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Spatial Analysis of Road Transit Firms in Port Harcourt Metropolis, Nigeria

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ABSTRACT

This study examined the spread of public and private road transit terminals with the rapid growth in economic activities in Port Harcourt Metropolis, without corresponding planning and provision of transport infrastructure that resulted in inadequacy in the transportation network. To satisfy a large number of travellers in Port Harcourt metropolis, call for development of Geographic Information System (GIS) based road network map that could be used to analyze easy means of accessing public transit boarding points. Data on precise locations of vibrant public transit terminals were gathered through the application of Global Positioning System Receiver standardized to Geographic Coordinate System, besides the International Terrestrial Reference System. The coordinate's insertion on the map shows that the vibrant road transit firms operating in Port Harcourt Metropolis, are located mostly along both sides of Port Harcourt-Aba Road, Olusegun Obasanjo Road, Ikwerre Road and East-West road. Thus, make it easier to travel from one terminal to another in search of a better, convenient, alternative or substitute transit road system if experience disappointment from one transport service. Hence, recommend that geographic location information of terminals within the metropolis, be made available to the public for easy access to transport facilities.

KEYWORDS: *Transit Terminals, GIS, Port Harcourt Metropolis, Public Transit, Commuters*

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I. INTRODUCTION

Public road transport terminals provided in Port Harcourt Metropolis were well designed and situated in a manner that enhanced easy accessibility to transport facilities. In as much as good transportation networks is a contributing factor to economic development, consequently, make Port Harcourt experience rapid growth. The rapid growth in economic activities of the city arising from an increase in population and volume of vehicles without corresponding planning and provision of transport infrastructure resulted in an inadequate transportation network. Accessing public transit vehicle boarding points became a challenge to commuters. Commuters, thus quest for a transit system that could ease their movement constraints.

Commuters are likely to stop patronizing a public transit system when experience delays that could be blamed on the transit agency, longboarding time, waiting at transfer points(McMahon, 2020).

Population growth and an incessant demand for road transport services in Port Harcourt metropolis, without corresponding availability of transport infrastructure, to ease commuters' accessibility to move them to their preferred destinations, call for the need to explore the efficient way of accessing transport facilities. Accessibility to transport terminals is the first step in the determination of the choice of the transit system. Improper location of public transit terminals brings about inadequacy in transportation network which is mostly attributed to improper planning and design of the roads system within Port Harcourt Metropolis. To satisfy a large number of travellers in Port Harcourt metropolis required development of a Geographic Information

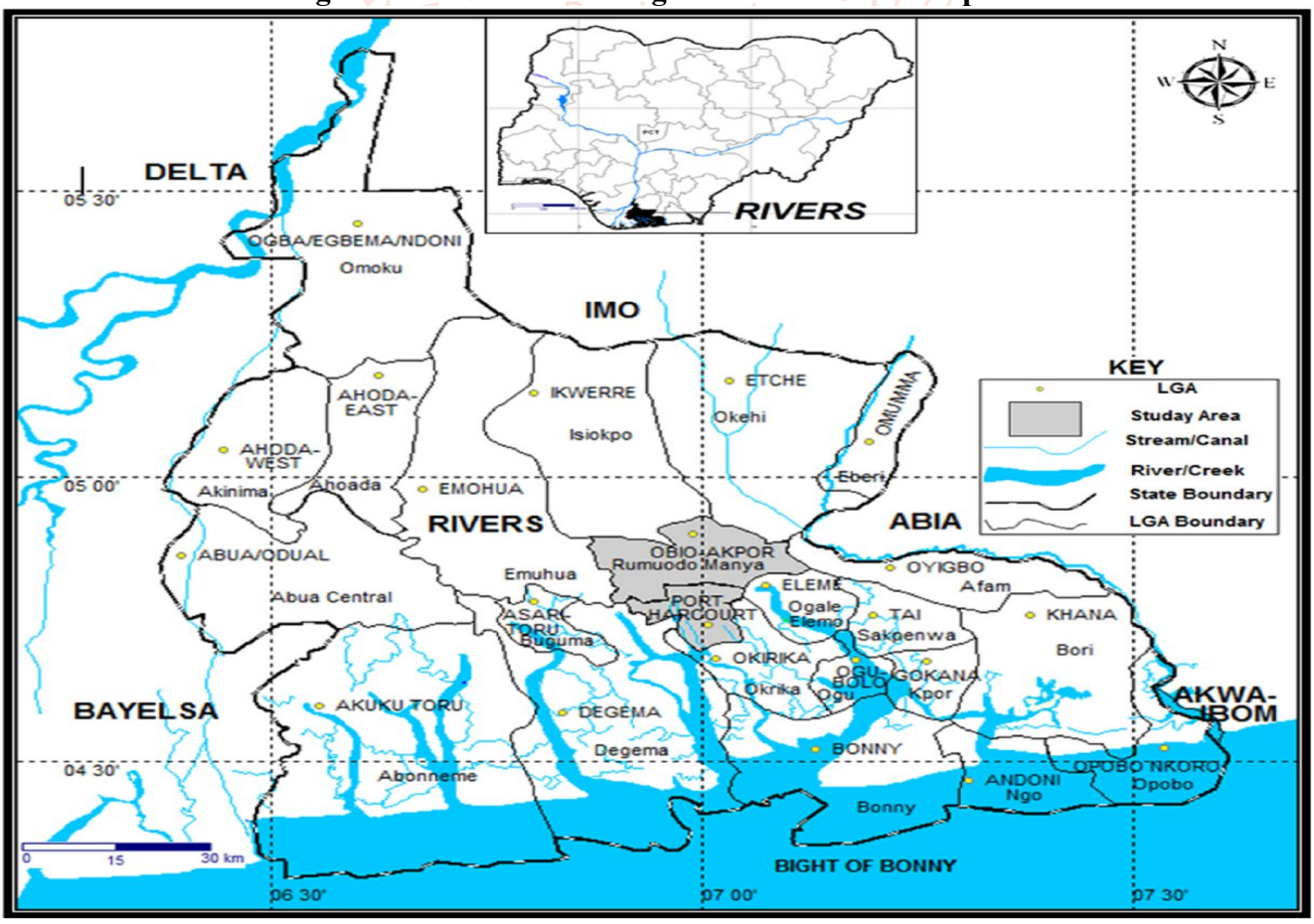
System (GIS) based road network map that could be used to analyze easy means of accessing public transit vehicles boarding points. The used Geographic Information System (GIS) analysis technology, on the spatial organization aid, to discover the dynamic features of a freight transportation connection network (Ling, Jing-jing and Xiao-feng, 2020). The use of Geographic Information System (GIS) in essence, will aid in acquiring geographic coordinates of major public transit terminals within the metropolis.

Spatial analysis of public road transport firms, as a means of generating information/evaluation of their operational base of public road transit operations in Port Harcourt metropolis, will aid in improving commuters' movement and enhance the survivability of key nodes that could balance the network connectivity and improve the stability of system preference. This could be achieved with the application Global Positioning System (GPS) in determining the geographical locations of public road transit terminals in the study area.

Port Harcourt Metropolis is the entire area undergoing review in this study. It became necessary because this research focused on road transportation terminals in Port Harcourt city. Port Harcourt is the centre of operations and capital of Rivers State in the south-south geopolitical zone of Nigeria. Port Harcourt is located in latitudes between 4° 44′ 58″N and 4° 56′ 46″N and longitudes between 6° 53″E and 7° 08′ 37″E, with an estimated land area of 664 square kilometres (Emenike and Orjinmo, 2017). It lies along the Bonny River, 41 miles (66 km) upstream commencing the Gulf of Guinea and is popularly known as an oil city. It was founded in 1912 and customarily occupied by the Ikwerre and Ijaw people. It started as a port named for Lewis Harcourt, then colonial secretary after the opening of the rail linkage to the Enugu coalfields in 1916. It is the initial point of the eastern branch of the Nigerian Railways mainline as well the trunk highway network serving former eastern Nigeria. It houses an international airport located eleven kilometres north.

Port Harcourt is densely populated within the neighbourhood of Diobu, ranked among most commercially vibrant places of the metropolis and consists of three main extensions, to be precise: Mile 1, Mile 2 and Mile 3, bordered by New GRA to the north, D-line to the northeast, Rivers State University to the northwest, Old GRA to the east, Kidney Island to the southeast, and Eagle Island to the southwest. Port Harcourt Metropolis comprises of Port Harcourt and Obio/Akpor local government area.

Fig. 1: Rivers State showing Port Harcourt Metropolis



Source: AkukweandOgbodo (2015)

It is bounded on the east by the Otamiri/Imo River basins and lying on the west by the New Calabar River. The region is drained by the Bonny River and its major tributaries include Elechi, Diobu, Woji and Okpoka (Ede, 2014).

Port Harcourt Metropolis experience high rainfall at a certain time of the year causes maximum soil saturation and brings the groundwater table very close to the surface which in some cases helps to damage road pavement, constituting challenges to operations of some public roads transit firms in the region. December and January are the only months that truly qualify as dry season months in the city (Sangari, 2018).

Population

The place of Port Harcourt metropolis in Rivers State covered two local government areas that comprise of Port Harcourt and Obio-Akpor. It covers a space of approximately15.54 km2 in 1914 and grew uncontrolled to an area of 360 km2 in the 1980s (Izeogu, 1989). According to www.citypopulation.de (2020), the National Population Commission of Nigeria has the population projection of 2016 for the two local government areas that constitute the Port Harcourt metropolis stated in the table below.

Table 1: Projected population of the study area

S/No	Local Government Area	Population Census 26-11-1996	Population Census 21-3-2006	Population Projection 21-3-2016	Population Projection 21-3-2020
1	Port Harcourt	440,399	538,558	756,600	879168
2	Obio-Akpor	263,017	462,350	649,600	754,834
Total		**703,416**	**1,000,908**	**1,406,200**	**1,634,002**

Source: Researcher population analysis of 2020.

Analysis from population census of March 21, 2006, and population projection of March 21, 2016, National Population Commission of Nigeria web, and National Bureau of Statistics web as in table 1.1 above, gave room for population projection of March 21, 2020. The population projection for 2016 was based on 40.4996% growth in ten years for each local government area. It implies that the population projection for each year was centred on 4.04996% growth. Going by this projection, the population of Port Harcourt Metropolis as of March 21, 2020, was One million, six hundred and thirty-four thousand, two (1,634,002) persons.

II. Literature Review

(Antwi, Quaye-Ballard, Arko-Adjei, Osei-wusu, Quaye-Ballard, 2020) affirms that, Global Positioning System (GPS) are used in numerous applications for instance: urban developments, agriculture, social sciences, etc. It uses satellite information in offering positioning, navigation, and time using a GPS receiver. Several devices such as cell phones that come with GPS fixed or installed in them, makes location information like transport survey data easier to gather which is an alternative for Automatic Vehicle Location (AVL) considering that it offers cost-effective means of gathering a large volume of transport data. The incorporation of geo-information knowledge with GPS into transport planning and land use modelling has become a standard application. Maps have become a popular product for geo-information technologies and played a crucial role in inspiring people's understanding of present and planned developments, routing and logistics, accessibility offered by transport routes, etc. Incorporation of geo-information technology with Geographic Information System GIS into transportation planning and land use modelling has been developed as a standard application, that aid people's understanding of present and intended developments, direction-finding accessibility provided by transport routes, etc. This technology offers conception tied to a geographic location as well as informs people on-trend and relationships embedded in a dataset (Antwi et al, 2020). In using GIS-based raster analysis and Geographically Weighted Regression (GWR) model, spatial-temporal distribution of highway accessibility could be investigated and approximate the connection and heterogeneity between transport accessibility and the level of economic development (Yang, et al., 2019).

Paul (2018), identified GIS as an instrument that could aid in achieving excellence in transportation. Geographic Information System (GIS) meaningfully helps in planning, monitoring and managing multiple systems used in transportation planning and management efficiently. It helps in defining capacity enhancements, improving operations, as well classifying the best strategic investments for keeping the transportation system of any nation running in a more desirable way. He further stated that Geographic Information System (GIS) data could likewise be transformed into serviceable road models for large-scale road traffic simulation; and equally delivers

great spatial analytics, enabling authorities to ascertain patterns and gain intelligence into a better understanding of travel behaviours as well perform accident analysis. Through the introduction of Geographic Information System (GIS) into transportation, greater efficiency could be achieved in the entire infrastructure lifecycle, beginning from planning and design via survey and construction management in the direction of operations and maintenance. GIS aids in extenuating woes for commuters and planners. By means of making commuters get to know of the best routes for their destinations, transportation specialists get equipped with the improved aptitude to manage their infrastructure. In as much as accessibility is the concept of whether a product or service can be used by everyone, Long (2017) opined that central to modelling accessibility is the scheming of the distance, time, or cost distance between dual (or extra) locations, which is an operation that geographic information systems (GIS) was intended to accomplish. He further stated that measuring accessibility entails measuring the opportunities for movement (access) to diverse services, goods, and activities (hereafter destinations). Hence, accessibility is influenced equally by the location of an individual to the locations of potential destinations. According to Rodrigue (2017), the spatial organization of transportation is linked with the location of economic activities. The objective is to uncover a suitable location that could maximize the economic returns for these activities which include the amount to be produced, the cost of production or market accessibility. Accessibility is an important factor in the location preferences of firms and individuals. As well, location in transport has four main influences which include costs, agglomeration, density and co-location. Thus, the assessment of public and private transit firms has location factors of the attributes of the site, the level of accessibility and the socioeconomic environment. Location factor has the benefit of minimizing transport costs either for passengers or freight. Fengjun, et al, (2016) asserts that spatial organization of transport networks is among the main objects of learning transport geography. Analysis of the regional structure, evolution, and mechanism of transport networks made it important to study. It's concerned mainly with describing, explaining, and predicting flows of people, goods, and information.

The design of the bus terminal should consider the physically challenged and the aged people. The characteristics of the bus terminal, in terms of location, design and usage should be able to accommodate all categories of users. This in turn will enhance public transport and mobility in broad-spectrum. Bus terminal spacing has a great influence on transit performance. Terminal spacing affects access time and consequently affects the demand for transit service (Federal Transit Admin., 2015).

In view of the various studies referred, there are some new efforts present in the literature, in relation to the use of Geographic Information System (GIS) in spatial analysis of public road transit firms operations. Scholars like: Antwi et al (2020) affirms the use of Global Positioning System (GPS) applications in urban developments, agriculture, social sciences, etc.; Antwi, Quaye-Ballard, Arko-Adjei, Osei-wusu, Quaye-Ballard, (2020) asserts that the incorporation of geo-information technology with Geographic Information System GPS into transportation planning and land use modelling, aid people's understanding of present and intended developments, direction-finding accessibility provided by transport routes; Paul (2018), identified GIS as an instrument that could aid in achieving excellence in transportation. Also, Yang, et al., (2019), declared that, in using GIS-based raster analysis and Geographically Weighted Regression (GWR) model, spatial-temporal distribution of highway accessibility could be investigated, but the use of Global Positioning System (GPS) coordinates of vibrant road transit firms' terminals, in specifying the space interval between the various terminals were ignored. This is the gap in the literature which this study uncovered.

III Methodology

Data on precise locations of the economically vibrant public transit firms within metropolises were gathered through the application of the Global Positioning System (GPS) in determining terminal positions. The GPS located the coordinate points of vibrant public road transit firms operating in Port Harcourt Metropolis. Before the GPS survey, the validity of the research was attested by two other professionals from the Department of Geography and Environmental Studies, Ignatius Ajuru University of Education, Port Harcourt. It was ensured that the Global Positioning System Receiver was standardized to Geographic Coordinate System (GCS) besides the International Terrestrial Reference System (ITRS) 2000 (epoch 2001.0).

IV Results and Discussion

Application of Global Positioning System (GPS) in Determining Terminals Locations

A survey carried out identified the coordinate's points of vibrant public road transit firms operational based in Port Harcourt Metropolis through the use of Global Positioning System Receiver (GPS) as indicated in Table 4.1 below.

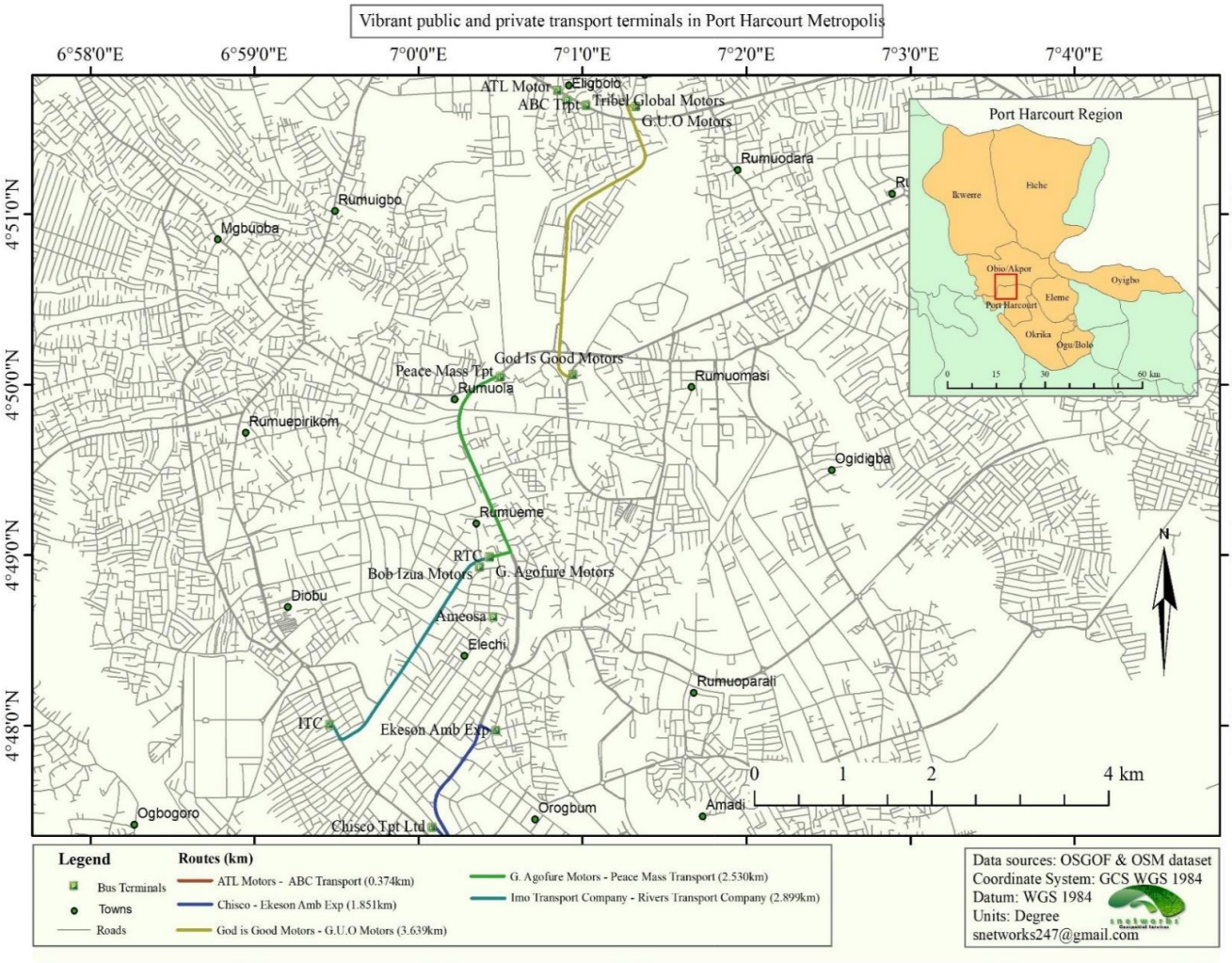
Table 4.1: VibrantRoad Transit Firms' Terminals withGPS Coordinates

GPS OF VIBRANT ROAD TRANSIT FIRMS OPERATING IN PORT HARCOURT				
S/No	**Transit Firm**	**Firm type**	**Terminal**	**GPS Coordinates**
1	Rivers Transport Coy	Corporate	OluObasanjo Rd by Waterline	Lat: N 4° 48′ 59.616" Lng: E 7° 0′ 25.8402"
2	Imo Tpt Coy	"	Ikwerre Rd by Mile 3 Park	Lat: N 4° 48′ 0.6582" Lng: E 6° 59′ 27.4014"
3	Ameosa	Private	3 OluObasanjo Rd by Waterline	Lat: N 4° 48′ 58.4922" Lng: E 7° 0′ 27.1902"
4	Bob Izua Motors	"	Bob Izua Park, Waterline OluObasanjo Road	Lat: N 4° 48′ 56.1342" Lng: E 7° 0′ 22.2942"
5	ChiscoTpt (Nig) Ltd.	"	Ikwerre Rd at Mile One	Lat: N 4° 47′ 24.4062" Lng: E 7° 0′ 4.8414"
6	EkesonAmbExp	"	OluObasanjo Rd by Waterline	Lat: N 4° 47′ 58.4952" Lng: E 7° 0′ 28.2902"
7	G. Agofure Motors	"	143 OluObasanjo Road	Lat: N 4° 48′ 59.5686" Lng: E 7° 0′ 25.9986"
8	Peace Mass Transit Coy	"	206 Port Harcourt - Aba Express way, Rumuola	Lat: N 4° 50′ 3.1806" Lng: E 7° 0′ 29.9154"
9	RT Express	"	East-West Road, Eligbolo	Lat: N 4° 51′ 40.3842" Lng: E 7° 0′ 54.1434"
10	God is Good Motors	"	3 Stadium Road, Rumuomasi	Lat: N 4° 50′ 3.804" Lng: E 7° 0′ 56.3826"
11	ABC Tpt Coy	"	Plot 100, East-West Road, Eliozu	Lat: N 4° 51′ 38.5194" Lng: E 7° 1′ 1.2966"
12	G.U.O Motors	"	239 Port Harcourt - Aba Express way	Lat: N 4° 51′ 38.1708" Lng: E 7° 1′ 19.3902"
13	ATL Motors	"	70c East-W Road, Eligbolo	Lat: N 4° 51′ 43.884" Lng: E 7° 0′ 50.7774"
14	Tribal Global Motors	"	East-West Road, Eligbolo	Lat: N 4° 51′ 38.5194" Lng: E 7° 1′ 1.2966"

Source: Researcher field Survey of 2020

Terminal locations were recognized as a fundamental element in public transport considering that commuters are pedestrians at each end of a bus' trip.

Fig 4.1 shows vibrant public transit terminals in Port Harcourt Metropolis



Source: OSOGOF and OpenStreetMap (OSM) dataset

Convenience and comfort of travel required better optimal location of bus terminals that will motivate patronage. The use of Global Positioning System Receiver (GPS) served as a computational approach in identifying the exact location of the terminals. It allows the precise locating of the terminals by using satellite signals in determining their coordinates. It helps travellers to determine their choice of terminal prior to or during a journey from the multi-route destination on a particular road network.

The coordinate's insertion on the map shows that the vibrant road transit firms operating in Port Harcourt, are located mostly along both sides of Port Harcourt-Aba road, OlusegunObasanjoRoad, IkwerreRoad and East-West road as indicated in fig 4.1. This makes it easier to travel from one terminal to another in search of a better, convenient, alternative or substitute transit road system if experience disappointment from one transport service.

Analysis of the Routes Structure

Spatial analysis of public road transit terminals that are vibrant within the Port Harcourt region shows that the transit firms are clustered mostly around one zone of Port Harcourt local government area, except those terminals situated on East-West road in Obio/Akpor local government area. The clustering is around Stadium road, PortHarcourt-Aba expressway, Olusegun Obasanjo Road, and Ikwerre road. The Four roads are linked together. Port Harcourt-Aba expressway and Ikwerre road are parallel roads connected by Olusegun Obasanjo road, while Stadium road is on the right-hand side of Port Harcourt-Aba road when going out of the city by expressway. Out of the fourteen (14), public and private road transit firms used for sampling, terminals of five (5) are located on Olusegun Obasanjo road, two (2) on Port Harcourt-Aba expressway, two (2) on Ikwerre road, one (1) on Stadium road, while the remaining four (4) are located on East-West road in Obio/Akpor local government area. Terminals around area cluster have their coordinates that vary within Latitude N 4° 47′24.4062" and N 4° 51′ 38.1708", while outside the cluster varies between Latitude N 4° 51′ 38.5194" and Latitude N 4° 51′ 43.884". It's an indication that there is the proximity between terminals in the cluster and those outside the cluster area. Commuters can always use terminals of their choice, considering their easy accessibility.

Analysis of space between the various terminals shows that there is proximity among them. The space between Rivers Transport Company (RTC) terminal, located at 143 OlusegunObasanjo way on Latitude: N 4° 48′ 59.616"/Longitude: E 7° 0′ 25.8402" and Imo Transport Company (ITC) situated on Ikwerre road by Mile 3 park with Latitude: N 4° 48′ 0.6582" and Longitude: E 6° 59′ 27.4014" is 2.889 kilometre (km). The space between Chisco Transport (Nig) Ltd, located on Ikwerre road by with Latitude: N 4° 47′ 24.4062"/Longitude: E 7° 0′ 4.8414" and Ekeson Ambassador Express situated on Olusegun Obasanjo Road by Waterline with Latitude: N 4° 47′ 58.4952"/Longitude: E 7°0′ 28.2902" is 1.8 kilometres (km). G. Agofure Motors situated at 143 OluObasanjo Road on Latitude: N 4° 48′ 59.5686"/ Longitude: E 7° 0′ 25.9986" has a focal length of 2.580 kilometres (km) from Peace Mass Transit Company located at 206 Port Harcourt - Aba Expressway, Rumuola, on Latitude: N 4° 50′ 3.1806"/Longitude: E 7° 0′ 29.9154". In-between. ATL Motors located at number 70c East-West Road, Eligbolo, on Latitude: N 4° 51′ 43.884"/Longitude: E 7° 0′ 50.7774" and ABC Transit' terminal situated on Plot 100, East-West Road, Eliozu, with Latitude: N 4° 51′ 38.5194"/Longitude: E 7° 1′ 1.2966" is a space interval of 374 metres. Also, a space interval of 3.639 kilometres (km) exist between God is Good Motors road transit terminal situated located at number 3 Stadium Road, Rumuomasi on Latitude: N 4° 50′ 3.804"/Longitude: E 7° 0′ 56.3826" and G.U.O Motors' terminal on Latitude: N 4° 51′ 38.1708"/Longitude: E 7° 1′ 19.3902" situated at 239 Port Harcourt - Aba Expressway.

V Conclusion and Recommendations

It was also observed that both government and private sector involvement in the provision of transport infrastructure and their performance in transport services supply across the nation, underscores the fundamental function of transport in the advancement of Nigeria as stated by Afolabi, (2016). Their inefficiency in the provision of public transport facilities conversely makes commuters move from one terminal to another in search of a better, convenient, alternative or substitute transit road system to meet their expectations. However, the application of GIS in spatial analysis of the operational bases (terminals) of the vibrant road transit system in Port Harcourt metropolis, supports commuters in making the best decision transit system whose service that suits their interest in terms of comfort, reliability, safety, accessibility, type of terminal connection, and environmentally friendly transport.

This study is indeed justified that the use of Global Positioning System Receiver (GPS) served as a computational approach in identifying the exact location of the terminals, considering that the optimal location of bus terminals motivate patronage. It thus recommends that geographic location information of terminals within the metropolis, be made available to the public for easy access to transport facilities.

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