

Building Sustainability in the Urban Environment: An Integration of Road and Water Transportation Systems in Port Harcourt Metropolis

Abstract

The apparent disconnect of different modes of transport in the Port Harcourt metropolis is causing difficulty in urban mobility among commuters. The study has assessed the integration of road and water transport systems to build a sustainable urban environment in Port Harcourt metropolis, Nigeria. The specific objectives of the study are to identify the road and water infrastructure transport systems in Port Harcourt metropolis and their state of functionality, identify and examine the disconnect existing in the street and water transportation in the study area, identify the challenges facing the integration of road and water transportation in the study, and provide physical planning strategy to achieving the integration of road and water transport systems in the study area. The study adopted a Mixed Methods Research (MMR) approach using concurrent triangulation research design to obtain the relevant data and information that addressed the study aim and objectives of the study. In addition, the study employed purposive and simple random sampling techniques, including the key informant method. A total of four hundred (400) commuters, fifty (50) each were interviewed from six (6) major road corridors and two (2) jetties in Port Harcourt City (Aggrey, Trans-Amadi and Olu-Obasanjo Roads) and Obio/Akpor (Akpajo-Elelenwo-Oil Mill, NTA and Agip Roads) and two (2) jetties: Port Harcourt City (Bille/Bonny/Nembe Jetty) and Obio/Akpor (Feltaco Jetty). Some Key informants from the transport sector like the Rivers State Ministry of Transport (RSMT) staff Rivers State Ministry of Urban Development and Physical Planning (RSMUDPP). Others are staff of the Rivers State Transport Company (RTC), National Union of Road Transport Workers (NURTW), Rivers State Marine Transport Company, waterways transport operators, and Town Planners were among those interviewed. The study found potential for integrating road and water transport systems in the study area, and some of the infrastructures are obsolete and lack maintenance, thereby impeding interconnectivity and interlinkage between both systems. The study also revealed that government unwillingness to harness and develop the potentials, poor urban planning and management, and poor urban governance contributes to the disconnect of the road and water transport systems observed, affecting the quality of life and well-being of residents and poor urban sustainability. Thus, to improve the potentials and challenges identified, the study suggested that the government should develop an integrated transportation policy framework to enhance the integration of road and water transport systems. The government should upgrade and rehabilitate roads and water transportation infrastructure to improve intermodal connectivity and linkages for efficiency and effectiveness in the study area. The Public-Private Partnership approach should be developed and adopted in the planning and management of the transport sector in the study area; develop all waterways within the study area through canalisation and channelisation, and the government should adopt sound governance principles to involve all stakeholders of the transport sector.

Keywords: Integration, Road and Water Transportation Systems, Sustainability, Urban Environment

Introduction

Urbanisation in recent times has triggered socio-economic growth and development, likewise bringing about many challenges in urban areas, especially in developing economies (The Global Risks Report, 2018). One of the most overwhelming and conspicuous challenges of urbanisation activities in urban areas of these developing economies today is efficient urban mobility (Sule, 2005). The functionality of a metropolitan area is determined by her circulatory systems and connectivity between land uses and easy movement of goods and services within her territory. The further expansion of urban areas in developing countries in Africa and Asia has recorded rapid urbanisation in the recent decades, resulting in attendant challenges such as rapid urban population growth, landuses becoming dispersed and increasing travel time by commuters (Salisu, 2019).

These resultant conditions necessitate the increase in demand for transport which led to the development of various urban transport systems that brought about many modes and means of movement (Fasina, Akanmu & Okunubi, 2020). The increase of multiple modes and means of transport in urban areas has led to the congestion and bottleneck on motorways, causing relative immobility, environmental nuisance, and impacting the quality of life of

urban dwellers in terms of the functional circulatory system (Salisu, 2019). Thus, these challenges in urban areas needed to be resolved and provide the needed transport systems to address urban mobility that impede urban sustainability. The condition of integration of the transport systems that exist in a metropolitan area is inevitable and viable to the socio-economic growth and development of the city. Adelabu (2017) defined the integration of road and water transport systems as one that involves the coordination of the water to road transports into one interlinked and interconnected transport system with inter modal exchange facilities that makes the movements of people, goods and services within an urban area and its peripheries convenient and possible. Also, Olarenwaju (2011) described the integration of road and water transport systems as an interconnected system to facilitate and increase the efficiency of the transport system that is to be operational in an urban area to improve the economic and social benefits as well as better the lives of its dwellers. However, these linkages and connectivity in many developing economies' urban areas impede efficient and effective transportation systems and are practically necessary.

African cities such as Port Harcourt metropolis is fast growing in population and spatial form, and liveability is becoming a challenge to its dwellers and urban managers as she lacked an efficient and effective integration of road and water transport systems. The metropolis having essential resources such as roads and waterways within its confines to improve urban mobility of commuters, goods and services is becoming an impossible task to government and stakeholders of the transportation sector. The opportunities presented by the transportation sector of the metropolis in term of integration of road and water transport systems is inevitable to the socio-economic growth and development of the urban area. As opined Adelabu (2017) states that the demand for transport and travel intensity tends to increase sharply with the size of a city since mobility and transportation are complementary in nature and functionality. Port Harcourt metropolis is becoming highly complex due to the characteristics of the modes of transport that transverse its landscape, the complexity of origins and destinations generated by land uses and activities, traffic variations and the interchanges and intermodal exchange facilities in the metropolis. Therefore, this study becomes essential in assessing and developing an integrated road and water transport systems policy into one holistic framework that will promote efficiency, build sustainability and effective connectivity in the transportation sector of the urban environment of the Port Harcourt metropolis and also improve the quality of life in term of functionality and connectivity.

Statement of the Problem

The current state of intracity transport in Port Harcourt metropolis has been observed to be chaotic, disheartening and disturbing given the level of disconnect and inaccessibility between the various segments, land uses and activities in the metropolis in terms of commuters' movement, transporting of goods and services. This challenge has led to delays in the movement of people and goods, traffic congestion and an increase in transport costs. Due to disconnected road networks and lack of intermodal exchange facilities to the metropolis' road and water transportation systems. The further increase in the urban landscape and population without proper urban planning policies and measures to curtail urban growth and development. This situation has characterised the transport situation stagnating and obstructing the movement of humans, goods and services and dwindling economic fortune of the area, where manhours are wasted and delayed resulting from urban immobility. The state of disconnect between and among these modes of transport results in disparities and variations in many forms, in road traffic congestion, poor road networks and connectivity and the obsolete facilities at the jetty terminals, as well as the disconnect between the road and water transport system had led to poor public transport service delivery. Also compounding the challenges to the public urban transport system are the issues of the poor road network. It

has further birthed the problem of not achieving free and easy movement within the study area. However, the persistence of this situation will further increase the impact on social and economic systems of the metropolis and equally affect the quality of life of residents of the study area. There need to investigate the reason for this disconnect between road and water transport systems in the metropolis, to improve the integration of the systems and urban mobility to build sustainability in the transportation sector within the urban environment and add to the body of knowledge of integration of road and water transportation systems.

Aim and Objectives of the Study

The study aims to assess the integration of road and water transport systems to build a sustainable urban environment in Port Harcourt metropolis, Nigeria.

The specific objectives of the study are to:

- i. Identify the road and water infrastructure transport systems in Port Harcourt metropolis and their state of functionality;
- ii. Identify and examine the disconnect existing in the road and water transportation in the study area;
- iii. Identify the challenges facing the integration of road and water transportation in the study; and
- iv. Provide physical planning strategy to integrate road and water transport systems in the study area.

Scope of the Study

The geographical scope of this study was delimited to Port Harcourt metropolis covering Port Harcourt Municipality and Obio/Akpor LGA in Rivers State (see Figure 1). The content scope of the study covered identifying the road and water infrastructure transport systems in Port Harcourt metropolis and their state of functionality, identifying and examining the disconnect existing in the road and water transportation in the study area, identifying the challenges facing the integration of road and water transportation in the study, and providing physical planning strategy to achieving the integration of road and water transport systems in the study area.

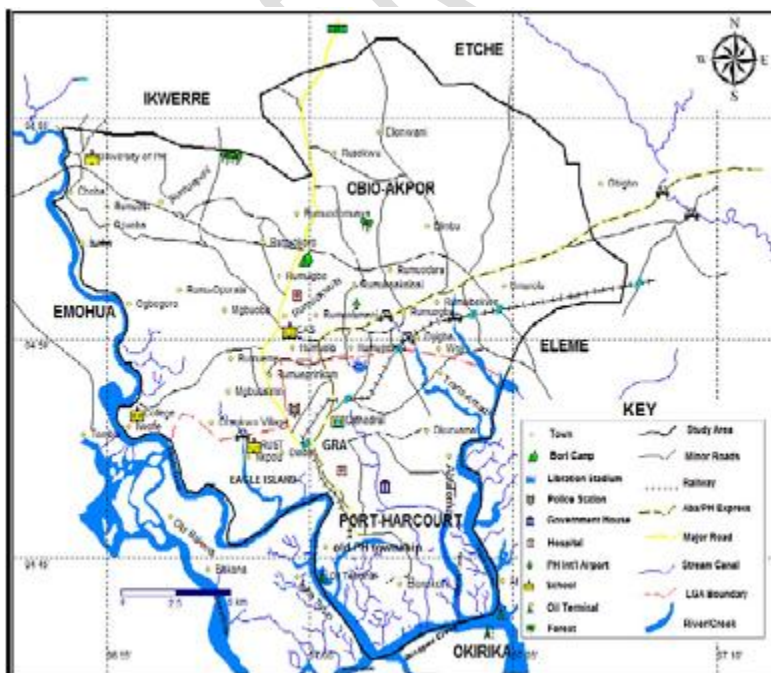


Figure 1: Port Harcourt Metropolis and Major Road Arterials and Waterway

Source: GIS Lab, Department of Urban and Regional Planning, Rivers State University, Port Harcourt, 2021

Literature Review

Integrated Urban Transport System as a Concept

Integrated Urban Transport System (ITS) in transportation involves integrating public and private transport activities or programmes within the metropolitan area to achieve coherent and coordinated movement of services, personnel, goods, activities, ideas, and innovations for economic development (Nosal, 2010). Correia (2017) described the concept as integrating and coordinating the different transport modes in the urban centre in a multifaceted and multi-dimensional system. In this perspective, IUTS requires the integration of the various transport modes through the consolidation, combination, creation and interconnection of different modes into one single system. However, May (1993) described the IUTS as an organisational process where elements of the public transport system, including network and infrastructure, fares and ticketing, information and marketing provided by different transport modes which use other modes, interact more efficiently and closely. All definitions have a singular connotation in the description of the concept of IUTS. It involves bringing together all systems for efficiency and effectiveness in an urban environment. The integration process may occur at different levels in a metropolitan area that contains various activities for sustainability and improvement of quality of life and service in terms of transportation.

The concept of IUTS has generally improved travel conditions and quality of services in which the individual elements of both the public and private transport are embedded together as a chain of movement and interaction (Nosal & Soleckaa, 2014). However, the integration in the transport systems as described by Nosal and Soleckaa (2014) include:

1. Involving different means of public transport.
2. Public and individual transport.
3. Transport policy with other policies concerning the spatial planning or investments in infrastructure.
4. Infrastructure integration consists of a defined combination of aspects that create the integrity of a transport network;
5. Transport integration includes all levels of the transport infrastructure serving urban, suburban or regional traffic through the integration of means/modes of transport to minimise time losses in change from one mean/mode to another;
6. Tariff integration, just like organisational integration at all levels of transport infrastructure serving urban, suburban or regional traffic regardless of the different transport means/modes; and
7. Information system integration includes all levels of the transport network that serve urban, suburban or regional traffic.

Achieving integration in the urban transportation system requires spatial integration specifying the spatial development of urban forms with the existing transport infrastructure. Proper and adequate urban land utilisation and the development of transport infrastructure are to be ensured in the metropolitan area by harmonising land use planning and management with transportation planning in the urban planning and management policy, programme and plan of the urban area (Nosal & Soleckaa, 2014).

Due to these problems, towns have identified that the changes in people behaviours in the context of their travelling, towards less vehicle use and encourage them to travel with the utilisation of public passenger means of transport are the crucial issue for reducing the problems (Nosal & Starowicz, 2010). This matter does not focus on eliminating individual

care travelling; however, on its more rational utilisation car travelling in case of a deficiency of opportunity to choose the more preferred modes of transport, especially public passenger transport (Correia, 2010). Eventually, the integration of several modes of passenger transport and public transport systems that may occur at various levels and may include a lot of technical, technological and transport activities is one of the tools which allow for shaping the way of travelling. Indisputably, the application of the public transport systems integration may help to improve the travel conditions and especially lead to increasing the public passenger transport utilisation.

Sustainability and Transportation Systems in Urban Area

Sustainability as a concept entails development that meets the needs of the present without compromising the ability of the future generations to meet their demand (World Commission on Environment and Development (WCED), 1987). implicitly any development being carried out should not negatively affect the environment (physically, socially and economically) or prevent future generations from carrying out their expansion and equally surviving in their times. In this light, all actions must gear towards sustainability by applying the principles of sustainable development. Urban areas are faced with many challenges, including their transportation systems. Thus, the Sustainable Development Goal (SDG) 11 has become eminent in principle and practice to achieve sustainable cities and communities globally (United Nations (United Nations Human Settlements Programme (UN-Habitat), 2021).

The SDG 11 from Target 11.2 of the goal has identified and specified access to transport from this assertion:

"Safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disability and older persons". UN-Habitat, 2021.

This assertion has created the opportunity for governments and other stakeholders of cities and communities to be proactive in the planning and managing their affairs concerning sustainable transport systems for their inhabitants. Thus, humankind can only achieve sustainability by applying the principle and guidelines of urban governance in the planning, development and management of the urban environment (Avis, 2016). Therefore, fostering good urban governance in the transportation planning process guarantees sustainability in the urban setting of cities and communities. Furthermore, the development of integration in the urban transportation systems as an integral part of urban planning and management strengthen functionality and accessibility in urban areas and demonstrates sustainable urban development in its affairs for the governments, urban communities, individuals and businesses to improve the quality of life and local economy.

Methodology

The study adopted a Mixed Methods Research (MMR) approach using concurrent triangulation research design to obtain the relevant data and information that addressed the study aim and objectives. The study employed purposive and simple random sampling techniques and key informant methods for data collection. Purposively the study selected six (6) major road corridors each in the study area: Port Harcourt City (Aggrey, Trans-Amadi and Olu-Obasanjo Roads) and Obio/Akpor (Akpajo-Elelenwo-Oil Mill, NTA and Agip Roads) and two (2) jetties: Port Harcourt City (Bille/Bonny/Nembe Jetty) and Obio/Akpor (Feltaco Jetty) used by commuters for transport in the study area. A total of Four Hundred

(400) commuters were randomly selected and interviewed, and fifty (50) commuters were sampled from each road and jetty (see Table 1). Consequently, the study applied the key informant method to select and interview stakeholders and professionals in the transportation sector, including staff of Rivers State Ministry of Transport (RSMT), Rivers State Ministry of Urban Development and Physical Planning (RSMUDPP), Rivers State Transport Company (RTC), National Union of Road Transport Workers (NURTW), Rivers State Marine Transport Company, waterways transport operators and Town Planners to seek their opinions and expertise in the subject matter. Also, the study used physical observations and photographs to characterise the current condition of integration of road and water transport systems in the study area.

Table 1: Sample Details of the Study

S/No.	Sampled Roads and Jetties by LGAs	No. of Commuters Interviewed
Port Harcourt City		
1.	Aggrey Road	50
2.	Trans-Amadi Road	50
3.	Olu-Obasanjo Road	50
Obio/Akpor		
4.	Akpajo-Elelenwo-Oil Mill Road	50
5.	NTA Road	50
6.	Agip Road	50
Port Harcourt City		
7.	Bille/Bonny/Nembe Jetty	50
Obio/Akpor		
8.	Feltaco Jetty (Iwofe)	50
Total		400

Source: Researchers' Compilation, 2021

Results and Discussion

Identified Road and Water Infrastructure Transport Systems and State of Functionality in the Study Area

The survey of the study area, from field data and observations, the road infrastructure transport system identified are constructed roads with various modes of road transport including commercial buses, taxis, tricycle (Keke) and private vehicles for conveying people and goods from one point to another. There are also other road infrastructures on some roads, such as streetlights and traffic signals and signs on some streets. The infrastructures identified in the water transport system are jetties and outboard engine boats, and hand-dug canoes for ferrying people and goods to various destinations.

Though, many roads don't have traffic signals and signs for the direction of vehicles and pedestrians to enhance the safety and security of road users. The nature and state of functionality of some roads from an interview of commuters and physical observations indicate that some streets in the study area are without street lights and traffic signs. The roads are constantly flooding when it rains; the roads are not adequately interlinked and

interconnected in some areas, some roads are untarred and unpaved, some roads are galloping with potholes representing 18.4%, 15.7%, 13.6%, 12.2% and 11.7%, respectively. However, some commuters and key informants interviewed acknowledged and observed that some roads are well tarred and smooth and well interconnected and interlinked in some study area locations, representing 14.1% and 14.4% of the distribution. This roughness is due to the road expansion and reconstruction ongoing in the study area undertaken by the Rivers State Government (see Table 2 and Figure 2). As presented in table 3 and figure 3 revealed that the conditions of the water transport infrastructure such as the jetties and waterways are spoiled and dilapidated, decaying and rusting, and inadequate and obsolete, representing 22.2%, 19% and 18.2% from the distribution. Other conditions include non-connectivity and lack of interlinkage between jetties connecting one part of the metropolis, shallow waterways, and non-modal exchange flight accounting for 17.3%, 12.2% and 11.1% respectively in the distribution of commuters' responses. Also, key informants interviewed, and physical observation showed some of these conditions of the water infrastructure transport system in the study area. The government recently has carried out some form of repairs and upgrading of the Bille/Bonny/Nembe Jetty (see Figure 4).

Table 4 reveals the state of functionality of the road and water infrastructure transport systems in the study area. From analysis, it was revealed that 30.4% of the respondents rate the state of functionality of the road and water infrastructure as functional, closely followed by commuters that rate it very not available and not usable, accounting for 28.8% and 21.1% respectively from the distribution. Other commuters interviewed rated the state of functionality of the road and water infrastructure as functioning below performance and very functional, representing 16.8% and 8.4%, respectively. These ratings indicated mixed filings in commuters' assessment of existing roads and water infrastructure identified and examined in the study area. Though, depending on the commuters' usage of these infrastructure and services for the movement of goods and passengers. However, from key informant responses, the road infrastructure is rated very functional because of the current improvement carried out on the roads through expansion and reconstruction of the existing routes. On the other hand, the water infrastructure is rated as not functional, obsolete, dilapidated, old fashioned, decaying and below standard from key informants' responses.

Table 2: Road Infrastructure Transport System

S/No.	Condition of Road Infrastructure/Transport System	No.	%
1.	The roads are well tarred and is smooth	52	14.1
2.	Well inter-connected and interlinked	53	14.4
3.	Some roads are untarred and unpaved	43	11.7
4.	The roads are galloping with potholes	45	12.2
5.	The roads are without streets lights and traffic signs	68	18.4
6.	The roads are always flooding when it rains	58	15.7
7.	The roads are not properly interlinked and interconnected	50	13.6
	Total	369	100

Source: Researcher's Survey, 2021

Table 3: Water Infrastructure Transport System

S/No.	Condition of Water Transport Infrastructure	No.	%
1.	Bad and obsolete	67	18.2
2.	Spoiled and dilapidated	82	22.2
3.	Decaying and rusting	70	19

4.	Non-connectivity and lack of interlinkage between jetties connecting one part of the metropolis and the other	64	17.3
5.	Shallow water way	45	12.2
6.	Non-modal exchange flight	41	11.1
	Total	369	100

Source: Researchers' Survey, 2021

Table 4: Level of Functionality of the Road and Water Infrastructure Transport System

S/No.	Level of Functionality	No.	%
1.	Very not functional	84	28.8
2.	Not functional	80	21.1
3.	Functioning below performance	62	16.8
4.	Functional	112	30.4
5.	Very functional	31	8.4
	Total	369	100

Source: Researchers' Survey, 2021



Figure 2: Trans-Amadi Road, an Improved Road Infrastructure

Source: Researcher's Survey, 2021



Figure 3: Feltaco Jetty Iwofe, in a Deplorable Condition

Source: Researcher's Survey, 2021



Figure 4: Bille/Bonny/Nembe Jetty, a Newly Improved Water Transport Infrastructure
 Source: Researcher's Survey, 2021

Identified and Examined Disconnect Existing Road and Water Transportation in the Study Area

The study has identified some factors impeding the disconnection of existing road and water infrastructure transport systems in the study area that may slow down the improvement sustainability in the urban environment. The nature of disconnects as identified by commuters in table 5 include bottlenecks caused by land-use conflicts; no interchange split causing chaotic traffic, jetties/waterways are not analysed and channelised to link each other, representing 22%, 21.1% and 19.5%, respectively. Another disconnect identified is that roads are not adequately interlinked and interconnected, and no intermodal and interchange facilities account for 19% and 18.4% of the commuters' responses. These natures of disconnects are instrumental to the level of disconnection that is observed in the study. These scenarios have not encouraged move effective and efficient movement of commuters and goods from one location to another in the study area, decreasing the possibility of achieving sustainability and improving the quality of life of the urban dwellers in terms of mobility. The factors identified as the causes of this disconnection between road and water infrastructure transport systems in the study area which has affected the different modes of transport in the metropolis are observed by commuters are poor transport planning, design and infrastructure, non-implementation of the transport policy of integration of the road and water transport system, and lack of proper canalisation of the creeks to create waterways for marine transportation in the area accounting for 22.1%, 22.1% and 19.5% of their responses. Other factors given by the commuters were non-connectivity between the various jetties in the area and absence of intermodal facilities, and intermodal exchange splits accounting for 19.1% and 18.4%, respectively (see Table 6).

In analyses, these disconnect portrays the problem of poor urban planning and management of the transportation sector in the study area, which has created the disconnection of road and water infrastructure that can propel a sustainable transport system in Port's urban environment Harcourt metropolis. This system will encourage the integration of different modes and means of transport to enhance residents' quality of life and well-being for easy commuters and goods movement. This interconnectivity and interlinkage of road and water transport systems are crucial for the socio-economic growth and development of the metropolis and other sectors.

Table 5: Nature of Disconnect Existing in the Modes of Transport System

S/No.	Nature of Disconnect	No.	%
1.	The roads are not properly interlinked and interconnected	70	19
2.	The jetties/waterways are not analysed and channelized to link each other	72	19.5
3.	There are no inter modal and interchange facilities	68	18.4
4.	There are no interchange split causing chaotic traffic	78	21.1
5.	The bottlenecks caused by landuse conflicts	81	22
	Total	369	100

Source: Researcher's Survey, 2021

Table 6: Causes of Disconnect in Modes of Transport between Road and Water Infrastructure Transport Systems

S/No.	Causes of Disconnect	No.	%
1.	Lack of proper canalization of the creeks to create water ways for marine transportation in the area	72	19.5
2.	Non-connectivity between the various jetties in the area	70	19.1
3.	Non-implementation of the transport policy of integration of the road and water transport system	78	21.1
4.	Absent of inter modal facilities and inter modal exchange splits	68	18.4
5.	Poor transport planning, design and infrastructure	81	22.1
	Total	369	100

Source: Researchers' Survey, 2021

Challenges Facing Integration of Road and Water Transportation in the Study Area

From commuters' surveys and observations, there are identified challenges facing the enhancement of the integration of road and water transportation systems in the study area to achieve sustainability in mobility and urban environment. Thus, table 7 revealed that the factors responsible for poor integration of road and water transportation in the study area are corruption in government agencies, lack of conformity in the implementation of government policies and programmes, lack of proper land use planning, and poor governance system accounting for 17.3%, 16.3%, 15.2% and 14.4% from the commuters' responses in the distribution. Other factors noted as challenges facing road and water transportation integration are lack of government will, lack of government implementation of the policy on integrated intra urban transport system, and lack of innovative and radical planning approach, the non-adherence to the application of modern planning techniques in the planning of riverine area transport sector as well as lack of modern integrating equipment in road and water transport system representing 13.6%, 12% and 11.4% respectively as presented in table 7.

The study found that the culprits responsible for creating the challenges impeding road and water transport integration in the study area are mainly the government accounting for 38.2% of the responses, closely followed by the landowners and waterfront owners, and planning authority representing 19% and 17.3% respectively. Other culprits involved in creating the challenges facing road and water transport integration, as recorded in table 8, are public office holders and the transport ministry officials accounting for 14.4% and 11.1%. From tables 7 and 8, it was evident that most of the challenges against the integration of road and water transport systems in the study area are projected by the government. These challenges include the inability of the government to provide the needed policy, infrastructure and

services that the private sector will be aligned to and create an efficient and effective transport system that will enhance sustainability in the urban environment and improve the quality of life of the urban residents in terms of urban mobility.

Table 7: Challenges Facing Road and Water Transport Integration

S/No.	Challenges Facing Integration	No.	%
1.	Lack of government implementation of the policy on integrated intra urban transport system	44	12
2.	Corruption in government agencies	64	17.3
3.	Lack of Government will	50	13.6
4.	Poor governance system	53	14.4
5.	Lack of conformity in the implementation of government policies and programmes	60	16.3
6.	Lack of proper landuse planning	56	15.2
7.	Lack of innovative and radical planning approach, the non-adherence to the application of modern planning techniques in the planning of riverine area transport sector as well as lack of modern integrating equipment in road and water transport system	42	11.4
	Total	369	100

Source: Researchers' Survey, 2021

Table 8: Culprits Responsible for Creating the Challenges

S/No.	Culprits Responsible	No.	%
1.	The Government	141	38.2
2.	Public office holders	53	14.4
3.	The transport ministry officials	41	11.1
4.	The planning authorities	64	17.3
5.	Landowners and waterfront owners	70	19
	Total	369	100

Source: Researcher's Survey, 2021

Conclusion

Integration of road and water infrastructure transportation systems is essential to the functionality of an urban area where these potentials exist. The condition of road and water transport systems in Port Harcourt City and Obio/Akpor LGAs within the metropolis presents a parallel relationship in integration to promote sustainability in urban mobility and environmental quality. The study has assessed the integration of road and water transport systems to build a sustainable urban environment in Port Harcourt metropolis, Nigeria. The study found some level of interconnectivity and interlinkage between the road and water transport systems but presented poor functionality in terms of urban mobility of commuters and goods. This gap has created some level of disconnect between both transport systems. This gap is caused by government unwillingness to harness the resources and potentials of road and water transport systems in the study area aided by corruption practices in government agencies, lack of conformity and implementation of government policies and programmes on urban planning and management, poor land-use planning and urban governance issues. These conditions are accentuated by the government and its planning agencies' negligence to pursue an integrated transport system to promote sustainability and the urban environment. Based on these findings, the study has suggested physical planning measures to improve the integration of road and water transport systems that will enhance residents' quality of life and well-being, enhance economic activities, and promote urban

sustainability. Furthermore, the study has contributed to the knowledge of road and water infrastructure transportation systems in urban areas, especially in developing economies.

Recommendations

Thus, from the findings, the following recommendations are suggested:

- i. Government should develop an integrated transportation policy framework to enhance the integration of road and water transport systems interconnectivity in Port Harcourt metropolis to achieve sustainability in the urban environment of the study area (see Figure 5);
- ii. Government should continue in the upgrading and rehabilitating of the road and water transportation infrastructure in the study area to improve intermodal connectivity and linkages for efficiency and effectiveness;
- iii. Public-Private Partnership approach should be developed and adopted that will involve government and private investors in collaboration in the planning and management of the transport sector in the study area;
- iv. Government should partner with the private sector to develop all waterways within the study area through canalisation and channelisation to improve the connectivity of all channels to the roads to enhance urban mobility and modal choice of residents; and
- v. The government should adopt sound governance principles to involve all transport sector stakeholders to implement the extant transportation policies in the study area.

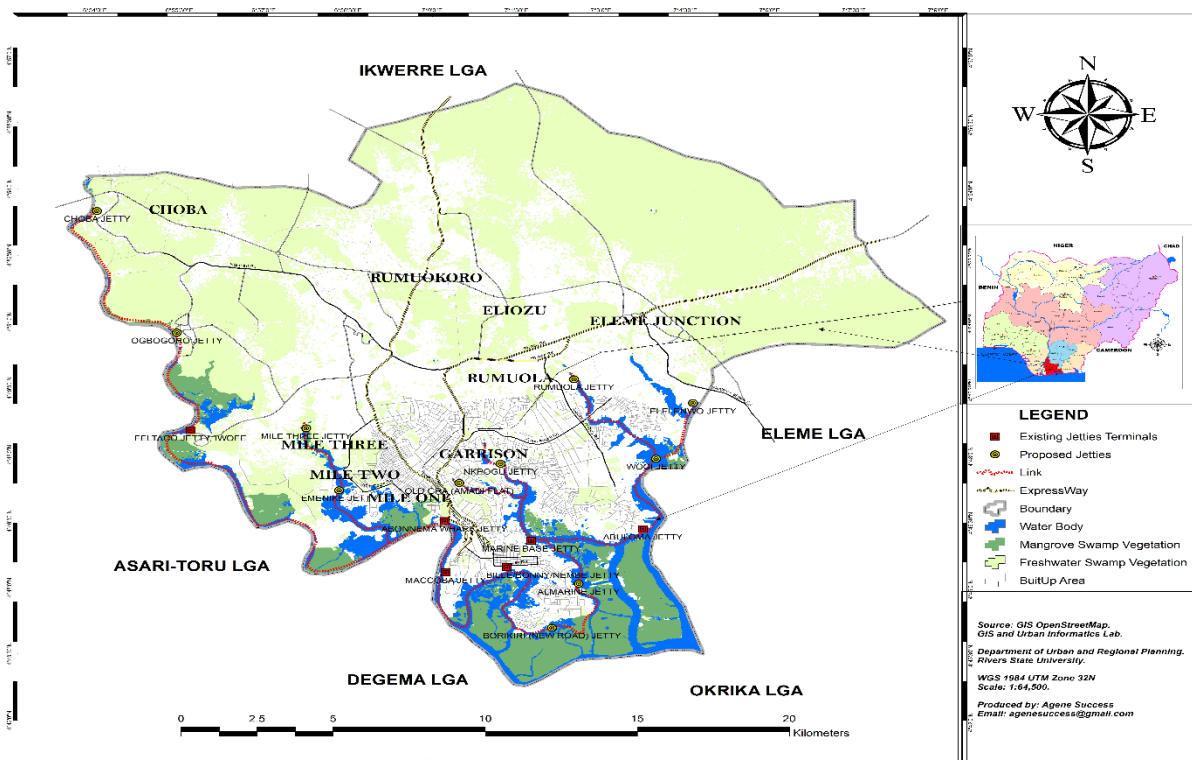


Figure 5: Proposed Road and Water Transportation Interconnectivity for the Port Harcourt Metropolis

Source: Researchers' Conceptualisation, 2021

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

References

- Adelabu, O.E. (2017). *Ensuring Efficient Urban Mobility in Ikeja, Lagos*. Abuja, Nigeria: Unpublished Professional Certificate Thesis, Nigerian Institute of Town Planners Examination Board.
- Avis, W.R. (2016). *Urban Governance: Service Delivery*. Birmingham, UK: GSDRC, University of Birmingham.
- Correia, J. (2017). Information for Urban Intermodal Transport: Brief Literature Review. *U. Porto Journal of Engineering*, 3(1), 61-71. DOI: 10.24840/2183-6493_003.001_0006
- Fasina, S.O, Akarimu, A.A., Salisu, U.O. & Okungbi, S.A. (2020). Intra-city Mobility and Characterization in a Fast-growing City of Lagos, Nigeria. *Journal of Logistics and Sustainable Transport*, 11(1), 33-50.
- May, A.T. (1993). How to Achieve Integration in Integrated Urban Planning and Transport Policies. *The Cambridge Conference On Urban Transport*, Christ College, Cambridge, UK.
- Nosal K. & Soleckaa, K. (2014). Application of the Multi-Critical Methods of Evaluating the Variants of Inter Modal Exchange in Integrated Urban Transport System. *Paper Presented at 17th Meeting of the Euro Working Group on Transportation*, Serilla, Spain, 2014.
- Olarenwaju, T.C. (2011). Intelligent Freights Transportation System: Assessment and Contribution in an Integrated Intra-City Transport System Development in Canada. *International Journal of Transport Studies*, 6(3), 23-30.
- Salisu, U.O. (2019). State of Transport Administrative Structure in Lagos, Ogun, and Oyo States, Nigeria. *Journal of Spatial and Organizational Dynamics*, 7(1), 68-85
- Sule, R.A.O. (2005). *Principles and Practice of Urban Planning in Nigeria*. Calabar: Thumprints International Company.
- The Global Risks Report (2018). *The Risks of Rapid Urbanization in Developing Countries*. Retrieved 18th November, 2021 from <https://www.zurich.com>globa-risks-report>
- World Commission on Environment and Development (WCED) (1987). *Our Common Future*. Oxford, UK: Oxford University Press.

United Nations Human Settlements Programme (UN-Habitat) (2021). *Sustainable Development Goals, Monitoring Human Settlements Indicators: A Short Guide to Human Settlements Indicators Goal 11*. Nairobi, Kenya: UN-Habitat.

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