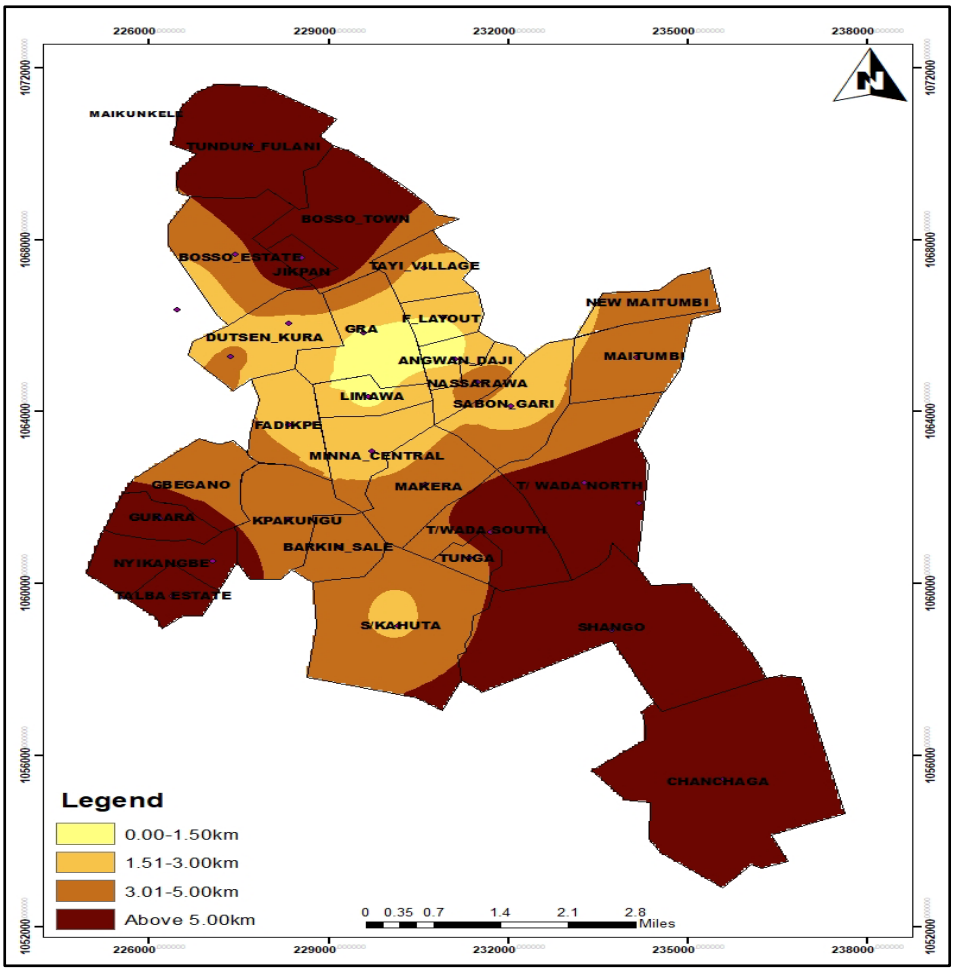
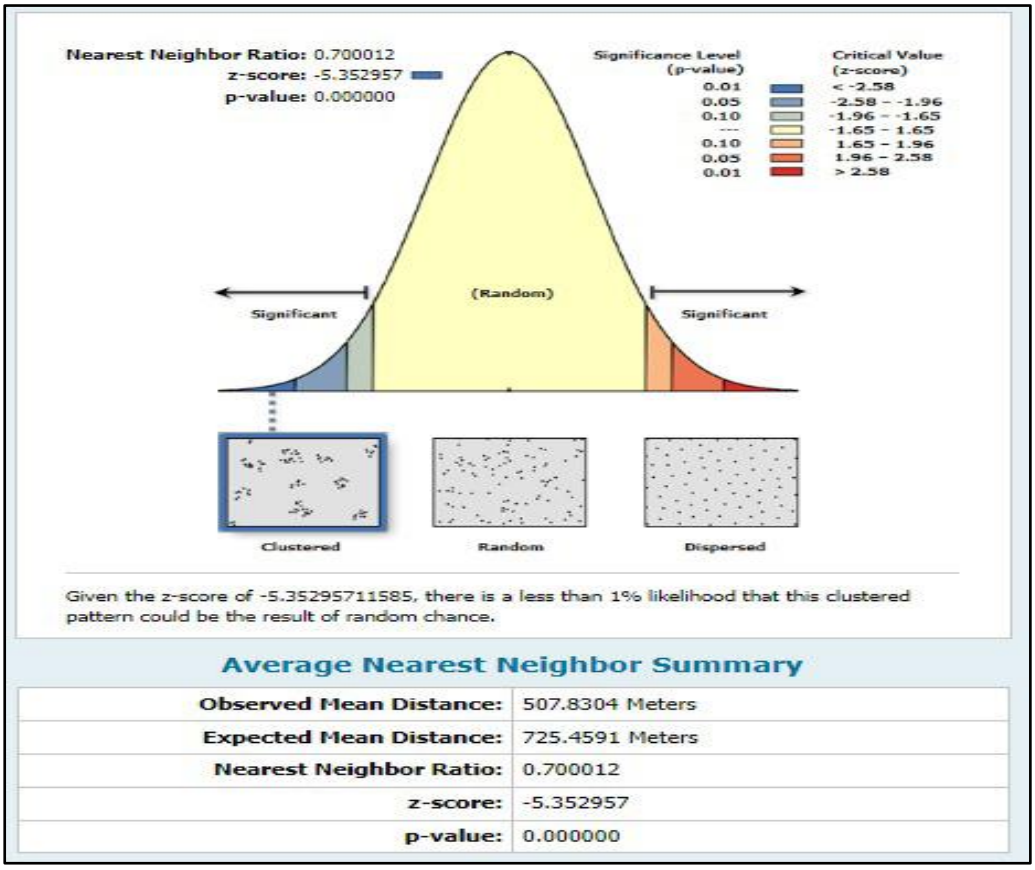


Figure 5: Spatial Variation of Distance Travelled of Private Secondary Schools in Minna
Source: Author's Analysis, 2023

Similarly, Figure 6 shows the spatial variation of the private secondary school trip length. The Figure reveals that respondents in private secondary schools in the core of Minna (Limawa, Angwan Daji, GRA, and F-Layout) tend to travel less than a kilometre from their home to schools due to the concentration of private secondary schools within their neighbourhood. Respondents in Chanchaga, Tundun Fulani, Sahuka Kahuta, Gurara, Nyikangbe, Talba Estate, Barkin Sale, Gbeganu, and Tundun Wada North travel for more than 5kms daily from their dwellings to school.

This finding is also corroborated by the 2km buffer analysis of private secondary schools in Minna. As depicted in Figure 6, the average nearest neighbourhood analysis of all the private secondary schools in the study reveals a cluster distribution with a Z score of – 5.3530 and the nearest neighbour ratio of 0.7000. The cluster distribution of the private secondary schools in the study encouraged a 2km travel distance from home to school within the city only.

On the other hand, the residents in the peri-urban neighbourhoods of the city are forced to take a trip of more than 5 km daily from their home to school daily (Figure 7).



Average Nearest Neighbor Summary

Observed Mean Distance:	507.8304 Meters
Expected Mean Distance:	725.4591 Meters
Nearest Neighbor Ratio:	0.700012
z-score:	-5.352957
p-value:	0.000000

Figure 6: Summary of Average Nearest Neighbour of Private Secondary Schools
Source: Author's Analysis, 2023

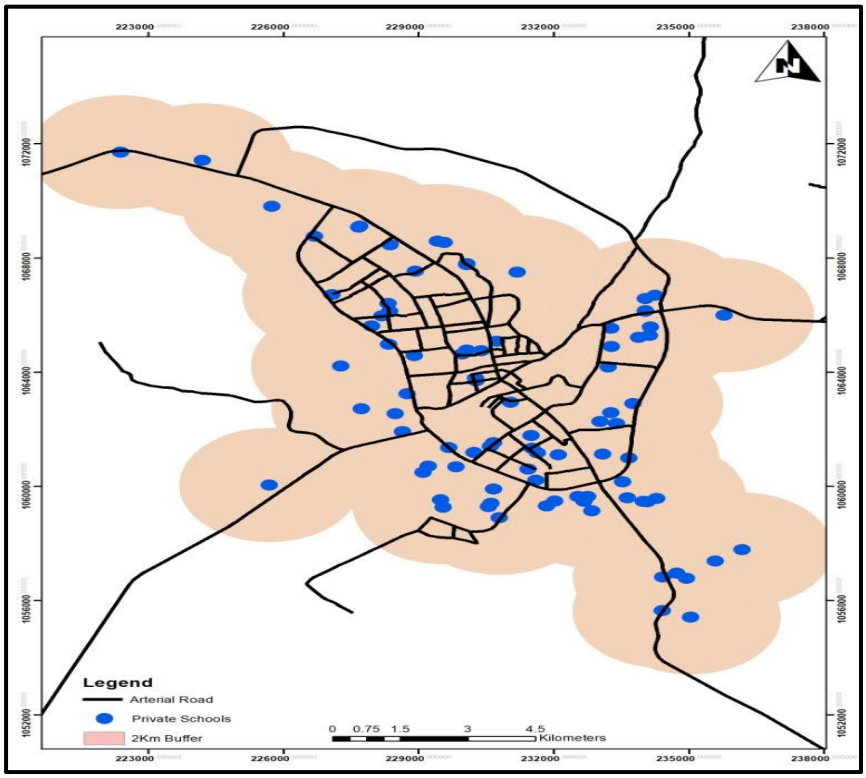


Figure 7: 2kms buffer of Private Secondary Schools in Minna
Source: Author's Analysis, 2022

3.5 Distance Covered by the Public and Private School Students

The study reveals that the average distance covered by students attending public schools (M =2.70km, Md = 2.19 km) is more than the distance covered by students attending private secondary school (M=2.07km, Md = 1.34km). This may be attributed to the high number and clustered pattern of private secondary schools compared to public secondary schools. However, the maximum distance covered by the public secondary school students (17.81 km) was less compared to their counterparts in private secondary schools, which covered a maximum distance of 19.42 km. Table 3 shows the distance covered by the students in public and private secondary schools in Minna.

H_0: There is no statistically significant difference in home-school distance covered by the Private and Public secondary school students

A Mann-Whitney U test was conducted to compare the home-school distance for private and public-school students. The result shows that showed that the difference was statistically significant (U = 7099552, $n1$ = 4324, $n2$ = 4093 p = <.001). Thus, the null hypothesis is rejected.

3.6 Home-School Maximum Distance and Proportion of Marginalised Students

As shown in Table 4, of the 8,422 students in the sample, 56.56% live below 2 km of the school they are attending but when disaggregated by type of schools attended, Students attending private schools tend to live closer to their schools than students attending public schools. Also, 69.97.51% of private school students live below 2 km from their schools, compared to 48.45% of public school students.

Table 3: Travel Distance of Public and Private Secondary schools

	School Type	N	Mean	Median	SD	Minimum	Maximum
Distance	Public	4093	2.6973	2.1888	2.2882	0.0870	17.8050
	Private	4329	2.0732	1.3397	2.2105	0.0138	19.4215

Source: Author's field survey, 2021.

Table 4: Number of students living below, within and above 2km distance of school

2km	N	Below	%	Equal	Above	%	Median
Citywide	8422	5012	59.51	0	3410	40.49	1.581
Public	4093	1983	48.45	0	2110	51.55	2.18
Private	4329	3029	69.97	0	1300	30.03	1.353

4.0 Discussion

The spatial variation of distance travelled by secondary students in the study area helps to understand the travel behaviours of students in Minna. Understanding the spatial travel variation of students in Minna can enhance the planning of education infrastructure. This assertion was affirmed by Mei *et al.* (2019), who were of the opinion that understanding the spatial characteristics of distance travelled by students to school provides a basis for improving accessibility to schools, which in turn can influence the enrolment of students.

The average nearest neighbourhood analysis shows that private and public secondary schools are concentrated in the city's core. At the same time, the peri-urban areas have fewer schools. This scenario implies that more students are attracted to the core of the city, whereas the peri-urban areas would have a weaker attraction because of the presence of few secondary schools. This means that the spatial distribution of both cluster and random distribution of secondary schools in the average nearest neighbourhood analysis for Minna is a reflection of poor education infrastructure planning. The average nearest neighbourhood analysis also reveals that secondary school students in neighbourhoods like Talba Estate, Gbaganu, Gurara, and Nyikangbe travel farther (above 5kms) to access secondary school education.

It is believed that travelling above 5kms to school daily is usually accompanied by commuting stress, which can weigh students down. The demands of the roads can make parents and guardians apprehensive while looking forward to the safe return of their children from school (Duze, 2010). Travelling farther than 5 km implies that there is a need to bring a secondary school closer to the students in the peri-urban neighbourhoods. Having secondary schools near students is believed to be cost-effective and provides a long-term solution to increase access and retention of students in school (United Nations International Children's Emergency Fund*, 2015*).

The travel distance of public and private secondary schools in Minna further explains the distinction in travel characteristics of students in both schools. The study reveals that the farther the private secondary school is in Minna, the fewer students travel to those schools. This result is similar to the findings of Kanayochukwu *et al.* (2020); and Mei *et al*. (2019), who assert that the farther the school, the lower the percentage of students that will make a trip to school. The travel distance of private secondary schools in the study area further reveals that more private secondary school students (69.97%) would travel less than 2kms to school daily. The lower travel distance of private secondary school students can be attributed to the cluster distribution of the private secondary schools in the study area and its high number, which is four times more than that of the public secondary schools.

More students (51.55%) travel above 2kms for public secondary schools, unlike their private secondary school counterparts, where more students travel less than 2kms. This implies that more public secondary school students would have to rely on paid transport, and those who cannot afford paid transport will have to walk a long distance to school. The lengthy travel

distance of more public secondary school students can be attributed to the random distribution of the few public secondary schools in the study area.

5.0 Conclusions and Recommendations

The spatial analysis of private and public secondary schools reveals that a cluster and random distribution in private and public secondary schools indicate poor education infrastructure planning in the study area. The distance travelled by the large proportion of public secondary school students was not in line with the ideal distance threshold for secondary school students. Therefore, the study recommends that proper education infrastructure planning should be carried out before setting up new secondary schools within Minna in the future. A public secondary should be made available in neighbourhoods where students travel more than 5kms to access secondary education to reduce home-to-school travel distance. Further studies can be carried out on the spatial distribution of schools in Minna by using the multicriteria analysis to determine the best location to site a secondary school for ease of access by students.

References

Adewuyi, G. K., and Bolanle, S. T. (2022). Geographical Locations of Secondary Schools and Effects on Students' Distance Travelled from Home to School in Five Urban Local Government Areas of Ibadan Metropolis, Oyo State, Nigeria. African Journal of Environment and Natural Science Research, 5(1), 34-54.

Adeyemi. H. O., and Yusuf. T. A. (2019). Tricycles for Nigerian public transport unit: Assessment of ergonomics design considerations. *Jurnal Kejuruteraan*, *31*(1), 57-63.

Agbabiaka, H. I., Aguda, A. S., and Nzere, R. B. (2020). Spatial distribution and proximal model of secondary educational facilities in a traditional Nigerian city. Journal of the Operational Research Society, 71, 1780 - 1798.

Aule, D., Jibril, M., and Adewuyi, T. (2023). Geostatistical Analysis of Accessibility to Secondary Schools in Parts of Benue State. Journal of Geographic Information System, 15(1), 1-18.

Day, A. L., Mcloughlin, C., Aslam, M., Engel, J., Wales, J., Rawal, S., Batley, R., Kingdon, G., Nicolai, S., and Rose, P. (2014). The role and impact of private schools in developing countries: a rigorous review of the evidence. Education Rigorous Literature Review. Department for International Development.

Duze, C. O. (2010). Average distance travelled to school by primary and secondary school students in Nigeria and its effect on attendance. *African Research Review*, *4*(4).

He, S., and Giuliano, G. (2017). School choice: understanding the trade-off between travel distance and school quality. Transportation, 45, 1475 - 1498.

Idowu, A. B. (2016). How distance to school and study hours after school influence students' performance in mathematics and English: A comparative study. International Journal of Educational Research and Innovation, 6(1), 1-10.

Igwe, A. U., and Osisioma, U. S. (2023). An Evaluation of Tricycle Transportation as a Means of Poverty Alleviation Programme in

Alimosho Local Government Area of Lagos State. *IGWEBUIKE: African Journal of Arts and Humanities*, *9*(1).

Kanayochukwu, E. C., Dogo, B., Oluwole, O. A., Oluwafemi, A. T., Ajibuah, J., Mwanret, D., and Queen, S. (2020). Assessment of the conditions of educational facilities in selected local government areas in Kaduna state, Nigeria. *Zbornik radova Departmana za geografiju, turizam i hotelijerstvo*, (49-1), 81-98

Mantovan, D. I., Gasperoni, G., and Santangelo, F. (20212). Home-school distance among native and immigrant-origin lower secondary students in urban Northern Italy. Journal of Ethnic and Migration Studies, 48(10), 2369-2395.

Mei, D., Xiu, C., Feng, X., and Wei, Y. (2019). Study of the school–residence spatial relationship and the characteristics of travel-to-school distance in Shenyang. *Sustainability*, *11*(16), 4432.

Mhiliwa, E. M. (2015). Effects of school proximity on students' performance in mathematics. International Journal of Education and Research, 3(1), 46-54.

OECD. (2012). Public and Private Schools: How Management and Funding Relate to their Socio-economic Profile. OECD Publishing. http://dx.doi.org/10.1787/9789264175006-en. Accessed 14th December, 2023.

Oneya, L., and Onyango, D. (2021). Perception of School Stakeholders on the Effect of School- Home Distance on Students' Academic Performance among Community Secondary Schools in Rorya District, Tanzania. East African Journal of Education and Social Sciences, 2(1), 76–81.

Tarkhnishvili, A., Tarkhnishvili, L., and Strielkowski, W. (2022, December). Factors influencing the choice of private or public schools: Evidence from Georgia. In *Frontiers in Education* (Vol. 7, p. 910593).

United Nations Educational Scientific and Cultural Organization [UNESCO] (2021). Can private schools improve equitable access to schooling for vulnerable families? Perceptions from parents in Kinshasa and Lagos. Global Education Monitoring Report Team [1052], Cambridge Education. ED/GEMR/MRT/2021/P1/37

United Nations International Children's Emergency Fund (2015). The Challenge: One in every five of the world's out-of-school children is in Nigeria. Available at: https://www.unicef.org/nigeria/education accessed 22/02/2024

Inclusive Mobility among School Children with Disabilities in Benin City Nigeria

Ojekere, S*.[1], Mkpandiok, D.[2] and Inclan-Valadez, C[3]

[1]Department of Urban and Regional Planning, Faculty of Environmental Design and Management, University of Ibadan, Ibadan, Nigeria.
[2]Transport Aid Initiative, Ibadan, Nigeria.
[3]The Global Road Safety Partnership, International Federation of Red Cross Red Crescent Societies, Genève. Switzerland.
*Corresponding Author: ojekerestanley@gmail.com

Abstract

Children with disabilities (CWDs) constitute a significant segment of the global population, with estimates ranging from 93 to 150 million. In Benin City, Nigeria, CWDs face substantial educational exclusion, with less than 10% of CWDs enrolled in primary school, leaving a staggering 90% entirely outside the public primary and secondary school system. Compounding this exclusion are significant mobility barriers that impede CWDs' access to and utilization of mainstream public transportation for their daily school commutes. This study adopts a mixed-methods research approach to examine the mobility barriers experienced among 114 children with physical, visual, hearing, and learning impairments enrolled in public primary and secondary schools in Benin City, Nigeria. The findings revealed that 59.6% of CWDs rely on caregivers for their mobility to and from school, while only 40.4% are self-sufficient in their movement. Surprisingly, 59.6% of the respondents were unaware of the existence of inclusive mobility-related policies that safeguard them against discrimination by public transport drivers. Furthermore, 64.9% have never received any form of government mobility support, and 87.8% spend at least 15 minutes to an hour traveling to and from school. Notably, 98.2% of CWDs lack access to school buses and rely on various alternative modes of transportation, such as minibuses, comrade buses, taxis, tricycles, and non-motorized transport (NMT), for their school commute. To address the mobility barriers of CWDs, the study recommends a POST strategy that focuses on, prioritizes, offers, sustains, and trains for inclusive mobility for schoolchildren with disabilities.

Keywords: *Mobility barriers, Inclusive mobility, school children with disabilities, Benin City, Nigeria.*

1.0 Background

Children living with disabilities are a ubiquitous presence across human societies. Globally, between 93 million and 150 million children live with a disability (ACPF, 2014; Their world, 2020). The term "children with disabilities" (CWDs), as used in this context, encompasses individuals under the age of 18 who experience long-term physical, visual, hearing, or intellectual impairments that, in conjunction with various societal barriers, hinder their full participation in society on an equal basis with children without disabilities (WHO, 2015). In many cities across low- and middle-

income countries (LMICs), CWDs are often overlooked, disregarded, and undervalued. The institutionalization of CWDs has persisted worldwide (Petrowsk et al., 2016). Globally, it is estimated that one in three children in institutional homes is a CWD (UNICEF, 2022). Studies have attributed this to cultural barriers in the form of beliefs, norms, and practices that see children with disabilities as burdens (Elshabrawi et al., 2021; Muhanna, 2018). Most of these CWDs disproportionately come from impoverished backgrounds and face significant challenges in accessing primary education (Stephen et al*.,* 2019). The United Nations Educational, Scientific, and Cultural Organization (UNESCO) (2007, 2015) alarmingly reported that 9 out of 10 CWDs in LMICs are deprived of educational opportunities.

In Nigeria, there are no fewer than 7 million CWDs (Joint National Association of Persons with Disabilities, 2015). Sadly, less than 10% of all CWDs receive basic or primary education, while a staggering 90% remain entirely excluded from the education system (Their World, 2020; UNICEF, 2021). CWDs have a fundamental right to education without discrimination, as enshrined in the Convention on the Rights of the Child (CRC) and the Convention on the Rights of Persons with Disabilities (CRPD). These international conventions require states to adopt all necessary measures to ensure the full enjoyment of CWDs of all human rights and fundamental freedoms on an equal basis with other children (articles 7 and 24) (Handicap International, 2018).

Additionally, Nigeria is a signatory to the 17 Sustainable Development Goals (SDGs), specifically Goal 4, which targets that by 2030, all school-age children, including those with disabilities, must have access to quality, functional, and effective basic education (Joint National Association of Persons with Disabilities, 2015). To fully realize their right to education on an equal basis with other children, CWDs require inclusive mobility options that address the barriers they face in accessing and utilizing transportation systems. These options should be tailored to their specific needs and ensure their safe and timely arrival at school.

1.1 Review of related literature

Like their non-disabled counterparts, CWDs require mobility to travel to and from school, often relying on public transportation systems or walking. However, in most cities in LMICs, public transportation systems often disregard the unique travel needs of CWDs (Neelima, 2008; Omirin and Ojekere, 2017). A study by Sagahutu (2008) revealed the prevalence of poorly maintained roads and inadequate public transportation options for CWDs in LMIC cities. Additionally, the study highlighted the inaccessibility of school environments for many children with mobility impairments. These inaccessible and poorly designed structures create physical and architectural barriers that hinder the mobility of CWDs and their families, restricting their access to schools, services, and facilities (Anjlee, 2020).

Consequently, CWDs continue to face significant mobility barriers while commuting to and from school, rendering them the most vulnerable group to road traffic crashes (RTCs), injuries, and fatalities (Access Exchange International, 2017). Smith *et al.* (2021) emphasized that while mobility plays a crucial role in promoting well-being by connecting individuals to various destinations and

opportunities, it is not without its obstacles, particularly for vulnerable groups like CWDs. The rights of CWDs to access and experience places of opportunity, including schools, are often compromised by inadequate public transportation systems and by social norms and values rooted in ableism, which perceives CWDs as incapable and ill-equipped to utilize mobility systems (Dunn, 2021). Furthermore, institutional barriers such as discriminatory laws, policies, strategies, or practices continue to hinder the inclusion of CWDs in the public system (Ariyo and Joseph, 2017; Yohanna, 2019). Additionally, Kett and Deluca (2016) and Lubitow, Rainer, and Bassett (2017) found that a lack of empathy among public transport drivers and assistants discourages CWDs from using public transportation to and from school. In alignment with the Sustainable Development Goals (SDGs), Target 11.2 specifically aims to achieve safe, affordable, accessible, and sustainable transport systems for all, including children with disabilities (CWDs), by 2030. This target promotes an inclusive public transport approach that prioritizes meeting the transportation needs of all individuals, ensuring that no one is left behind, particularly vulnerable groups like CWDs. Moreover, Article 9 of the United Nations (UN) Convention on the Rights of Persons with Disabilities (CRPD) (2006) mandates countries to identify and eliminate obstacles and barriers that hinder the mobility of people with disabilities, including CWDs. This includes ensuring that CWDs are included and have access to their environment, transportation, public facilities and services, as well as information and communication technologies (Handicap International, 2018).

Inclusive mobility, in this context, refers to public transport systems, such as minibuses, taxis, tricycles, motorcycles, and other modes of transport, that are specifically designed to meet the mobility needs of CWDs. These systems aim to eliminate travel barriers while providing equal access to socioeconomic opportunities and aspirations. Velas-Suarin (2021) similarly defines inclusive transportation as a transportation system that facilitates mobility for all individuals, regardless of their circumstances. Key attributes of inclusive mobility include accessibility, affordability, availability, reliability, attractiveness, comfortability, and safety (Serra, Sarrió, and Magallon, 2022). Such mobility options are crucial for CWDs, as they enable them to travel to and from school with ease and participate fully in their communities. While studies like Wheeler (2009), Haveman (2013), Ross *et al*. (2020), Buliung *et al.* (2021), and Chan (2022) have explored various aspects of mobility barriers faced by schoolchildren with disabilities in developed countries, there is a lack of comprehensive research on mobility barriers faced by school children with disabilities in LMICs. Like their non-disabled counterparts, the lives, mobility, education, and future aspirations of CWDs are equally important and deserve to be addressed.

Therefore, this study aims to address this gap by investigating the mobility barriers and needs of school children with disabilities in Benin City, Nigeria. Specifically, it seeks to answer the following research questions: What do we know about the mobility barriers faced by school children with disabilities? What are the mobility needs of school children with disabilities? What strategy or option

exists for enhancing inclusive mobility among school children with disabilities? Besides, the study examines this hypothesis: Are there significant differences in mobility barriers experienced among different categories of school children with disabilities?

2.0 Universal design as a framework for inclusive mobility design among school children with disabilities

Enhancing inclusive mobility for school children with disabilities in LMIC cities requires a thorough understanding of their specific mobility needs. Universal design (UD) emerges as a crucial approach in designing mobility systems that cater to the needs of all users, regardless of their abilities or limitations. UD principles aim to create products, buildings, and environments, including transportation systems, that are accessible and usable by everyone to the greatest extent possible, without the need for further adaptations (University of Buffalo, 2023). In other words, UD seeks to design mobility systems that are inherently inclusive and accommodate the diverse needs of all users (North Carolina State University, 2008; Burgstahler, 2021).

Marie (2013) aptly describes UD as a value-based strategy for achieving an inclusive society where everyone has a place and the opportunity to participate fully. This notion encapsulates the essence of UD: to foster an inclusive society where everyone, regardless of their age, abilities, or disabilities, has equal opportunities to participate in all aspects of life (Nygaard, 2018). In the context of designing a safe and accessible mobility chain for school children with disabilities in LMIC cities, UD principles provide a valuable framework (Anjlee, 2020). UD advocates for prioritizing the specific mobility needs of school children with disabilities at every stage of the design process, from understanding their needs to planning, implementation, and evaluation (DFT, 2018; TUMI, 2019).

This approach ensures that the needs of students with disabilities are considered when retrofitting existing urban public transport systems or implementing new ones. By integrating UD principles into the design of mobility systems, LMIC cities can effectively address the mobility barriers faced by school children with disabilities, ensuring their protection and inclusion in school attendance and participation in all aspects of city life. The table below outlines the key principles of UD that can be applied to design inclusive and safe mobility solutions for school children with disabilities:

Table 1: Application of principles to inclusive mobility design for school children with disabilities

S/N	UD principles	Application to inclusive mobility design for school CWDs
1	Equitable use	This principle allows for the design of an urban public transport system to provide fair and just access for schoolchildren with disabilities.
2	Intuitive and easy-to-use	This principle allows for the design of an urban public transport system to be easily understood and used by schoolchildren with disabilities,

		regardless of their prior experience, knowledge, language skills, or current concentration level.
3	Flexibility in use	This principle allows for the design of urban public transport systems that accommodate a diversity of users' preferences and abilities.
4	Simple and intuitive	This principle allows for the design of an urban public transport system that eliminates extraneous complexity, which makes it suitable for schoolchildren with disabilities.
5	Perceptible information	This principle allows for the design of an urban public transport system such that travel information is organized in a way that is visible, consistent, accessible, and relatable to schoolchildren with disabilities.
6	Tolerance for error	This principle allows for the design of urban public transport systems to minimize hazards in the event of crashes or unintended actions by schoolchildren with disabilities.
7	Size and space for approach and use	This principle allows for designing an urban public transport system such that schoolchildren with disabilities, including wheelchair users, have enough space to be well accommodated.

Source: Authors' Compilation (2023).

Elaboration of universal design in inclusive mobility for children with disabilities. An urban public transportation system designed using the principles of universal design (UD) can significantly enhance the rights of school children with disabilities to inclusive mobility and ensure their safety in LMIC cities. Without inclusive mobility options, CWDs are less likely to attend and complete primary education in most LMIC cities (UNICEF, 2012; UNICEF, 2013).

3.0 Methodology

The Mixed-methods research (MMR) design was employed as the methodological framework for this study to effectively address its aim and objectives. MMR is an integrative research approach that combines both quantitative and qualitative research methods to comprehensively answer research questions within a single study (Aramo-Immonen, 2011; Kumar, 2015). The fundamental premise of MMR lies in its ability to facilitate a more comprehensive utilization of data, thereby providing a more holistic understanding of human behaviour and experiences related to the phenomena under investigation (Wisdom and Creswell, 2013). Kumar (2015) highlighted the strengths of MMR, emphasizing its inclusivity, pluralism, complementarity, and eclectic nature, which enhance its potential to effectively address critical research questions. The validity of the MMR approach in disability transport research has been established in various studies. For instance, Velho, Holloway, Symonds, and Balmer (2015) employed a mixed-methods analysis to explore the impact of transportation accessibility on the social inclusion of wheelchair users.

The target population for this research comprised public school children with disabilities aged 6-18 residing in Benin

City, Nigeria. Geographically, Benin City is situated within latitudes $6^0$26'N and $6^0$31'E and longitudes $5^0$35'E and $5^0$41'E, respectively. It encompasses three (3) urban local government areas (LGAs): Oredo, Ikpoba-Okha, and Egor (refer to Figure 1 below).

3.1 Sampling technique

The study adopted a cluster sampling technique. The cluster sampling technique is a probability sampling method in which the population is divided into smaller groups called clusters. A random sample of clusters is then selected, and all elements of the selected clusters are included in the sample (Lohr, 2019). Following this approach, Benin City, the study area, is divided into three urban Local Government Areas (LGAs): Oredo, Ikpoba-Okha, and Egor, and three peri-urban LGAs: Ovia North East, Ovia South-West, and Uhuwande (Figure 1). Within the city, there are two public special secondary schools and two public special primary schools that cater to students with disabilities (CWDs).

The public special secondary schools include Idia College and Iyogbe College, located in Oredo LGA, while the public special primary schools are Ivoire Primary School, also located in Oredo LGA, and the School for the Physically Impaired, located in Uhuwande LGA. Out of these four public special schools, two secondary schools, Idia College and Iyogbe College, were randomly selected from the Oredo LGA cluster, and one primary school, the School for the Physically Impaired, was randomly selected from the Uhuwande LGA cluster. GWDs enrolled in these three selected special public schools participated in the study. A cross-sectional research design was adopted, allowing researchers to collect data from a population at a specific point in time and draw inferences from the collected data.

3.2 Sample frame and size

The study included four categories of children with disabilities (CWDs): physically impaired, visually impaired, hearing impaired, and learning/speech impaired. The sample frame for this research was derived from the 2020 baseline survey of four public special schools in Benin City, Nigeria, where CWDs are enrolled. The sample frame from the baseline survey comprised 282 schoolchildren with disabilities. To determine the sample size for this study, 40% of the sample frame was selected, resulting in a total of 113 school children with disabilities.

3.3 Instrument for data collection

The primary instruments for data collection in this study were a structured questionnaire and a focus group discussions (FGDs) guide. The structured questionnaire, comprising closed-ended questions, was employed to gather quantitative data from respondents on their mobility barriers and needs, while FGDs were utilized to collect qualitative data on the lived experience of mobility among respondents. Each FGD included a minimum of one participant from each of the following categories: physically impaired, visually impaired, hearing impaired, and speech impaired. A total of ten (10) CWDs, aged 12 to 18, participated in the FGDs. The data obtained from the field survey were coded and analyzed using SPSS for quantitative analysis and Atlas Ti for qualitative analysis.

Descriptive and inferential statistics were employed to characterize the respondents and generate evidence for

enhancing inclusive mobility among school children with disabilities in Benin City, Nigeria.

3.4 Results and Analysis

3.4.1 Test for validity and reliability of data collection instrument

The validity of the quantitative instrument was tested using Pearson product-moment correlation (PPMC), with a significance level of < 0.05 indicating that the instrument is valid. On analysis, Pearson correlation gave a significance level of 0.000 < 0.05 for all variables. Hence, the instrument is valid for the research. Cronbach's alpha was used to test for reliability, with reliability statistics < 0.6 being the minimum acceptable coefficient, which implies that Cronbach's alpha > 0.6 indicates that the instrument is reliable. Cronbach's alpha on analysis had a value of 0.839 > 0.6. Hence, the instrument is reliable for the research.

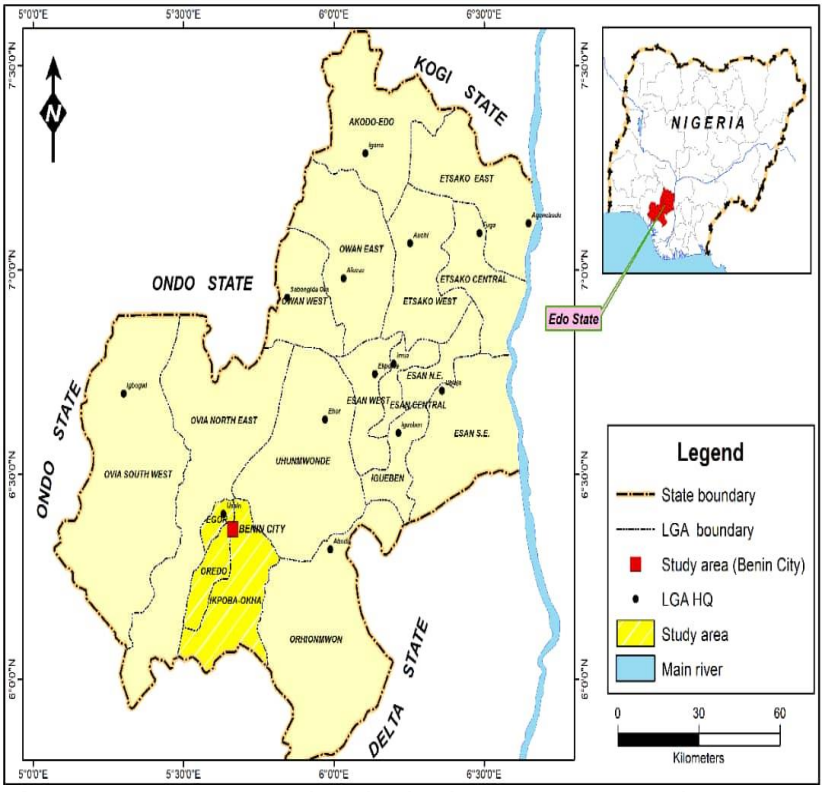


Figure 1: Map of Benin City in the Context of Edo State, Nigeria

Source: Authors' Mapping (2023).

3.4.2 Socio-Demographic Characteristics of Respondents

Table 2: Socio-demographic characteristics of respondents

Characteristics		**No. = 114**	**%**
Sex	Male	57	50
	Female	57	50
Age group, years	6 - 12 Years	30	26.3
	13 – 18 Years	84	73.7
School	Primary school	46	41.4
	Secondary school	65	58.6
Local Government Area	Oredo	36	31.9
	Ikpoha-Okha	42	37.1
	Egor	26	23
	Others	9	8
Types of Disability	Physical Impairment	10	8.8
	Visual Impairment	34	29.8
	Hearing Impairment	55	48.2
	Speech Impairment	15	13.2
Cause of Disability	Birth defect	50	56.8
	Poliovirus	5	5.7
	Road crash/accident	6	6.8
	Disease of the eye	26	29.5
	Others	26	29.5
Duration of Disability	Since birth	40	35.7
	Less than 1 year	10	6.3
	1 – 5 years	10	8.9
	6 – 10 years	14	13.4
	11 – 15 years	26	23.2
	Above 16 years	14	12.5
School Trip Experience	Dependent on someone	68	59.6
	Not dependent on someone	45	40.4
Dependent on Who	Father	21	25.6
	Mother	35	42.7
	Brother	6	7.3
	Sister	5	6.1
	Family relative	6	7.3
	Neighbour	7	8.5
	Others	2	2.4

Source: Authors' Analysis (2023).

The demographic characteristics of the respondents revealed an even gender distribution, with 50% identifying as male and 50% identifying as female. In terms of age, 26.3% of the respondents were between 6 and 12 years old, while 73.7% were between 13 and 18 years old. Regarding school type, 41.4% of the respondents attended primary school, and 58.6% attended secondary school. The distribution of respondents' local government areas (LGAs) of residence indicated that 31.9% lived in Oredo, 37.1% in Ikpoha-Okha, 23% in Egor, and 8% in other LGAs. When examining the types of disabilities among the respondents, 48.2% identified as hearing impaired, 29.8% as visually impaired, 13.2% as speech impaired, and 8.8% as physically impaired. The primary causes of disability were identified as birth defects (56.8%), eye disease (29.5%), road traffic crashes (6.8%), the polio virus (5.7%), and other factors (29.5%).

Regarding the onset of disability, 35.7% of the respondents were disabled from birth, while 23.2% were disabled between 11 and 15 years old. In terms of mobility dependence, 59.6% of the respondents relied on assistance for travel to and from school, while 40.4% were independent in their mobility. Among those who were travel-dependent, 42.7% primarily relied on their mother for transportation, and 25.6% depended on their father.

3.4.3 Mobility barriers of school children with disabilities

Modes of public transport used to and from school, as shown in Figure 2, showed that 98.2% of school children with disabilities do not have access to school buses. As a result, a substantial proportion of the students relied on minibuses (33.7%), taxis (23.9%), comrade buses (18%), NMT (12.8%), and tricycles (10.3%) as a mode of travel to and from school. These various travel modes to and from school were buttressed by these statements from two of the participants at the FGD session:

> *"I use public transport because the distance will not be easy for me to trek" FGD – Visually impaired student, (2023).*
> *"I do not use public transport because I live around the school and usually walk to school" (FGD – Speech impairment student, 2023).*

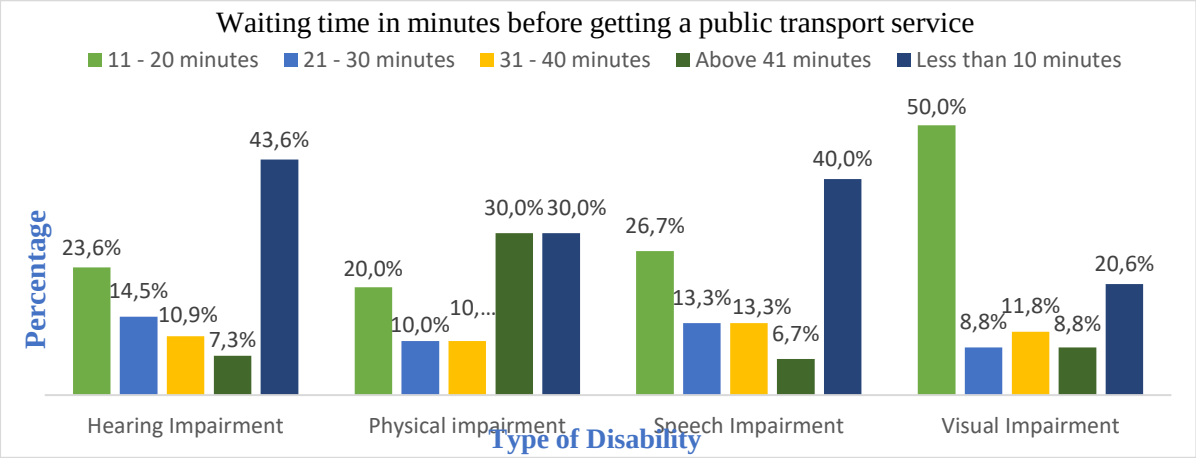


Figure 3: Waiting time in minutes before getting a public transport service
Source: Authors' Analysis (2023)

The waiting time in minutes before getting a public transport service, as shown in Figure 3, indicated that 79.4% of all schoolchildren with disabilities spend 11 minutes or more waiting before getting a public transport service to and from school. Interestingly, the study revealed that among all categories of students, visually impaired students (50%) spent the most time (11–20 minutes) waiting for public transport.

This was buttressed by the statement from one of the participants at the FGD session:

> *"Most times when I wait for public transport between 15 – 20 minutes and it does not come on time, and when it comes, it is quickly occupied with other passengers, leaving me behind" FGD – Speech impaired student, (2023).*

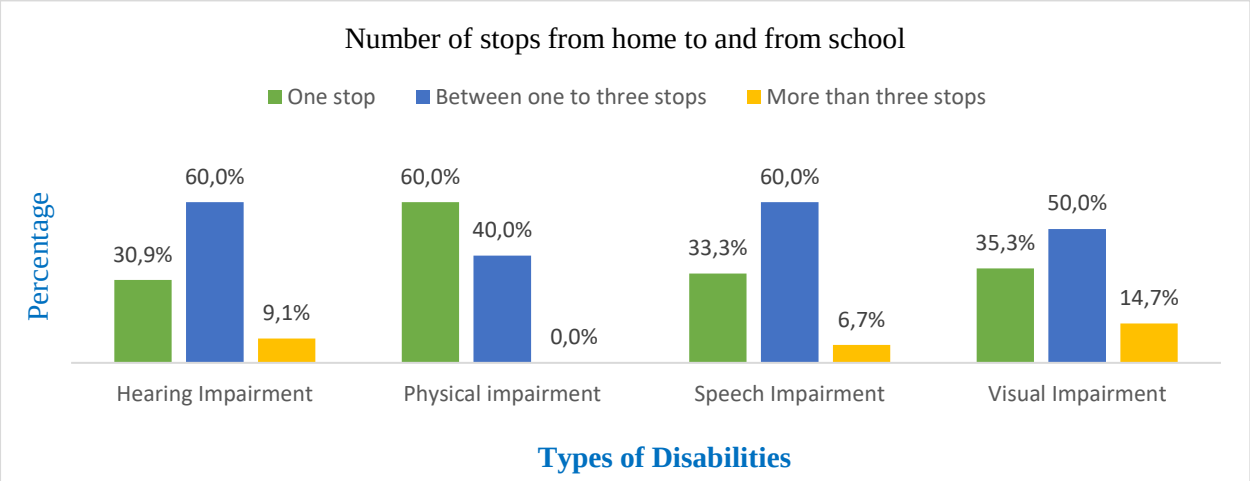


Figure 4: Number of stops from home to and from school
Source: Authors' Analysis (2023)

Table 3: Respondents perception of quality of public transport services

	Row label	Very high	High	Moderate	Low	Very low	Grand Total
Perception of availability of public transport service	Hearing Impairment	21.8%	30.9%	10.9%	10.9%	25.5%	100.0%
	Physical impairment	10.0%	20.0%	30.0%	20.0%	20.0%	100.0%
	Speech Impairment	13.3%	26.7%	20.0%	26.7%	13.3%	100.0%
	Visual Impairment	5.9%	23.5%	23.5%	17.6%	29.4%	100.0%
	Grand Total	14.9%	27.2%	17.5%	15.8%	24.6%	100.0%
Perception of the timeliness of public transport service	Hearing Impairment	27.3%	9.1%	12.7%	21.8%	29.1%	100.0%
	Physical impairment	20.0%	20.0%	20.0%	30.0%	10.0%	100.0%
	Speech Impairment	6.7%	20.0%	33.3%	20.0%	20.0%	100.0%

Visual Impairment	20.6%	0.0%	23.5%	41.2%	14.7%	100.0%
Grand Total	21.9%	8.8%	19.3%	28.1%	21.9%	100.0%

Source: Authors' Analysis (2023)

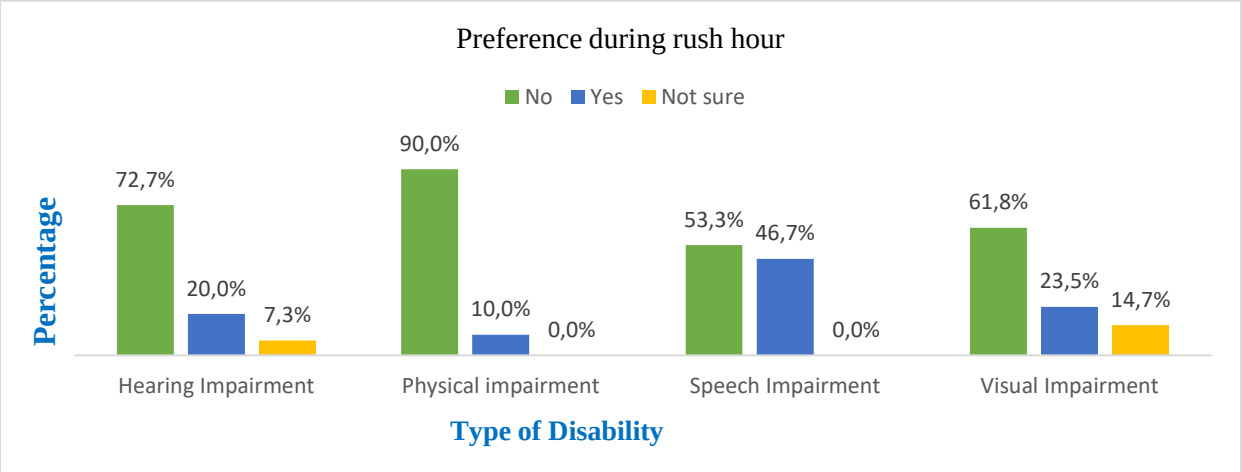


Figure 5: Preference during rush hour
Source: Authors' Analysis (2023).

The number of stops made from home to and from school, as shown in Figure 4, indicates that on average, 60.1% of all school children with disabilities made two stops on their way to and from school. This is indicative of a lack of proximity between the homes of this group of students and the special schools that they attend.

The perception of the quality of public transport service, as shown in Table 3, indicated that public transport was not available to 40.4% of school children with disabilities to and from school, while 50% of school students with disabilities considered the timeliness of public transport service low.

Preference during rush hour by public transport drivers, as shown in Figure 5, indicated that 68.4% of all respondents were not considered to enter and sit in public transport vehicles by drivers during rush hours. It was also revealed that 90% of physically impaired students, 72.7 percent of hearing impaired students, 61.8 percent of visually impaired students, and 53.3% of speech impaired students were given the least preference by bus drivers during rush hour. This was buttressed by the statement from one of the participants at the FGD session:

> *"If I don't have someone with me, there won't be anyone to tell me to sit either in front or back of the bus. I will have to trace it myself. In the process of tracing it myself, my hand may mistakenly meet another passenger which will be embarrassing." FGD – visually impaired students (2023).*

The duration in minutes from home to school, as shown in Figure 6, indicates that (64.3%) of all respondents spent on average 15 minutes to 1 hour travelling before getting to and from school. It was also revealed that the school they were enrolled in was not within walking distance of their home.

This was buttressed by the statement from one of the participants at the FGD session:

> *"The distance between where I live and my school is quite far, and it takes a lot of time before I reach my school." FGD – visually impaired students (2023).*

The cost of public transport service to and from school, as shown in Figure 7, indicated that 66.4% of all the respondents reported spending less than 500 Naira, while the others 33.6% spent above 500 Naira (1.30 USD) on transport to and from school daily.

This was buttressed by the statement from one of the participants at the FGD session:

> *"My home is very far from my school. My mother brings me to school daily. She spends about 1,000 Naira on transport to and from school." FGD – Speech impaired student, (2023).*

Sufficiency of time to board and alight from public transport modes, as shown in Figure 11, revealed that 60.2% of respondents had sufficient time to board and alight from public transport modes, whereas 39.8% of respondents did not get sufficient time to board and alight from public transport to and from school. More so, it also revealed that 64.7% of the visually impaired respondents had the least sufficient time given to them to board and alight from public transport mode, compared with 33.3% of the speech impaired, 30.9% of the hearing impaired, and 30% of the physically impaired respondents.

This was buttressed by the statement from one of the participants at the FGD session:

> *"Whenever I am using public transport, the drivers are always in a hurry. When they stop, other passengers will want to enter, causing a rush. Inside the vehicle, the driver may not get to the exact bus stop you want to stop at. If you get to tell them once, they will not respond, or sometimes they will respond with just a nod. I won't be able to see them because I am blind. But when you remind them again the second time, they will shout at you." FGD: visually impaired student (2023).*

"Also, while alighting from the vehicle, they won't wait for you to come down properly. They will definitely make you fall off the vehicle, or someone will push you. You may still be coming down without your leg landing on the floor, and the bus will move." FGD: physically impaired student (2023).

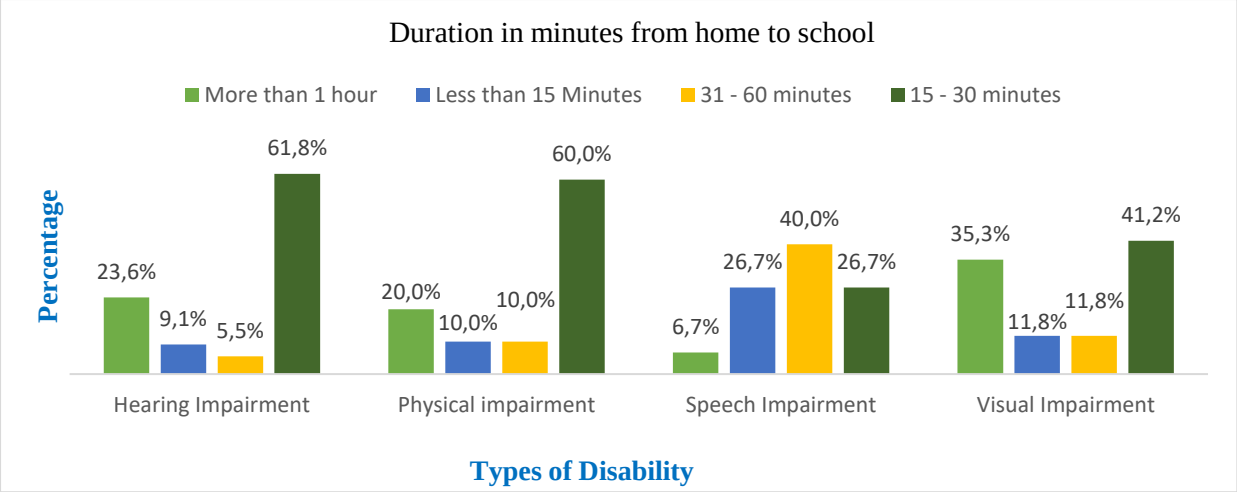


Figure 6: Duration in minutes from home to school
Source: Authors' Analysis (2023)

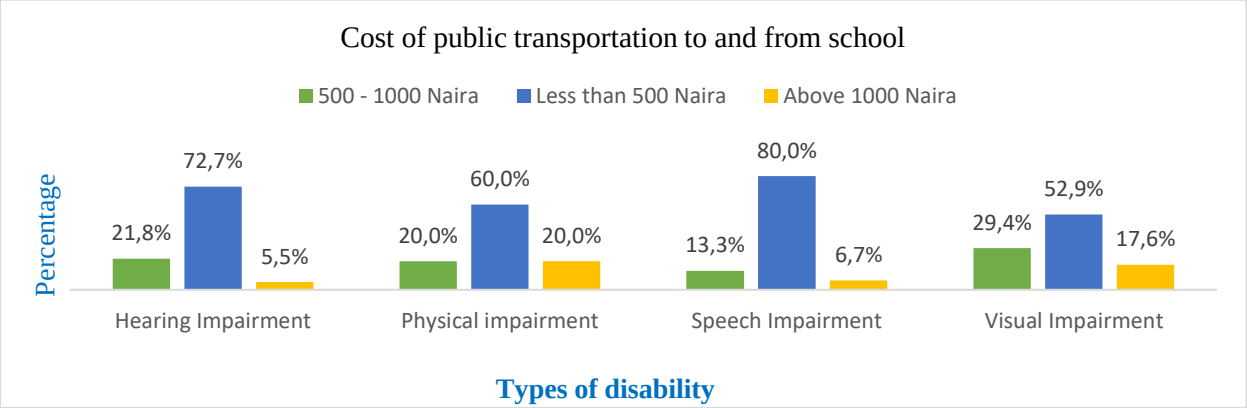


Figure 7: Cost of transportation to and from school
Source: Authors' Analysis (2023)

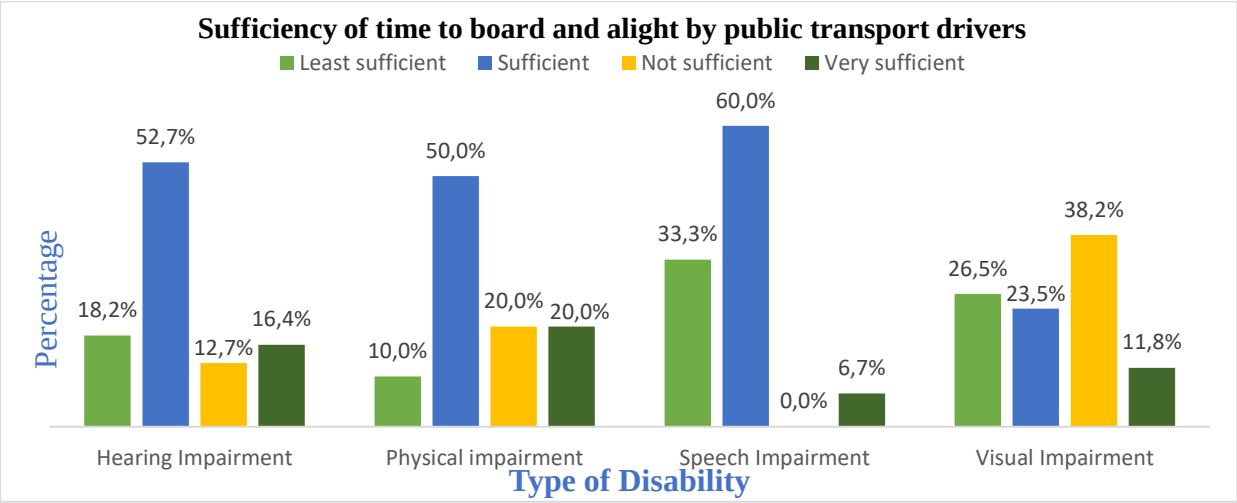


Figure 8: Sufficiency of time to board and alight from public transport mode
Source: Authors' Analysis (2023)

3.4.4 Mobility Needs of School Children with Disabilities

Table 4 shows the highest mobility needs of children living with disabilities in Benin City, Nigeria, based on percentages. The physically impaired students had the following highest needs: affordability (70%), safety (70%), and comfortability (60%). Similarly, the hearing-impaired students had the following highest needs: availability (62.3%), safety (48.1%), and comfortability (45.1%). The visually impaired students had the following highest needs: accessible travel information (54.9%), affordability (54.8%), and availability (51.6%). The speech-impaired students had the following highest needs: availability (60%), safety (60%), and comfortability (53.3%).

Table 4: Ranking of mobility needs based on categories of disabilities

Mobility needs		Categories of disabilities		
		Physical impairment		
		High	**Moderate**	**Low**
1	Affordability of public transport	70.0%	10.0%	20.0%
2	Safe public transport	70.0%	10.0%	20.0%
3	Safe crossing facilities	60.0%	0.0%	40.0%
4	Comfort in public transport	60.0%	20.0%	20.0%
		Hearing impairment		
5	Availability of public transport	62.3%	7.5%	29.9%
6	Safe public transport	48.1%	11.5%	23%
7	Comfortability in public transport	45.1%	21.6%	27.5%
8	Affordability of public transport	37.8%	30.2%	39.6%
		Visual impairment		
9	Access to travel information	54.9%	6.5%	38.7%
10	Affordability of public transport	54.8%	6.5%	38.8%
10	Availability of public transport	51.6%	16.1%	32.3%
11	Barrier-free pedestrian sidewalk	46.7%	20.0%	33.3%
12	Safe pedestrian crossing	46.6%	16.7%	38.7%
		Speech impairment		
13	Availability of public transport	60%	13.3%	26.7%
14	Safe public transport	60%	13.3%	26.7%
15	Comfortability in public transport	53.3%	26.7%	20%
16	Affordability of public transport	50%	1.7%	42.2%

Source: Authors' Analysis (2023)

3.4.5 Difference in mobility barriers experienced among school children with disabilities

One-way analysis of variance (ANOVA) was used to test the stated hypothesis;

There is a significant difference in mobility barriers experienced among school children with disabilities. Dependent variables include physical barriers, social barriers and personal/emotional barriers as dependent variables, while categories of disabilities are independent variables.

Table 5: ANOVA table for mobility barriers experienced by schoolchildren with disabilities

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Physical barriers	Between Groups	5.476	3	1.825	5.542	.001
	Within Groups	35.567	108	.329		
	Total	41.042	111			
Social barriers	Between Groups	1.590	3	.530	1.353	.261
	Within Groups	42.301	108	.392		
	Total	43.891	111			
Psychological/emotional barriers	Between Groups	2.662	3	.887	3.057	.032
	Within Groups	30.181	104	.290		
	Total	32.842	107			

Source: Authors' Analysis (2023)

Table 5, the ANOVA table above shows that there exists a statistically significant difference between our group means as shown in the $F(3,108) = 5.542$, with $p = 0.001$ for physical barriers. It is also seen that there is a significant difference between group means of personal and emotional barriers as shown in the F-value of 3.057 with $p = 0.032$ which are both less than $p = 0.05$. This is an indication that across the various types of disabilities, there is a significant difference in physical barriers and personal/emotional barriers experienced among school children with disabilities. The table also shows non-significance between group means in social barriers with F-value = 1.353 and $p = 0.261 > 0.05$. Hence, there is no significant difference in the social barriers experienced among school children with disabilities.

After establishing the significance of the ANOVA, we can then proceed with the post hoc test.

Table 6: Post hoc test

Dependent variable	Type of disabilities	Mean
Physical barriers	Physical Impairment	1.9800
	Visual Impairment	1.8737
	Hearing Impairment	2.3704
	Speech Impairment	2.0944
	Total	2.1522
Social barriers	Physical Impairment	2.1944
	Visual Impairment	2.2399
	Hearing Impairment	2.3654
	Speech Impairment	2.3167
	Total	2.3066
Psychological/emotional barriers	Physical Impairment	2.2130
	Visual Impairment	2.1515
	Hearing Impairment	2.4936
	Speech Impairment	2.4464

Source: Authors' Analysis (2023)

Table 6: Multiple comparisons Table (Tukey HSD)

Dependent Variable	Type of disabilities	P- value (sig.)	Significance
Physical Barriers	Physical vs visual impairment	.956	No
	Physical vs hearing impairment	.203	No
	Physical vs speech impairment	.962	No
	Visual vs hearing impairment	.001	Yes (hearing > visual)
	Visual vs speech impairment	.606	No
	Hearing vs speech impairment	.357	No
Social barriers	Physical vs visual impairment	.998	No
	Physical vs hearing impairment	.880	No
	Physical vs speech impairment	.969	No
	Visual vs hearing impairment	.813	No
	Visual vs speech impairment	.980	No
	Hearing vs speech	.994	No
Psychological/emotional barriers	Physical vs visual impairment	.990	No
	Physical vs Hearing impairment	.476	No

	Physical vs speech impairment	.741	No
	Visual vs hearing impairment	.026	Yes (hearing > visual)
	Visual vs speech impairment	.320	No
	Hearing vs speech impairment	.991	No

Source: Authors' Analysis (2023)

The multiple comparisons table above shows which groups differed from each other. The Tukey post hoc test is generally the preferred test for conducting post hoc tests on a one-way ANOVA. We can see from the table that there is a statistically significant difference in physical barriers experienced by the visual impairment and the hearing impairment (0.001) and also there is a difference in the personal and emotional barriers experienced by the visual and hearing impairment (0.026) with the mean of the hearing impaired (2.3704, 2.4936) being greater than that of the visual impaired (1.8737, 2.1515) for both respectively. However, there are no differences in the other mobility barriers experienced in other groups under the physical, social and personal/emotional barriers among school children with disabilities.

4.0 Discussion of Findings, Conclusion and Recommendations

4.1 Discussion

A gender breakdown of the respondents revealed an equal distribution, with 50% identifying as male and 50% identifying as female. Regarding age, 26.3% of the respondents were between 6 and 12 years old, while 73.7% were between 13 and 18 years old. The distribution of respondents across school types indicated that 41.4% attended primary school and 58.6% attended secondary school. An analysis of respondents' local government areas (LGAs) of residence showed that 31.9% lived in Oredo, 37.1% in Ikpoha-Okha, 23% in Egor, and 8% in other LGAs. The study found that 48.2% of the respondents were hearing impaired, while 29.8% were visually impaired. The respondents also self-reported the causes of their disabilities, with 56.8% attributing their impairments to birth defects and 29.5% to eye disease. Regarding the duration of their disabilities, 35.7% of the respondents had been disabled since birth, while 23.2% had acquired their disabilities between the ages of 11 and 15. Importantly, the study also revealed that 59.6% of the respondents relied on assistance for mobility to and from school, while 40.4% were independent in their mobility. Among those who were travel-dependent, 42.7% primarily relied on their mother for transportation, and 25.6% depended on their father.

In terms of mobility barriers faced by schoolchildren with disabilities in Benin City, Nigeria, the average travel time from home to school was found to be 15 minutes to 1 hour, with 64.3% of respondents spending this duration. This extended travel time can be attributed to the widespread exclusion of schoolchildren with disabilities from mainstream public transportation options in the city. This finding aligns with previous research. For instance, Hawani et al. (2021) reported an average commuting time of 12 to 25 minutes for students with special needs in Johor Bahru, Malaysia. Similarly, Buliung et al. (2021) found that students with

disabilities in Ontario, Canada, experienced substantial excess travel time, particularly those labelled as deaf, physically disabled, or having behavioural exceptionalities. This excess travel time can exacerbate missed classroom time and limit opportunities for peer interaction. Regarding the mode of public transport used by schoolchildren with disabilities, only 1.8% had access to school buses, with the remaining 98.2% relying on minibuses, commune buses, taxis, tricycles, and NMT for their daily commute. This finding is consistent with a study by Ojekere et al. (2021), who reported that minibuses and taxis were the most common modes of transport for the PWD population in Benin City. Additionally, 60.1% of respondents made two stops on average during their commute, indicating a lack of proximity between homes and school locations. Perceptions of the availability and timeliness of public transport services also revealed significant challenges. A substantial proportion of respondents (40.4%) lacked inclusive access to existing public transport services, with 40% of the physically impaired and 47% of those with visual impairments reporting particular difficulties. Moreover, 55.9% of respondents rated the timeliness of public transport services as low or moderate with respect to meeting their travel needs.

In terms of driver consideration and seating arrangements, 68.4% of respondents faced difficulties entering and sitting in public transport vehicles during rush hours. Additionally, the majority of respondents lacked priority or dedicated seats reserved for them in government-owned and managed public transport vehicles. The waiting time for public transport services was also a significant barrier, with 79.4% of respondents spending an average of 11 minutes waiting before getting a public transport service to and from school. Furthermore, 66.4% of respondents spent a minimum of 100 Naira (1.25 USD) on a single trip to school on daily transportation, while 33.6% spent more than ₦500.

A comprehensive analysis of the mobility needs of schoolchildren with disabilities revealed distinct priorities for each group. The physically impaired students identified affordability, safety, comfort, public transport, and safe crossing facilities as their top five mobility needs, with each need receiving a 70% endorsement rate. Similarly, the hearing-impaired students prioritized available, safe, and comfortable public transport, with respective endorsement rates of 62.3%, 48.1%, and 45.1%. For visually impaired students, accessible travel information, affordability, and availability of public transport emerged as the most critical needs, each receiving endorsement from over 50% of respondents. Finally, speech-impaired students identified availability, safety, and comfortability in public transport as their top three mobility needs, with each need endorsed by at least 60% of respondents. This finding is consistent with Buliung et al. (2021), who also found that the availability of mobility services for students with disabilities will confer significant access to education for students with disabilities.

The results of the ANOVA indicated that schoolchildren with disabilities across all disability types faced similar physical barriers, as determined by $F(3,108) = 5.542$, $p = 0.001$. However, a significant interaction effect was observed for emotional or psychological barriers, $F(3,104) = 3.057$, $p = 0.032$. This suggests that while schoolchildren with disabilities generally encounter similar physical barriers, their experiences of emotional or psychological barriers may vary depending on the specific type of disability.

4.2 Strategies to boost inclusive mobility among school children with disabilities

This study has uncovered several gaps in understanding the mobility challenges and needs of schoolchildren with disabilities in LMIC cities. Based on the research findings, the POST strategy has been offered, which indicates, prioritizes, offer, sustain, and train for inclusive mobility of schoolchildren with disabilities:

- **Prioritize school bus services for school children with disabilities**

School bus services are essential to break the cycle of mobility exclusion faced by thousands of schoolchildren with disabilities in LMIC cities. Therefore, state governments, in collaboration with education ministries, should provide free, disability-inclusive school buses for each special-needs school across the city. This will undoubtedly contribute to increased school attendance rates among children with disabilities.

- **Offer free public transport services for children with disabilities**

Affordable public transport service to and from school remains a crucial need for children with disabilities. In view of this, public transportation services should be made free for schoolchildren with disabilities who are identified with a uniform and a designated school identity card. This will help to ease the burden of travel costs on their parents and encourage school attendance among this group of students.

- **Sustain seat reservations on government public mass transit for children with disabilities**

As a policy matter, dedicated seat reservations should be prioritized for students with disabilities on government-owned public mass transit services. Students can be identified using a school ID issued by the state Ministry of Education. Furthermore, bus drivers and assistants should strictly enforce the use of these dedicated seats, and a system for reporting non-compliance should be established.

- **Sensitize public transport operators on the mobility needs of children with disabilities**

Equipping public transport operators, including drivers and conductors, with the necessary knowledge of CWDs' mobility needs is paramount for delivering truly inclusive public transport services. Therefore, comprehensive training programs should be implemented across the city's public transport system, focusing on sensitizing operators to the travel requirements of CWDs and equipping them with the skills to effectively address those needs.

4.3 Conclusion

The analysis, discussions, and findings of this study reveal that schoolchildren with disabilities face varying degrees of mobility exclusion in their daily commute to and from school in LMIC cities. There is an urgent need to move beyond the current narrative of disabling public transport systems, which continue to hinder the potential and abilities of schoolchildren with disabilities, and towards an inclusive and equitable approach to urban mobility. To achieve this transformation, the mobility needs of schoolchildren with disabilities must be recognized and prioritized within the urban public mobility system.

Conflict of Interest: There were no conflicts of interest among the authors in the conceptualization, writing and review of this research.

Funding: This research is funded by the Road Traffic Injuries Research Network (RTIRN) with support from the FIA Foundation.

References

Access Exchange International, 2017. Bridging the Gap: Your role in transporting children with disabilities to school in developing countries. Pg. 9-32. San Francisco, California, USA. www.globalride-sf.org

African Child Policy Forum, 2014. The African report on children with disabilities: Promising starts and persisting challenges. Addis Ababa: ACPF. Pg.1.

Addo, G., 2014. Analysis of Barriers to Children with Mobility Impairment in Basic Education in Accra Metropolis. M.Sc. thesis development planning and management, Kwame Nkrumah University of Science and Technology, Kumasi. Pg. 3-121.

Ariyo, A., & Joseph, O., 2017. Public Transport Policy in Developing Countries: Nigeria as A Case Study. *1st International Conference of the School of Management Technology (SMAT) Federal University of Technology, Akure, Nigeria*. Pg. 1-37.

Anol, B., 2012. *Social Science Research: Principles, Methods and Practices.* Textbooks Collection. 3. Available at; https://digitalcommons.usf.edu/oa_textbooks/3?utm_source=digitalcommons.usf.edu%2Foa_textbooks%2F3&utm_medium=PDF&utm_campaign=PDFCoverPages

Anjlee, A., 2020. School accessibility and universal design in school infrastructure. Background paper prepared for the 2020 Global Education Monitoring Report. United Nations Educational, Scientific and Cultural Organization.

Aramo-Immonen, H. 2013. Mixed Methods Research Design. In: Lytras, M.D., Ruan, D., Tennyson, R.D., Ordonez De Pablos, P., García Peñalvo, F.J., Rusu, L. (eds) Information Systems, E-learning, and Knowledge Management Research. WSKS 2011. *Communications in Computer and Information Science*, Vol. 278. https://doi.org/10.1007/978-3-642-35879-1_5

Baptiste S. J., Malachie, T., & Struthers, P., 2013. Physical Environmental Barriers to School Attendance among Children with Disabilities in two Community Based Rehabilitation Centres in Rwanda. *Rwanda journal of health science*, Vol. 2, No. 1, pp. 10-14.

Burgstahler, S., 2021. Universal Design. University of Washington.

Buliung. R., Bilas, P., Ross, T., Marmureanu, C., & El-Geneidy, A., 2021. More than just a bus trip: School busing, disability and access to education in Toronto, Canada. *Transportation Research Part A: Policy and Practice*, Vol. 148, pp. 496-505.

Chan, L., Senserrick, T. & Saggers, B. 2022. Behind the Wheel: Systematic Review of Factors Associated with Safe School Bus Transportation for Children with Neurodevelopmental Disorders. *Rev J Autism Dev Disord*. https://doi.org/10.1007/s40489-022-00341-

Department for Transport, 2018. The Inclusive Transport Strategy: Achieving

Equal Access for Disabled People. Pg. 7. Available at; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachmentdata/file/728547/inclusive-transport-strategy.pdf

Department for Transport, 2014. National Travel Survey 2014: Travel to school. Pg.1-10. Available at; https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/476635/travel-to-school.pdf

Dunn, D. S. 2021. Understanding ableism and negative reactions to disability. Engaging in critical thinking can be helpful in altering beliefs and avoiding ableist conclusions. Available at: https://www.apa.org/ed/precollege/psychology-teacher-network/introductory-psychology/ableism-negative-reactions-disability#:~:text=Ableism%E2%80%94prejudice%20and%20discrimination%20aimed,inherently%20inferior%20to%20nondisabled%20people.

Filtness A., Thomas P., Talbot R., Quigley C., Papadimitriou E., Yannis G., Theofilatos A., Aigner-Breuss E., Kaiser S., Machata K., Weijermars W., Van Schagen I., & Hermitte, T., 2016. The application of systems approach for road safety policy making, Deliverable 8.1 of the H2020 project Safety Cube.

Federal Republic of Nigeria, Official Gazette, 2019. Discrimination against Persons with Disabilities (Prohibition) Act, 2018. Pg. 101-105.

Eleweke, C. J., & Ebenso, J., 2016. Barriers to Accessing Services by People with Disabilities in Nigeria: Insights from a Qualitative Study. *Journal of Educational and Social Research*, 6(2), 113.

Egilson, S. T. & Traustadottir, R. 2009. Participation of Students with Physical Disabilities in the School Environment. *The American Journal of Occupational Therapy: official publication of the American Occupational Therapy Association*. Vol.63, Number 3. pp. 264-272.

Elshabrawi, E., Hassanein, A., & Taha, R. A., (2021). Barriers to Including Children with Disabilities in Egyptian Schools. *Journal International Special Needs Education*. Vol. 24, No. 1 pp. 25–35.

Handicap International, 2018. Inclusive urban mobility and getting to school safely in developing countries. Pg. 1-8. Available at; https://www.hi.org/sn_uploads/document/Safe-Inclusive-Mobility-Thematic-Brief-2_School_web.pdf

Haveman, M., Tillmann, V. Stöppler, R. Kvas, S. & Monninger, D. 2013. Mobility and Public Transport Use Abilities of Children and Young Adults with Intellectual Disabilities: Results from the 3-Year Nordhorn Public Transportation Intervention Study. Journal of policy and practice in intellectual disabilities. https://doi.org/10.1111/jppi.12059

Hawani, I. N., Bakhtiar, A., Afiqah. N., & Izran, I. M. H., 2021. "Travel Time Patterns of Students with Special Needs to Special Education Integrated Program-based Schools in Johor Bahru, Malaysia: An Initial Finding." *International Journal of Geospatial and Environmental Research*. Vol.8: No. 2.

Kett, M., & Deluca. M., 2016. Transport and Access to Inclusive Education in Mashonaland West Province, Zimbabwe. *Social Inclusion*, Volume 4, Issue 3, Pages 61- 71. Doi: 10.17645/siv4i3.502

Kumar, J., 2015. Mixed Method Design in Disability and Rehabilitation Research. *International Journal of Advanced Research in Education & Technology (IJARET)*. Vol. 2, Issue 4, pp. 1-4.

Larsson, P., Dekker, S.W. A., & Tingvall C. G., 2010. The need for a systems theory approach to road safety. *Safety Science*. 48(9) pp.1167-1174.

Lubitow, A., Rainer, J., & Bassett, S., 2017. Exclusion and vulnerability on public transit: Experiences of transit-dependent riders in Portland, Oregon. Mobility's, 12, 924–937.

Lohr, S. L. 2019. Sampling: Design and analysis (4th ed.). Cengage Learning.

Mogaji, E., & Nguyen, N. P., 2021. Transportation satisfaction of disabled passengers: Evidence from a developing country. *Transportation Research Part D: Transport and Environment*. Vol. 98, Available at: https://doi.org/10.1016/j.trd.2021.102982.

Marie, I. L., 2013. Developing the theoretical content in Universal Design. Scandinavian Journal of Disability Research. Vol. 15, No. 3. pp. 203-215, http://dx.doi.org/10.1080/15017419.2012.724445

Muhanna, M. (2018). Investigating differences in attitudes, beliefs, and knowledge of inclusion of students with autism between special and general primary teachers in Jordan. *Journal of Contemporary Scientific Research*, Vol. 2, No. 2, pp. 13-55.

Neelima, C., Purnima, P., & Nishi, M., 2008. Mobility and Accessibility Problems around Schools in Delhi (India): A Case Study. Central Road Research Institute, New Delhi. pp.1-11.

Petrowski, N. C. Cappa, & P. Gross. 2017. "Estimating the Number of Children in Formal Alternative Care: Challenges and Results." *Child Abuse and Neglect*. Vol.70, pp. 388–398. doi:10.1016/j.chiabu.2016.11.026.

Ojekere, S., Ojo, O., & Mkpandiok, D., 2021. Analysis of Public Transport Inclusiveness among Persons with Disabilities during COVID-19 in Benin City, Nigeria. Reported submitted to High Volume Applied Research Network, UK. Reference No. HVT029.L1S179.

Omirin, O. J., & Ojekere, S., 2017. Transporting the Physically Challenged in Benin City, Nigeria. African Journal for the Psychological Study of Social Issues Vol. 20, No. 3, Pp. 254-271.

Odame, P. K., & Amoako-Sakyi, R., (2019). Sidewalk Accessibility and Pedestrian Safety among Students with Physical Disability in the University of Cape Coast. *Current research journal of social sciences*. Vol. 02, No. (2) Pg.1-15.

Odame, P. k., Abane, A., & Amenumey, E, K., 2020. Campus shuttle experience and mobility concerns among students with disability in the University of Cape Coast, Ghana. *Geography and Environment*. Wiley. DOI: 10.1002/geo2.93. Pg. 1-12.

Stephen, k., Lorraine, W., Rasmus, S., Bjorn, G., Anh, T., & Heiner, S., 2019. Leaving No One Behind Building Inclusive Social Protection Systems for Persons with Disabilities. Development pathways.

Ross, T. Bilas, P. Buliung, R. & El-Geneidy, A., 2020. A scoping review of accessible student transport services for children with disabilities. *Transport Policy*. Vol. 95, Pg. 57-67.

Sagahutu, J. B., 2008. Barriers to School Attendance among Children with Disabilities in Rwanda. MSc. Thesis Department of Physiotherapy, University of the Western Cape.

Smith, M., Calder-Dawe, O., Carroll, P., Kayes, N., Kearns, R., Lin, E.Y.J. and Witten, K., 2021. Mobility barriers and enablers and their implications for the wellbeing of disabled children and young people in Aotearoa New Zealand: A cross-sectional qualitative study. *Wellbeing, Space and Society*, *2*, p.100028.

Serra, A., Sarrió, N., & Magallon, I., 2022. The Five 'A's for Digital Transport Inclusivity. Available at; https://baxcompany.com/insights/the-5-as-for-digital-transport-inclusivity/

Joint National Association of Persons with Disabilities, 2015. Report of the Baseline Survey and Stakeholders Mapping on Inclusive Basic Education in Akwa Ibom State, Kwara State and the Federal Capital Territory Abuja. Pg.21-55. Available at; https://www.jonapwd.org/report_of_baseline_survey_.pdf

Their world, 2020. Children with Disabilities. Available at; https://theirworld.org/explainers/children-with-disabilities

TUMI, 2019. Disability-inclusive public transport. Practical steps to making public transport disability inclusive. Pg.1-25. Available at; https://www.transformative-mobility.org/assets/publications/HVT-Disability_STANDARD_ONLINE_v2A.pdf

Thompson S., 2020. Nigeria Situational Analysis. Disability Inclusive Development. Pg. 5. Available at; https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/15561/DID%20SITAN%20Nigeria%20V2%20July%202020.pdf?sequence=1&isAllowed=y

UNESCO, 2007. EFA global monitoring report: EFA. Strong foundations: Early childhood care and education, Paris.

UNESCO, 2015. A growing number of children and adolescents are out of school as aid fails to meet the mark. Policy paper 22/factsheet 3. Available at: http://www.usaid.gov/sites/default/file/document/1865/growing_number_children_out_school.

UNICEF, 2012. Global Initiative on Out-of-school Children Pg.1-91. Available at; http://uis.unesco.org/sites/default/files/documents/out-of-school-children-nigeria-country-study-education-2012-en.pdf

UNICEF, 2013. Children and Young People with Disabilities Fact Sheet. Pg. 4. Available at: https://www.unicef.org/media/126391/file/Fact-Sheet-Children-and-Young-People-with-Disabilities-2013.pdf

UNICEF, 2021. Combatting the Costs of Exclusion for Children with Disabilities and their Families. United Nations Children's Fund, New York.

UNICEF, 2022. UNICEF Fact Sheet Children with Disabilities. Pg. 4. Available at; https://www.unicef.org/sites/default/files/2022-10/GIP02115_UNICEF_Children-with-Disabilities-Factsheet-final%20-%20accessible.pdf

University of Buffalo, 2023. Universal Design Principles. Available at; https://www.buffalo.edu/access/help-and-support/topic3/universaldesignprinciples.html

Velho, R., Holloway, C., Symonds, A., & Balmer, B., 2015. The Effect of Transport Accessibility on the Social Inclusion of Wheelchair Users: A Mixed Method Analysis. *Social Inclusion*, 4(3), 24-35.

Vanderschuren, M. J.W.A & Nnene. N., 2020. Inclusive Planning: African Policy Inventory and South African Mobility Case Study on the Exclusion of Persons with Disabilities and Other Vulnerable Groups. Research Square. https://doi.org/10.21203/rs.3.rs-131860/v1.

Velas-Suarin, M.A.M., 2021. The Role of Inclusive Transport in Pursuit of Sustainable Development. In: Leal Filho, W., Azul, A.M., Brandli, L., Lange Salvia, A., Wall, T. (eds) Industry, Innovation and Infrastructure. Encyclopedia of the UN Sustainable Development Goals. *Springer, Cham*.

World Bank, 2020. Disability Inclusion in Nigeria: A Rapid Assessment. World Bank. Washington, DC. Available at; https://documents.worldbank.org/en/publication/documents-reports/documentdetail/780571593336878236/disability-inclusion-in-nigeria-a-rapid-assessment

Wheeler, K. Yang, Y. & Xiang, H., 2009. Transportation use patterns of U.S. children and teenagers with disabilities. *Disability and Health Journal*. Vol. 2, No. 3, pp.158-164.

WHO, 2011. World Report on Disability. Available at; https://www.who.int/disabilities/world_report/2011/report.pdf

WHO, 2015. WHO global disability action plan 2014-2021. Better health for all people with disability. Pg. 1-2. Available at; https://www.who.int/publications/i/item/who-global-disability-action-plan-2014-2021

WHO, 2017. Save LIVES - A road safety technical package. Geneva: World Health Organization. Available at; https://www.who.int/publications/i/item/save-lives-a-road-safety-technical-package

Wisdom, J., & Creswell, J. W., 2013. Mixed Methods: Integrating Quantitative and Qualitative Data Collection and Analysis While Studying Patient-Centered Medical Home Models (pp. 1-5). PCMH Research Methods Series 13.

Yohanna, T. A., 2019. ‘‘They Called Us Senseless Beggars’’ Challenges of Persons with Disabilities in North-Eastern Nigeria. Grassroots Researchers Associations (GRA)