

Public Transport in the Federal Capital Territory, Abuja: A GIS-Based Analysis of Key Indicators

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Abstract: *The prevalence of private car for commuting in the Federal Capital Territory (FCT), Abuja is of concern to transport policy makers and planners because of its negative consequences on both physical and socio-economic environments. This study therefore investigates commuters' access to public transport using four key indicators (public transport fare, service frequency, walking distance to access points and waiting time at public transport terminals/bus stops). Relevant data were collected from the public transport operators and commuters using a combination of interview, questionnaire and GPS (Garmin 62x), the data collected were analysed and manipulated on Geographic Information System (GIS) Arc-GIS 9.3 environment to show areas with equal mean values of waiting time, transport fare, bus service frequency and distance to public transport access points. It was discovered that Gwagwalada and Zuba axis with 58 mean bus frequency per day, average 109 metres to public transport access points, about 20 min mean waiting time in the park and N158 mean transport fare per tip has the best access to public transport in FCT but still fell short of best practices. The study recommended a redesign of public transport routes, bus stops and terminals across the FCT that will reflect its current physical development pattern, while stakeholders should stepped-up efforts to provide enough and affordable public transport services.*

Keywords: Transportation, public transport systems, transport centre, GIS-Based Analysis

1. INTRODUCTION

Transport needs of major cities in Nigeria now present significant challenges for policy makers as the unpredictable shift in population dynamics in response to the need for employment, housing and sustenance continues. The expansion of cities in Nigeria coupled with increasing urban population result in greater demand for transport provision. This demand however, has not always been met and effort to provide adequate transport infrastructural facilities are ad-hoc, uncoordinated and poor (Akpoghomeh, 2019). Access to public transport has the potential of extending transport services to greater proportion of urban residents who do not have private cars and cannot afford exorbitant taxi fares (Bamidele, 2022). It has the potential of being used as a policy tool to reduce the number of cars on urban roads and by implication reduce traffic congestion in the city.

The basic function of urban transport is to link residents and employment as well as producer and users of goods and services. The demand for public transport in most Nigerian cities is very high. This is due in part to the fact that a large proportion of urban residents are low-income earners who cannot afford personal vehicles. On the other hand, available means of public transport are very few and limited especially when compared with what obtains in developed countries of Europe and America where trains are used for intra and inter urban movement as part of an integrated urban transport system (Drummond-Thompson, 1993). A good and efficient public transport system is the one which enables commuters to travel where they want, when they want and at the price they can afford. Achieving this can be done through the development of a multi-modal transport system which provides a variety of public transport services to suit a wide range of individual needs.

Public transport service access level is defined as the overall measure or perceived performance of the public transport system from the commuters' point of view (Jean-Paul, Comtois & Slack, 2016). It is used to denote the ease of getting to and quality of service derived from the operational characteristics of transportation facilities Public transport service accessibility indicators which include but not limited to bus service frequency, distance to access points public transport fare, transport time, bus service reliability and comfort reflect two important aspects of transport service: first, the degree to which transport service is available to a given location and secondly, the comfort and convenience of the service provided to commuters (Duranton & Turner, 2012). For any public transport service to be accessible within the framework of a viable public transport planning system, the indices mentioned earlier must be considered. These indices differ from both traditional highway service quality measures which are more vehicle-oriented than person-oriented. For any meaningful transportation planning, these indices within the framework of the geographical context must be integrated in the transportation planning system. This study therefore, examines the pattern of public transport access level in the Federal Capital Territory (FCT), Abuja-Nigeria.

2. LITERATURE REVIEW

Conceptual Clarification

According to Onokala, (2022), transportation is conveying, or being conveyed or a means of conveyance from one place to another. It is the movement or displacement of persons, good and other movable possessions in time and space for a particular purpose. In human societies, this is not chaotically done because recognized paths marked out by individuals or the societies are usually followed. It is the easiest way of movement of humans, animals and goods from one location to another. This movement is done through the following modes, air, land (rail and road), water, cable, pipeline and space (Olubomehin, 2012). Transportation is the engine room of any society and hence provides room for effective socio-economic development and societal improvement (Imobighe & Awogbemi, 2006). This implies that transportation plays key role in urban development and nations building.

According to Onokala (2017), transportation is no doubt an indispensable catalyst for activating and stimulating the tempo of economic, social, political and strategic development in any society. Thus, effective and efficient functioning of urban centres depends on the provision of basic infrastructures one of the most important being transport.

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According to Taffee, Morrill & Gould (2013), transportation is no doubt an indispensable catalyst for activating and stimulating the tempo of economic, social, political and strategic development in any society. Thus, effective and efficient functioning of urban centres depends on the provision of basic infrastructures one of the most important being transport. The role of government in providing quality urban transport services in Nigeria has not been encouraging (Okafor, 2021). Government tends to neglect transportation sectors and focus on other sectors of the economy without knowing that quality urban transport services provided in any modern society could enhance effective delivery in economic growth and societal development (Bamidele, 2022). As further observed by Bamidele (2022) the provision of urban transport services in most Nigerian cities has been seriously affected by lack of adequate fund have resulted to poor road network, poor transportation facilities and lack of community and environmental facilities. Transportation is inherently central to development of nations. It is not only a necessity to life but also have a resultant of nations. It is not only a necessity to life but also have a resultant effect on all aspect of human existence (Nwafor & Onya, 2019). It provides access to goods, services and social activities to maintain a good quality life. It is fundamental in breaking isolation and thus strengthening individual capital base (Akpoghomeh, 2019).

Transport system can be conceptualized as the set of relationships between nodes, networks, and demand. These relationships involve locations spatially expressing this demand, flows between them, and infrastructures designed to handle and link these flows (Olubomehin, 2012). All the components of a transport system are designed to facilitate the movements of passengers, freight, and information, either as separate or joint components. Transport systems are composed of complex relationships between the demand, the locations they service, and the networks that support movements. The introduction of information technologies is changing mobility and its relations with geography since it can support, modify, substitute, or expand transportation activities (Jean-Paul, Comtois & Slack, 2016).

Cities across the world are in a state of rapid transition, the inability and sustainability of these cities are intrinsically interwoven with not only the degree of efficiency and effectiveness with which existing transport capacity is managed but also how well intermediate and future transportation plans and programme are articulated, laid out and implemented in order to meet the needs of the people (Michael, 2016).

The spatial structure of cities especially in developing countries is highly varied and complex, some areas are adequately provided with services and facilities which in other area are grossly inadequate. The variation in the spatial structure results in different socio-economic characteristics of urban dwellers with strong challenges of getting equal and efficient urban service for the disadvantaged (Imobighe & Awogbemi, 2006). The quality of life in most cities is poor and closely related to accessibility to alternative employment, education and medical facilities, essential public services and nature of recreational open spaces. Bamidele (2022) noted that transportation has been a major contributor to the economy competitive force in business. It is activity that physical connects the business to its supply chain partners, such as suppliers and passengers, and it is a major influence on the passenger's satisfactions with the country. Transportation is required in the whole production procedures, from manufacturing to delivery to the final consumers and returns. Only a good co-ordination between each component would bring the benefits to a maximum (Nwafor & Onya, 2019).

A comparison of government and private operation of public transport operations in Nigeria shows that the state, and local government public transport is more organized while private sector operators are largely unorganized (Onokala, 2022). Private sector

operators rely mainly on revenue and financial support from informal sector such as friends, relative. Government – owned public transport have better trained staff and maintenance facilities than most of the private sector operators; their services are often provided on fixed routes and are relatively cheaper than those provided by private sector operators. Government owned public transport operator also have service schedules, but in practice are rarely followed because of the inadequacies of vehicle, declining fleet utilization rates, growing competition with private and para-transit operators, poor traffic management, congestion especially during peak travel periods and other problems associated with the operating environment (Onokala & Olajide, 2020).

In a study of public transport in Nigeria, it was reported that taxis and private vehicles carrying fare paying passengers represent 53% of the public transport trips, while 30% made use of motorcycles. In many cities in developing countries, motorcycles account for about 90% of feeders' trips to taxis and mini bus terminals (Onokala, 2022; Nwafor & Onya, 2019). Similarly, in the study of dynamics of infrastructure and economic growth in Nigeria, Michael (2016), found that most urban road networks are not only poorly developed with feeder streets, they are grossly inadequate and their inadequacies more often than not forced vehicles to concentrate on the primary roads with serious implications on commuters' modal choice and mobility pattern especially along the same urban transport corridors. Onokala (2022), and Nwafor and Onya (2019) affirmed that urban poor in Nigeria pay very high proportion of their income for transport services and spend long period of trekking time, travelling time and waiting for infrequent and unreliable bus service.

The Study Area

The FCT was created in 1976 in pursuance of the Federal Government's decision to relocate the Federal Capital of Nigeria from Lagos. Within the Territory a site was selected, where an entirely new modern city was and is being developed as the new Capital City. With an area of 8,000 square kilometres the territory can be compared in terms of land mass with the states of Rivers, Enugu, Ondo and Osun. While the states of Anambra, Ekiti, Lagos, Imo, Akwa Ibom, Ebonyi and Abia are much smaller in size. As the extensive Territory is not intended to become one of the states of the Federation, it has been conceptualized and operationalized as the administrative Territory of the Country. The FCT- Abuja is centrally located within Nigeria's geographical space, which makes it equally accessible to all parts of the country (Pillah: 2022).

The Federal Capital Development Authority (FCDA) was established in 1976 to provide platform for administration and the development of transport infrastructure in the city. Today, the FCDA has developed massive transport infrastructure to meet the transport demand of the city. One of the main areas of the transport need of the city is mass transit system that will move the ever-increasing city population. Bamidele (2022) noted that the current public transport supply is grossly inadequate which compels most commuters to rely heavily on private automobiles with its attendant consequences on traffic and socio-economic environment of the city.

An Overview of Transportation Infrastructure Situation in Nigeria

The major problems of Nigerian transportation among many others are; bad roads network; inadequate fleets of buses and trucks; irregular, insufficient and overcrowded trains and airplanes and congested ports. Besides, there exists scarcity of suitably-trained transport managers and planners, capital investment difficulty, problems of institutional reforms and ineffective traffic regulations (Nwafor & Onya, 2019). This situation has never helped the pursuit of accelerated economic development in emerging Nigeria economy and has created abnormal defects in resources distribution and rendered many of us deformed and a few deaths thanks to road accidents and plane crash. Undoubtedly, the government of Nigeria has in various ways played unqualified roles to reposition transport infrastructure in Nigeria. This intention has been incorporated within the various National developmental and rolling plans. Every government that has piloted the affairs of the country has in a method or the opposite attempted to enhance on transportation infrastructure.

However, the world remains far away from the specified level of development capable of speedy acceleration of economic development of the country. FRN (Federal Republic of Nigeria) in year 2000 pointed out that, Nigeria had about 195,500 km road network in the country. Out of the entire, a proportion of about 32,000km are federal roads while 31,000km are state roads. An outsized proportion of those roads have infrastructural imbalances as a result of insufficient investment and lack of adequate maintenance, and poor maintenance policy. The four classifications of Nigerian roads are: the federal trunk 'A' roads, owned, managed and controlled by the federal. Trunk 'F' was initially under the management of the state, but was appropriated by the federal with the intention to make sure its upgrading to federal highway standard and adequate maintenance. Trunk 'B' roads are owned by the state who develop and maintain it while trunk 'C' roads are under the government ownership and control. Each of the amounts of state shared the responsibility of designing, construction and maintenance of roads in each respective domain (Ighodaro, 2009; Onokala, 2017). This arrangement is to make sure even development of the whole country (Ighodaro, 2009). Disgustingly, lack of adequate investment has made these roads very poor, and intrinsically has retarded the extent of resources mobility over the years, which is related to economic backwardness effects, in terms of inefficient mobility of inputs of production and low-income generation. The country's dilapidated infrastructure situation has been pointed by Michael (2016) and Imobighe and Awogbemi

(2006). They explained that most of the factors debilitating the achievement of the Nigeria's vision of being one among the most important economies in the millennium. Nigeria's road network is very poor since studies (Okafor, (2021; Onokala, 2021; Nwafor & Onya, 2019) show that about 70% of 193,000 kilometers of roads are during a deplorable condition. However, they also noted that Nigeria is currently allocating 7% of her gross domestic product on infrastructure, which is relative above average in Sub-Saharan Africa, and according to them, this has not propelled the economy to the specified level of development it wants to attain.

Suffice to say that, economic activities cannot take place without a good infrastructure base. The highly transactional and service-oriented functions of the various transport activities underline the complex relationship between its physical and human capital needs. as an example, effective logistics believe infrastructures and managerial expertise (Imobighe & Awogbemi, 2006). For its intensive use of infrastructures, the transport sector may be a crucial component of the economy and a typical tool used for development. To Taffee, Morrill and Gould (2013), this is often even more so during a worldwide economy where economic opportunities are increasingly related to the mobility of people and freight, including information and communication technologies.

A relationship between the amount and quality of transport infrastructure and thus the extent of economic development is obvious (Taffee, Morrill & Gould, 2013). High-density transport infrastructure and highly connected networks are commonly associated with high levels of development. When transport systems are efficient, they provide economic and social opportunities and benefits that end in positive multiplier effects prefer accessibility to markets, employment, and additional investments. When transport systems are deficient in terms of capacity or reliability, they're going to have an economic cost such as reduced or missed opportunities and lower quality of life. At the mixture level, efficient transportation reduces costs in many economic sectors, while inefficient transportation increases these costs. Additionally, the impacts of transportation aren't always intended and should have unforeseen or unintended consequences (Onokala, 2012). As an example, congestion is typically an unintended consequence within the supply of free or low-cost transport infrastructure to the users. However, congestion is additionally a symbol of a growing economy where capacity and infrastructure have difficulties maintaining with the rising mobility demands.

Transport carries an important social and environmental load, which cannot be neglected. Assessing the economic importance of transportation requires the categorization of the sorts of impacts it conveys (Onokala, 2022). These involve core (the physical characteristics of transportation), operational and geographical dimensions. The core is the foremost fundamental impacts of transportation-related to the physical capacity to convey passengers and goods and thus the associated costs to support this mobility. This involves the setting of routes enabling new or existing interactions between economic entities. While the operational explains improvement within the time performance, notably in terms of reliability, also as reduced loss or damage. Which implies that a much better utilization level of existing transportation assets benefiting its users as passengers and freight are conveyed sooner and with fewer delays. The geographical dimension explains the access to a broader market base where economies of scale in production, distribution, and consumption are often improved. It adds that there can be increases in productivity from the access to a much bigger and more diverse base of inputs (raw materials, parts, energy or labor) and broader markets for diverse outputs (intermediate and finished goods).

The economic importance of the transportation industry can thus be assessed from a macroeconomic and microeconomic perspective: At the macroeconomic level (the importance of transportation for a whole economy), transportation and thus the mobility it confers are linked to A level of output, employment, and income within a economy. In many developed countries, transportation accounts between 6% and 12% of the GDP. Further, logistics costs can account for between 6% and 25% of the GDP.

Further, the price of all transportation assets, including infrastructures and vehicles, can easily account for half the GDP of a sophisticated economy. At the microeconomic level (the importance of transportation for specific parts of the economy), transportation is linked to producer, consumer, and distribution costs. The importance of specific transport activities and infrastructure can thus be assessed for each sector of the economy (Onokala, 2021). Usually, higher income levels are associated with a greater share of transportation in consumption expenses. Transportation accounts, on the typical, between 10% and 15% of household expenditures, while it accounts for around 4% of the costs of each unit of output in manufacturing, but this figure varies greatly according to sub-sectors.

The added value and employment effects of transport services usually extend beyond those generated by that activity; indirect effects are salient (Michael, 2016). As an example, transportation companies purchase an area of their inputs (fuel, supplies, maintenance) from local suppliers. The assembly of these inputs generates additional value-added and employment within the local economy. In turn, the suppliers purchase goods and services from other local firms (Onokala, 2017). There are further rounds of local re-spending, which generate additional value-added and employment. Similarly, households that receive income from employment in transport activities spend variety of their income on local goods and services (Filani, 2019). These purchases end in additional local jobs and added value. Variety of the household income from these additional jobs is spent on local goods and services, thereby creating further jobs and income for local households. As results of those successive rounds of re-spending within the framework of local purchases, the overall impact on the economy exceeds the initial round of output, income, and employment generated by passenger and freight

transport activities (Bamidele, 2022). Thus, from a general standpoint, the economic impacts of transportation can be direct, indirect, or induced

The outcome of improved capacity and efficiency where transport provides employment, added value, larger markets, also as time and costs improvements is the direct impacts. While the outcome of improved accessibility and economies of scale, where jobs are the results of local purchases by companies directly dependent upon transport activity are the indirect impact (Akpoghomeh, 2019). This implies that transport activities are responsible for an honest range of indirect value-added and employment effects, through the linkages of transport with other economic sectors. Therefore, the outcome of the economic multiplier effects, where the price of commodities, goods, or services drops or increases is the induced impacts.

History of Transportation in Nigeria

The British claimed Nigeria in the late 19th century, and the pattern of British infrastructure development clearly revealed their intentions. The British immediately sought out to build a transportation network that would make ruling over the area as well as resource extraction easier (Duranton & Turner, 2012). Road construction, and later railroad construction became primary goals of the colonial government. The unification of the Protectorate of Sokoto and the southern regions into one political entity in 1912 intensified these goals. A vast majority of the roads and railroads in Journal of Sustainable Development Studies 177 Nigeria lead south-north, from the coast to the inland and back again. Eastwest transportation routes weren't necessary because the flow of goods—such as ground nuts, cocoa, and cotton—was from the inland to the coast where it could be shipped to Britain for processing. The designers of the British road networks attempted to use existing footpaths to connect cities in Nigeria, but found that the nature of these footpaths made them difficult, if not impossible, to expand into wide roads suitable for automobiles.

These new roads were still subject to the damaging effects of their rainy season, though, so they were often damaged or destroyed every season when the rains came. Frustrated by repeatedly rebuilding bridges, some local governments stopped importing wood, steel, or concrete and used entirely local material to produce cheap, expendable bridges, instead (Oshin, 1988). Nigerians took advantage of the introduction of automobiles by developing taxi and goods transportation services. Nigerian methods of transportation were often more efficient than their British counterparts. They were more flexible, made use of more appropriate technology, and could charge lower rates. A British transport company called Weakes Transport announced that it was offering scheduled services in 1923. Because of the inflexibility of scheduled routes, Weakes Transport vehicles often ended up carrying less than full loads at higher prices than their indigenous counterparts. The average rate for a Weakes Transport shipment was 2s 7d per ton mile compared with 6d per ton mile for indigenous transporters (Oshin, 1988). Nigerians tended to favor American vehicles for transportation during the colonial period. They were cheaper than British vehicles, costing about half as much as the equivalent British imported machine. They were also common and easily-serviced because of a plethora of spare parts, while British vehicles had lacking after-market support in colonial Nigeria. American cars, especially the Ford, was also very light and had pneumatic tires, which allowed it to travel over roads that wouldn't be suitable for the heavier British vehicles. A colonial administrator in Lagos commented that, there are nearly 2,000 miles of road over which motor cars can travel. But only 180 miles are metalled to take heavy motor cars. He went on to comment that the American Ford completely outstrips the English equivalent in (Drummond-Thompson, 1993). Post-colonial transportation systems can be simply described as the minimal maintenance of the infrastructure the British had set up. The political and military strife within Nigeria had a significant effect on the transportation infrastructure in Nigeria. Funding to maintain and expand road and rail was redirected to corrupt politicians and nationalized transportation corporations (Walker). The biggest introduction into the transportation market in independent Nigeria is aircraft. Aircraft transport is ideally suited to Nigeria because of its high speed and independence from roads, rails, and rivers that are subject to forces of nature. Unfortunately, air networks suffered from the poorly-connected roads and airports that are poorly-designed for moving bulk goods around the nation or internationally.

The Core Area

The essence of overlaying is to determine whether or not there will be any core area(s) within FCT where shortest waiting time for public transport, shortest walking distance to the nearest bus stop, cheapest public transport fare and highest bus service frequency can be found. As observed, there is no clearcut core area, but what can be termed as multi-nuclei core areas lie in pockets of locations, principally around the city centre where public transport commuters enjoy the highest degree of bus frequency, while the Gwagwalada area have the least walking distance and waiting time at bus stops/terminals. This result is at variance with the work of Duranton and Turner, (2012) in his assessment of the quality of intra urban bus services in the city of Enugu, which identifies a single central core area around the CBD for the city of Enugu-Nigeria.

The two core areas appear to be the two major economic nerve centre of FCT, where most of the administrative, educational, business and commercial activities were located. They are characterized by the greatest concentration of business offices, massive high-rise buildings, for both public and private establishments. Specifically, these buildings include; government Ministries, Departments and Agencies (MDA's), foreign embassies, wholesale and retail commercial outlets, banks, university, construction companies,

churches, mosques and staff quarters just to mention a few (Drummond-Thompson, 1993). These core areas have the highest densities of roads in the FCT. Because of the high concentration of economic and social activities in the areas, they therefore become the originating and terminating points of large numbers of bus commuter trips to and from the rest of FCT most part of the day.

Transportation System in Nigeria

With respect to road travel, it is important to evaluate the extent and quality of the road network. In terms of the extent of the road network, the federal government has done much in the last fifteen years to improve the coverage of Nigeria road system. One outstanding example is the work of the Directorate of Food, Roads, and Rural Infrastructure (DIFFRI), which in the late 1980's embarked on a campaign to construct approximately 60,000 kilometers of new rural roads. As can be seen from a tour of rural areas, many roads that have been constructed are in a terrible state of disrepair (Nwafor & Onya, 2019). As with so many things in post-oil-boom Nigeria, many rural (and urban) roads have not received adequate maintenance. Poorly maintained roads are particularly problematic in the rainy season (approximately March to October). In fact, some rural areas are only accessible by car in the dry season. The slow rate of travel is necessary given the large and frequent potholes that mark the many rural roads. Certain stretches of rural roads are so bad that motorized vehicles have bypassed the original roadway to form new dirt tracks. Other portions of rural roads have been reduced to one lane. The road network of the Jos Plateau is indicative of the poor state of maintenance of many rural roads. Even though a good network of colonial-era roads existed (partly due to the intensity of mining activity on the plateau), many of these roads have not been maintained in the post-independence period. Proper maintenance is critical because rainstorms can be tremendously intense. Thus, small areas of road decay can very rapidly expand under the forces of erosion and weathering in the rainy season. Much of the problems associated with the erosion of roadways are compounded by the lack of adequate drainage infrastructure (which also makes driving hazardous during heavy rains). While Nigerians are not forced to address maintenance, problems derived from recurrent freezing and thawing (like temperate areas of the United States), they do have to deal with intense seasonal rain. Although urban roads are in better condition than most rural roads, maintenance of roads is also a problem in the cities. Since the collapse of oil prices in the early 1980's and implementation of a Structural Adjustment Program in 1986, state budgets have been extremely tight. Fiscal austerity has also been exacerbated by corrupt military regimes that have fuelled state revenues into non-productive projects (often contracted to firms owned by military leaders) or foreign bank accounts. Although almost all urban roads are paved (Nigerians often say "tarred"), many have large pot holes or large sections where pavement has been eroded. An interesting scene in the city of Ibadan is the activity of informal road repair crews. Young men can often be seen filling city pot holes with dirt and rocks. In return for their unsolicited service, road users often tip these unofficial public workers. The work of these brave maintenance crews notwithstanding, Nigerian urban roads can still be very rough. The important point to note is that aside from uncomfortable travel, poor urban roads can cause bottlenecks in traffic and contribute to traffic congestion Walker, Gilbert James.

The problem of transport centres and city market in FCT, Abuja.

Poor road transportation management is one major problem that is affecting the urban transport quality services and growth of the economy especially in the city of Port Harcourt with millions of residents in it. This has led to the ineffectiveness and collapse of the city's road system. This in turn has bounced as the road transportation system characterized by heavy duty Lorries overworking the road system and the resultant effect is damages of roads causing accidents and loss of lives and property. Okafor (2021) contributed that poor management of road transportation systems has led to an unorganized road transport system, bus drivers do not make use of the bus stops again to load and offload passengers and goods, paying little or no attention to the traffic rules anymore, causing unnecessary gridlock in the City giving the city a bad image and most road users are greatly dissatisfied with condition of road transportation in the city (Zou, Zhang, Zhuang, & Song, 2008).

The absence of technology development to monitor or regulate the speed of vehicles, high overloading of goods and traffic congestion in Port Harcourt has become a "bone in the neck" issue and has turned mobility by road to a nightmare, especially during peak hours; this has increase lateness to work, school and businesses. There are also cases of lowered productivity, chronic fatigue and bad stress.

The government participation in transport delivery through the mass transit has not been effective over the years and the public transport service delivery quality in the city is poor, poor maintenance of fleet and unsafe service (Okafor, 2021). The cumulative effect is a gradually crashing down the local economy of the city. And finally, the urban road transportation system has suffered many setbacks and has resulted to bad roads in both the city centre and other parts of the LGA, the presence of street trading has reduced the efficiency of the quality urban road transport, also the road transport workers have a great contribution to the problems of urban road transport and lastly the unorganized bus system resulting to poor quality service of the urban road transport system (Olubomehin, 2012). Therefore, this research is focused on assessing public transport in the Federal Capital Territory, Abuja: A GIS-Based analysis of key indicators and proffering/sustainable affordable solution.

Empirical literatures explain that Boopen (2006), analyzed the contribution of transport capital to growth for a sample of Sub Saharan African (SSA) and a sample of Small Island Developing States (SIDS), using both cross sectional and panel data analysis. In both cases, the analysis concluded that transport capital has been a contributor to the economic progress of those countries. Analysis further revealed that in SSA case, the productivity of transport capital stock is superior as compared thereto of overall capital while such isn't the case for the SIDS where transport capital is seen to possess the typical productivity level of overall capital stock. For research of transport investment and growth in developing economies, Demurger, 2001 cited Zou, 2008) examines data of 24 provinces of China in 1985-1998 and points out that the inequality of transport infrastructure is one among the most factors resulting in growth inequality across provinces. Using a statistic analysis for the investment into road infrastructure and economic process in South Africa, Michael (2016) explains that road infrastructure does indeed cause economic process in South Africa both by boosting GDP directly and by raising the marginal products of other production factors.

Discussing further on the review of empirical shows that in Nigeria, Imobighe and Awogbemi (2006) regressed private capital stock, non-military, net investment, time to capture the consequences of the technical changes in economic process, one year lag GDP and electricity supplied against Gross Domestic Product to assess the impact of capital stock in Nigeria's economic process from 1980-1998. They found gross domestic product to be positively associated with private capital stock by one year lag GDPt-1 and electricity supply was negatively associated with recurrent and cost, except expenditure on defense and technical change. They further found that while lagged value of gross domestic product significantly increases output in Nigeria, other explanatory variables were, individually insignificant in explaining output in Nigeria. Michael (2016) also found that infrastructure, when measured in physical sense; impacts positively on economic growth. Some researchers explored the impact of public capital on the expansion rate of output. Canning et al (2004) cited in (Zou et al, 2008) used physical measures like kilometers of paved road to research "the end of the day consequences of infrastructure provision on per capital income during a panel of countries" covering the amount between 1950 and 1992. His estimate results suggested that for paved road the sign of the impact of a rise in provision on GDP per capital varies across countries. Some studies also show that public capital can cause economic process by raising total factor productivity of all inputs. Duranton and Turner (2008) estimated the consequences on major cities of major roads and transportation system on the expansion of major cities within the US between 1980 and 2000 and located that a ten percent increase in city's stock of roads causes a few 2 percent increase in its population and employment and a little decrease in its share of poor households. Zou, et al (2008) in their own study of transport infrastructure, growth, and poverty alleviation in East and central China with panel data of 1994 to 2002 and a statistic data of 1978-2002 reported a better growth level from better transportation. Since increase in road safety is said to increasing socio-economic development, Garg and Hyder (2006) studied the trends in injury and death rates in India and analyzed these trends in reference to economic and increase. Using rectilinear regression models to check 'a priori' hypothesis of a positive relationship between net domestic product (NDP) and death rates from road crashes, they reported an inverted U-shaped relationship between injury, death rates and NDP authenticating Kuznets phenomenon for within-country level comparisons. He therefore recommended a state investment in road safety additionally to any overall national efforts. The novelty of this study is that it attempts to research the public transport in the Federal Capital Territory, Abuja, investigating the GIS-based analysis of key indicators of public transport capital to economic process.

3. METHODOLOGY

The method of data collection adopted in this research is questionnaire survey and interview with the operators. The questionnaire was designed to cover the key indicators of public transport accessibility namely: commuters waiting time at terminals, walking time to terminals, public transport service frequency on routes and public transport fare. A total of 950 copies of questionnaires were administered on commuters at 17 major public transport terminals operated by government and private sector.

It is important to note that the Central Area and the Three Arm zone in which most government institutions that attract and generate traffic of fixed time work place trip have no major public transport terminals closer. This can then imply that most FCT commuters trek long distance before getting to their nearest bus stops/terminal. One major factor responsible for this, and which was discovered during field survey was the inadequate public transport route traversing the city centre. For instance, Wuse II, Maitama and Asokoro Districts of the city centre were not adequately covered by the bus route; leaving the commuters around these areas at the mercies of car drops services.

Commuters Mean Waiting Time

Optimum mean waiting time world wide as recommended by the World Bank (2000) otherwise referred to as the bus headway, ranges from 5 to 10 min indicating high quality public transport service access level and the maximum time commuters are expected to wait for the arrival of bus at the terminal/bus stop ranges from 11-20 minutes which indicate moderate accessibility. When the commuter waiting time exceeds 20 minutes, it portends poor access level (World Bank, 2000). The study reveals that within the context of World Bank standard, no single location in FCT has good access level. At best, the Dutse Alhaji, Area 1 and Gwagwalada by market, can qualify for moderate access level, because they have mean waiting time of 18.7, 28.8 and 20.4 min respectively.

The Gwagwalada by El-Rufai (20.4), Zuba by Dankogi (20.6) and Zuba by U-turn with 24.4 min respectively have long waiting time for public transport and by implication poor level of access. Looking at scenarios from Kuje motor park (50.9), Nyanya under bridge (46.8), Kubwa by FHA (28.8 minutes) and Bwari with 30.7 min, it can therefore be concluded that public transport access level and waiting time is poor all through the FCT. This might be one of the disincentives for public transport patronage, and the prevalence of private car use in FCT.

The commuters waiting time at the AUMTCO park at the three principal axis of Nyanya, Kubwa and Gwagwalada is not in any way better as 26.2, 25.2- and 25-min waiting time were recorded against them respectively. Thus, it makes no economic sense in running an empty bus service in the name of higher bus frequency to reduce commuters waiting time. It is to be noted that, commuters' trip is principally unidirectional to the city centre in the morning hours, and outwards to the periphery during the afternoon and late evening hours. Again, the capacity of road during the rush hours are limited because there are no dedicated lanes for public transport buses, hence the traffic congestions limit the bus trip frequency.

Mean Public Transport Fare

The amount of money a public transport operator charges as fare influenced how commuter's patronage will be secured. This is because, there is usually a fixed proportion of disposable income that the commuters are willing to attribute to workplace, social and other forms of commuting per unit of time. Odumosu (2004) argued that commuting cost should not be more than 30% of commuters' disposable income, the lower the public transport fare, the higher the possibility of commuters using the public transport. This argument becomes more rational against the backdrop of the fact that commuting costs on the part of the commuters is the sum total of the monies expended in other (intermediate) means of transport from trip origin to immediate bus stop/terminals (where he/she board the public transport) and from the public transport final bus stop to the commuter's final destination.

The result shows that the mean public transport fare in the FCT was at its lowest in AUMTCO parks/ buses; Kubwa (N79.5), Nyanya (N103.9) and Gwagwalada (N118.7). This is because these buses are government owned and are operated by an agency of the Federal Capital Territory Administration called, Abuja Urban Mass transit Company (AUMTCO). They are not solely a profit-making outfit, but to provide an efficient transport service to commuters at a subsidized rate. The company enjoys grants and subventions from the Ministry of Federal Capital Territory Administration. With regards to other private public transport operators in FCT, Wuse park within the city centre mean public transport fare is the best with a value of N116.6, this is followed by Kubwa village and Lugbe park which tallied at (N121.9), Abuja city by Area 1 has a mean value of N123 and Bwari park has N127.6 in that order. Mean public transport fare in the FCT has the highest value in Gwagwalada by El-Rufai Motor Park with a mean value of N325.

Observation at the park during the survey shows that this motor park (Gwagwalada by El-Rufai Motor Park) is operated by a private company outfit, which operates small capacity, green painted air-conditioned buses between Gwagwalada and the city centre. Kuje and Zuba by U-turn Motor Park are within the mean value of 165.7 and 165.1 respectively. The public transport fare structure adopted by most operators in FCT is the flat rate structure, indicating same fare from origin to destination payment irrespective of how close or how far the commuters will go before disembarking relative to the bus final terminal or bus stop. Despite this, the public transport operators pick passengers along the way, not minding the fact that the commuters who alighted had paid for the seat till the end of the trip. These practices adopted by the operators contribute to the number of illegal stoppings along the trip. The practice also prolongs bus trip time, impair commuters' comfort and safety- as the buses may likely engage in over loading during rush hour, reduce bus service frequency thereby contributing to public transport supply-demand gap.

The mean public transport fare displayed here also reflect the fact that the distances of each location from the city centre to the suburb has influence on the mean public transport fare, hence Gwagwalada, Kuje and Zuba have higher mean public transport fare values. This therefore implied that physical distance of trip is a major factor considered by operators to arrive at the public transport fare along the route. This is so, because some vehicle consumables like fuel and maintenance costs, vary directly with the distance covered by the public transport vehicle.

Way forward for improving transport infrastructure in FCT Drawing from final Result

Restructuring transport infrastructure are often said to be positively associated with poverty alleviation considering the multiplier effect of its establishment employed creation, productivity increase and income generation. The positive effect of the investment within the sector tends to scale back the amount of individuals who don't earn income thanks to the available ones that are during a deplorable state and lack maintenance. This study investigation is geared towards checking the chain that can bring about improved transport infrastructure which can have an excellent power to make different development opportunities that may enhance efficient and effective resources mobilization and utilization, which in turn can create economic development in sorts of ways, thereby repositioning employment and income generation, which can alter poverty trend in an economy.

The study investigates that Abuja City at the Wuse and Garki area terminal has the highest hourly bus mean frequency. This is because, most public transport coming from the city periphery (Zuba, Gwagwalada, Bwari, Lugbe and Kubwa) empties into them. In terms of real time availability of buses, Wuse and Garki area may infer better accessibility to public transport services. This is followed by Nyanya, Lugbe, and Zuba terminals, because these settlements are not only served by better road network, but also there are pockets of densely populated residential zones around them where large volumes of commuters reside. The Central Area and the Three Arm Zone where most government institutions that serve as attractor and generators of fixed time work place trips have no close public transport terminals. This makes most FCT commuters walk long distance before getting to their nearest bus terminals. Commuters waiting time in FCT terminals is at its best in Dutse Alhaji by Area 1, Gwagwalada by market and El-Rufai Motor Park. However, neither of these locations meets international standard and thus could be one of the disincentives for public transport patronage and the prevalence of private car use in the Territory.

The mean public transport fare in FCT was lowest in AUMTCO parks; Kubwa, Nyanya and Gwagwalada parks, this is because these buses are government owned and are operated by an agency of the Federal Capital Territory Administration called, Abuja Urban Mass transit Company (AUMTCO). The company enjoys grants, subventions and subsidies from the Ministry of Federal Capital Territory. With regard to other private public transport operators, Wuse park within the city centre has the best, followed by Kubwa village and Lugbe parks. There is no clearcut core area where public transport service is at best practice, but a pocket of multi-nuclei core areas lies around the City Centre and Gwagwalada axis. These two areas appear to be the major economic nerve centre of FCT, where most of the administrative, educational, business and commercial activities were located. On the basis of the aforementioned, it is hereby recommended that Both the FCT administration, Area Councils and private sector organizations should collaborate to provide a sound, neat and safe public transport buses for commuters, with a view to increasing service frequency, reduce waiting time and public transport fare, thereby making it more accessible to the commuters with or without private car.

In the light of the foregoing, the study recommended a redesign of the public transport routes, bus stops and terminals across the territory to reflect its current physical development pattern and a further step by the stakeholders to provide adequate, clean and affordable public transport services throughout the length and breadth of the territory (Onokala & Olajide, 2020). The routing of such transport services should link-up all major activity centres (public institutions, markets, schools etc). This will eliminate frequent need for intermediate transport and the associated costs or long-distance walking to the existing public transport bus terminals/stops and ultimately improve the current level of access to public transport service.

4. CONCLUSIONS

While the effort and money being put into maintaining and expanding systems stagnated or decreased the demand for transportation services increased with the growing population. Between 1962 and 1974, the volume of road traffic increased by 13.5% per year, while funding increased less than 2.8% per year. Between 1967 and 1981, the number of passengers on Nigerian railways increased by 25%, but the number of locomotives in service has only increased by half that much, some of those locomotives are steam-powered and date back to British rule. Further, both the quality and gauge of the rails are questionable. The rails are insufficient for carrying heavier loads and require custom-fitted rolling stock because the gauge smaller than standard. The problems in modern Nigerian transportation systems are a product of the past. Both colonial and post-colonial mismanagement of road, rail, water, and air infrastructure has contributed to the economic and social problems within Nigeria. At the same time, Nigerians were able to take advantage of opportunities in transportation networks for economic prosperity, as seen in the Nigerian taxi drivers and Overland Airways. There is a lack of sources covering 1985 to 2005 that made researching the modern era of Nigerian transportation exceedingly difficult. Future research projects might focus on this period to find more information, especially national budgets for infrastructure maintenance and development [Måns Söderbom; Francis Teal]. Because investments in transport infrastructure are very capital intensive, the Nigerian government should encourage competition by relaxing fiscal measures to empower Nigerian transport entrepreneurs and encourage private sector participation in ownership, funding and operations. That will help intensify the effort to modernize transport infrastructure and services as we continue in our march to attain vision 20/2020.

5. RECOMMENDATIONS

First, Nigeria's transportation model focused on paying for physical infrastructure roads, bridges, rail lines; rather than procuring service availability. We hereby recommend Institute service procurement approach to annual transport capital expenditure budget, issuing service purchase guarantees not construction contracts. Second, risk allocation tends to be too heavily skewed towards government in Nigerian transport infrastructure procurement (contract-to-build versus pay-for-service). In this regard, we must begin to implement changes to payment model for transport capex projects, require private operators to raise funding backed by government off take contracts Third, PPP application appears to be tied too closely to concessions and user-pay projects, as opposed to a broader tool of government procurement from a self-funding private sector. There is the greater need to broaden application of PPP use beyond concession issuance for existing road, rail and port assets, to service delivery on new capex, and operations/maintenance projects. Fourth, the operating philosophy in Nigeria has been to look first to government for funding, with private finance and PPP

options seen only as a side opportunity. Relevant government agencies must begin to incorporate additional planning element to annual transport budgeting process that seeks to exhaust private financing potential before public spending. Finally, PPP model requires an industry of service providers, not just traditional contractors reinvented as concessionaires. The government should, as a matter of urgent national importance begin process of developing private infrastructure service delivery industry through use of annual budget spending power.

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