Afropolitan Journals

ISSN: 3027-2971 www.afropolitanjournals.com

Mapping of Road Network and Connectivity among Small Sized Urban Centres (SSUCs) in Kogi State, Nigeria

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DOI: *https://doi.org/10.62154/ajmbr.2025.018.010674*

Abstract

Mapping of urban structure is essential for proper planning and development of urban centres. This study worked on the mapping of road network and connectivity among small sized urban centres (SSUCs) in Kogi State, Nigeria. The objectives of the study are to identify the road network, map out the road network and to ascertain the quality of the road network. Purposive sampling techniques was used to select (20) local government headquarters in Kogi State. The study adopted geo-spatial techniques to identify and map out the road network and the distribution of e-questionnaires on five-point Likert scale to ascertain the quality of the road network. The purposive-convenience sampling technique was used to distribute the e-questionnaire. A total of (370) e-questionnaire was returned for analysis. Finding of the study shows the mapping of twenty (20) SSUCs road network connectivity. Also, 43.25% respondents agree that road network quality of SSUCs in Kogi State is good, 33.78% fair and 9.46% poor. While, 8.11% and 5.41% respondents' perception of the road network quality of the SSUCs in Kogi State is very good and excellent respectively. The study shows that less than 50% respondent perception of the quality of road network agree that it is good. This suggests that the road network in the SSUCs in Kogi State needs further improvement for the growth of the SSUCs. The study provides insights into the nature of the road network and connectivity among SSUCs in Kogi State. Therefore, the study recommended multi-faceted approach of rehabilitation of road network, investment on road construction, implementation of road maintenance policy and establishment of road agency among the SSUCs in Kogi State in other to improve the road network quality.

Keywords: Transport Infrastructure, Urban Mobility, Urban Centre, Road Network, SSUCs, ArcGIS.

Introduction

Transport systems all over the world are one of the drivers of social- economic and industrial development. According to Daful and Oluwole (2016), transportation is a major human activity all over the world and a very indispensable component of the economy. It plays a major role in spatial relation between locations. In fact, it creates a link between cities, regions and economic activities. Transportation infrastructure is critical to economic development. This is because it reduces trade costs and promotes factor mobility. Others include market integration, improved productive capacity, agglomeration effect in terms of

attraction of resources, stimulating private investments, improving labour productivity and technological innovation.

Essentially, transport infrastructure is the link that allows the flow of goods and services. In particular, the road infrastructure is the bedrock of accessibility in the urban centre. Road transportation is the heart of the concept of accessibility in a region and serves as a medium by which demand and supply where they do not coincide in space are linked. Consequently, socio-economic activity and industrial production in any city or urban area is a function of efficient and effective road network (Daful and Oluwole, 2016).

In fact, economic activity in an urban centre is tied to the nature and quality of the road network. These road networks enhance connectivity and accessibility that takes place in the urban centre. Lamidi, Jegede & Ogundiji(2022) asserted that road network remains the basic and important component of transport system of any nation. Consequently, Nigeria is seen as the nation with the highest road network in Africa and second in the South of the Sahara. The national network is evaluated to be 94,200km of which 34,120km (17.6%) is federal road, 30,500km (15.7%) state roads and 129,580km (66.7%) local and rural roads. Francis and John, (2017), indicates that 15% of the federal roads was very good, 20% good, 30% poor and 35% in a very bad condition. Equally, Infrastructural Concession Regulatory Commission (ICRC) in 2017 affirms that Nigeria has about 195,000km of road network. Out of which 32,000km are federal roads, 31,000km are state roads. And 60,000kmis paved. Of the paved roads, a large proportion is very poor due to insufficient investment and lack of adequate maintenance (*https://www.icrc.gov.ng*).This suggest increasing decline in the quality of Federal roads and paved roads in Nigeria.

Essentially, good road network determines the growth of urban centres. According to Maigari (2016), road network is the most basic level of transportation infrastructure within the urban centre and it is one of the basic indexes of measuring the quality of urban wellbeing. Consequently, road networks stimulate the development of cities in terms of commercial activities, urban development and job creation.

Small-size urban centres constitute urban centres with economic activities, functional roles and population of less than 500,000. SSUCs are known to perform functions such as market nodes, providers of services, good and non-farm employment to their inhabitants and the surrounding region. Small-size urban centres (SSUCs) in Kogi State are creation of government promulgation of local government administration. The establishment of the local government administration in 1979 in Nigeria led to the development of smaller town particularly the local government headquarters which became centre of economic activities. This is attributed to the fact that they are attraction point for villagers to the town. Apparently, mobility among the (SSUCs) is enhanced and determined by the quality of the road network provided.

Olorunfemi (2021), posit that transport infrastructure in urban centre bridge the gap between areas of consumption and production and increase spatial interaction. However, continues deplorable state of this road infrastructure is affecting this goal. Therefore, the

study attempts to ascertain the quality of these road networks among the SSUCs in Kogi State. Also, the budgetary allocation for road infrastructure out of the total annual budget in Kogi State has been fluctuating since 2008-2018. The budgetary allocation indicates 0.88% in 2008, 2.13% in 2012, 8.59% in 2015 and 4.23% in 2018 of the total budgetary allocation for Kogi State (Olorunfemi, Akanmu & Salisu, 2022). Therefore, how impactful has this budgetary allocation contributed to the road network in the state? Likewise, it has been observed that SSUCs in Kogi State have several road networks. However, adequate documentation and empirical analysis of these road network and connectivity cannot be ascertained. Equally, the mappings of these road networks in the SSUCs are not usually documented. This forms the premise of this study.

More importantly, the study is driven by the central place theory put in place by Walther Christaller (1933). Consequently, urban services/functions that take place in the central business district (CBD) is enhanced by the movement of goods and services as well as spatial interaction from lower order settlement to the higher order settlement. These flows are attributed to the nature of road network and connectivity among the SSUCs.

Several empirical studies on road network are identified. Lamidi et al, (2022) worked on road network mapping and analysis of Ado-Ekiti township roads using remote sensing and GIS techniques. The study employed the use of road extraction and extent of each roads located within the study area with the help of OpenstreetMap(OSM) as the base map and modify from satellite imagery(Google Earth Pro) . The study recommends the use of the methodology for emergency response map, crime, mapping and accessibility analysis.

More so, Olurunfemi et al, (2022), studied government investment on road infrastructure in Kogi State, Nigeria: The impact on urban mobility. The study used mixed- method research design and administered 1,215 questionnaires. Equally, data on road infrastructure expenditure from 2008-2018 and state budgetary allocation was sourced. Findings show that government investment on road infrastructure is fairly impactful. The study recommends government increase in budgetary allocation for road infrastructure.

Ebre, Ezenwa & Jacob (2024), looked at road network analysis of emergency services in Lokoja Metropolis, Kogi State, Nigeria. The study using GIS technique mapped and analysed the accessibility of ambulance services, hospitals and fire services in Lokoja metropolis. ARCGIS10.8 was used in the network analysis. Findings of the study indicates mapping of seven (7) ambulance service stations, five (5) fire service stations, fifteen (15) hospitals and best route of evergreen services. The study recommends collaboration with transportation providers for enhanced connectivity.

Furthermore, Olurunfemi (2021), worked on performance assessment of the state of road infrastructure in selected urban centre in Kogi State in Nigeria. The study used a total of 1,215 structured questionnaires as head of households are the respondents in other to ascertain the perception on road infrastructure in Kogi State. The study used Z-sore. The finding of the study shows that Lokoja has a high Z-score of 3.85 and Mopa-Amuro with the least of Z-score of -0.28. Also, respondents were not satisfied with the condition of the road

networks in the study area. The study recommends implementation of standard road infrastructure frame work

Maigari (2016) studied road network: the silent treasures of Kano Metropolis. The study adopted secondary data and the use of satellites imageries. The finding indicates that 72% of road networks in Kano metropolis conform to planning standard, 22.72km/km^2 road network density and that inadequate road maintenance culture is the major challenge of road networks in Kano metropolis. The study recommended that the scope of Kano State Road Maintenance Agency (KARMA) be increased to care for full road revitalization and Kano State Road Traffic Agency (KAROTA) be increased to take care of road vandalisation, detraction and mutilation.

Daful and Oluwole (2016), studied an assessment of road network quality in Jos City, Nigeria: Using Geographic Information System (GIS). The study adopted the use of Geographic Information System (GIS), on-field data acquisition through measurement, observation and counting. The findings of the study indicates that 3.91% of the road network are in good condition, 19.55% are fairly good,51.40% are at average condition, 23.44% are below average and 1.68% are under repairs. The study recommended provision of adequate transport facilities in other to improve accessibility. Furthermore, researchers on road network have been conducted on global cities and documented. However, the availability of data and information in smaller settlement (small and medium - sized urban centres) is not readily available. Given the empirical review and none documentation of mapping of road network among the SSUCs, the study worked on the mapping of road network among SSUCs in Kogi State.

Study Area

Kogi State, is located approximately between Latitudes7°30′N and 8°10′N North of the equator and Longitudes 6°42′E and 7°50′E East of the Greenwich meridian (Ogunkolu, 2021).

Kogi State is regarded as a landlocked state as it is bounded by ten (10) states and the Federal Capital Territory (FCT). The states are Niger State to the North, Nasarawa State to the North East and to the East, Benue State. To the South East, Enugu State, South, Anambra State and South West, Edo State. Equally, Kwara State to the North West, West, Ondo State and Ekiti State (Macmillian Atlas, 2006). Kogi State is approximately 29,833km^2 which accounts for 3.23% of the total landmass of Nigeria. (Macmillian Atlas, 2006). More so, Kogi state is about 158km and 385km Southwest of Abuja and Northeast of Lagos State respectively (Ogunkolu, 2021; Babatimehin, Ayansina, Babatimehin and Jibril 2011).

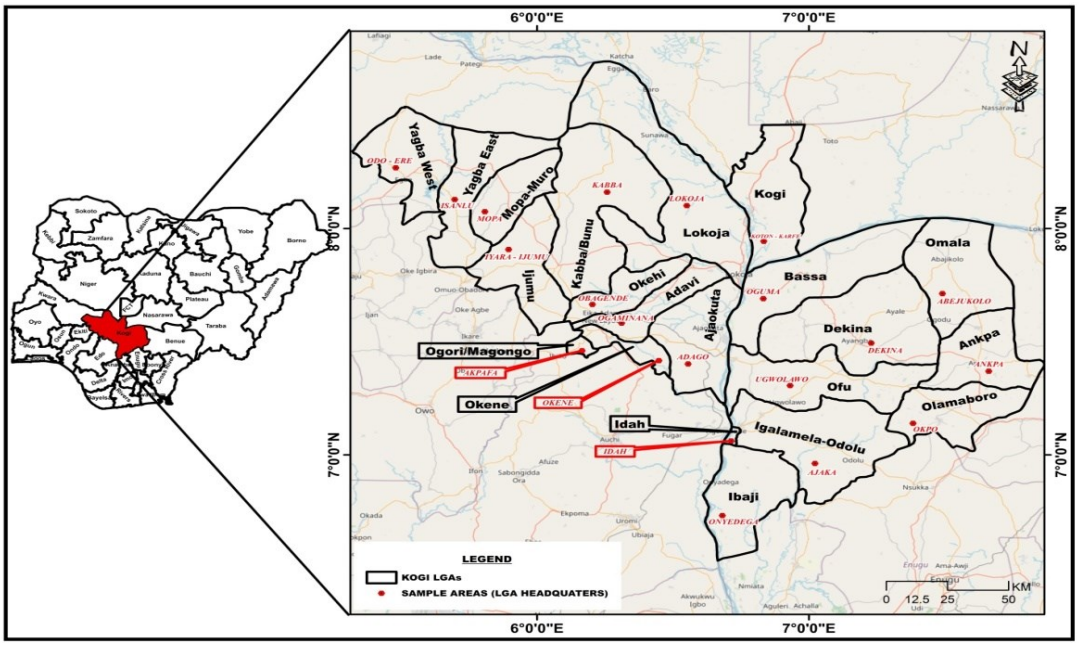

Figure 1: Map of Nigeria showing Kogi State// Kogi State showing selected sampled Study Area (SSUCs).

Source: GIS Lab, Department of Geography and Environmental Studies, Prince Abubakar Audu, University, Anyigba (2023)

According to Ogunkolu(2021), Kogi State is located within the Western Basement complex and the Lokoja-Jakura Scrist belt, but in contact with the Western side of Anambra Basin.The rocks in Kogi State are made up of Gneisses, Migmatites, Granites, Schists, Phyllites, graphite, marble and Quartizites. Mount Pati in Lokoja, Obangogo Hills in Egunbe community in Kabba and Ego Hills in Kabba are the major hills in the state (Macmillian Atlas, 2006).

Kogi State is majorly drained by River Niger and Benue with it confluence at Lokoja. The Benue River drains the major rivers in the North-eastern part of the state while the Niger River drains the major rivers in the North-western down to the Southern part of the State and their tributaries. According to Koppen (1978) as quoted by Iwena (2015), Kogi State lies within the sub-humid tropical climate (Aw) which is normally referred to as local steppe climate. The climate of Kogi State is of two distinct seasons that is typical of the Northern hinterland of Nigeria. Precipitation reaches its peak in August with an average of 236mm, April remains the warmest month with an average of 31.4°C (Ogunkolu, 2021, Ifatimehin and Musa, 2009). Kogi state falls within two vegetation belts; the woodland forest and the Southern guinea savannah. Farming is the major socio-economic activity of Kogi State as the climate and vegetation of the state supports the cultivation of several crops. (Macmillian Atlas, 2006). Several mineral deposits in Kogi State includes Gold, Tin and Limestone, Iron ore, Marble, Clay, Gypsum, Tale, Felspar, Mica, Cassiterite, Quartz, Columbite, Granite, and Tnatalite among several others. River Niger and Benue and several other river tributaries found in the state support fishing activities.

Methodology

The study used geospatial techniques and the distribution of e-questionnaire. The geospatial technique was used to map out the location of road network, while the e-questionnaire was used to get perception of respondents on the quality of road network in the study area.GIS techniques was used because it allows for the digitalization of the road network and easy collection of data for mapping. And the option of e-questionnaire was adopted because of the advantage of efficiency, speed, quality of data, potential cost saving, flexibility, customizability and benefits of green economy over the use of hard copy. In other to perform the road network map and length, the study area boundary which was in a shapefile format was used. As such conversion tools in arctools box was used to convert it to keywhole markup language (KML). After the conversion was done, the supposed boundary of the study area was overlaid on google earth (OSM) to enable the researcher to capture and traced all roads (Tarred and untarred) within the study area boundary. All roads captured and traced on google earth (OSM) were imported into the ArcGIS environment using another conversion tools in arctools box (from KML to Layer) then a geometric calculation was performed on each and every roads imported in other to determine the actual length in kilometres.

Purposive-convenience sampling technique was used to distribute the e-questionnaire. This sampling techniques help to select respondents such as teachers, lectures, civil servants/public servants that are educated enough to respond to the e-questionnaire. Furthermore, sample size of 384 was obtained using Krejice & Morgan (1972) at 95% confidence level at 5.0% margin level. The 384 sample size was used because the table indicated that any population above 1,000,000 should use 384 sample size. Consequently, proportional sampling techniques was used to determine the share sample distribution of each of the SSUCs selected. The e-questionnaire was distributed by the two research assistant in each of the SSUCs. Out of 384 questionnaires distributed only 370 e-questionnaires were returned for analysis. More so, twenty (20) SSUCs were selected. These SSUCs are local government headquarters in Kogi State. This is because the establishment of the local government administration in 1979 led to the development of smaller town particularly the local government headquarters which became centre of economic activities. However, Lokoja local government has been excluded from the study as it has gone beyond the basic characteristics of SSUCs.

Results and Discussion

Road network is one critical infrastructure that enhances urban mobility and improves the economic activities in any urban centre. As such, the road network of the SSUCs in Kogi State was ascertained for analysis. Figure 2 to 21 shows the road networks in the SSUCs in Kogi State.

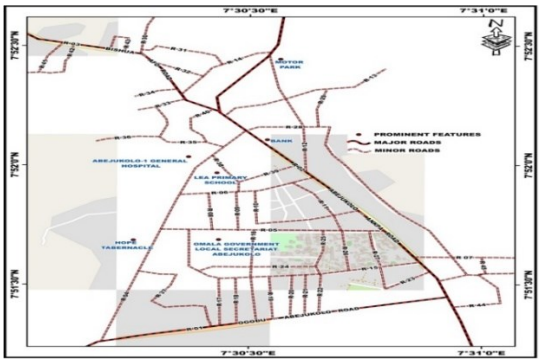

Fig.2: Abejukolo showing distribution of road network

Source: Authors' Field Work,(2024)

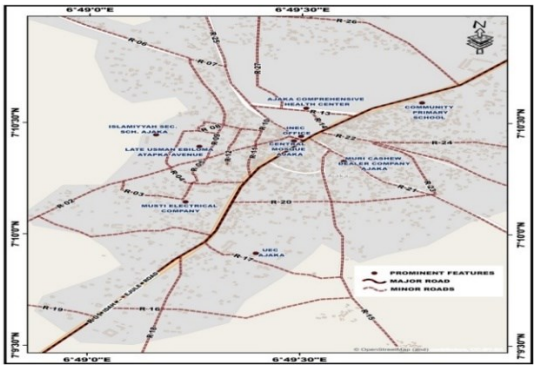

Fig.3: Ajaka showing distribution of road network

Source: Authors' Field Work,(2024)

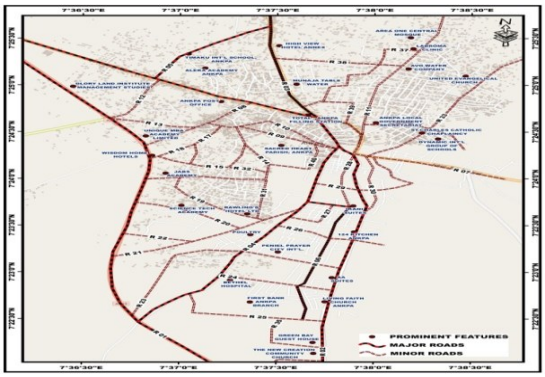

Fig. 4: Ankpa showing distribution of road network

Source: Authors' Field Work,(2024)

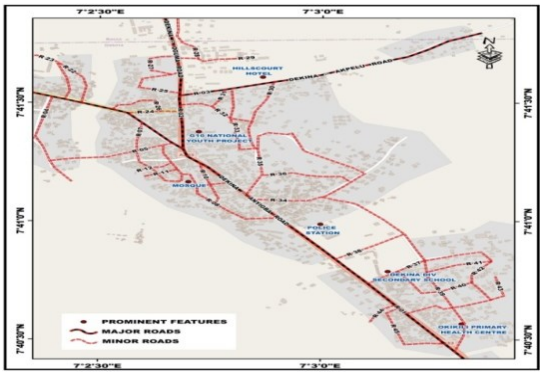

Fig. 5: Dekina showing distribution of road network

Source: Authors' Field Work,(2024)

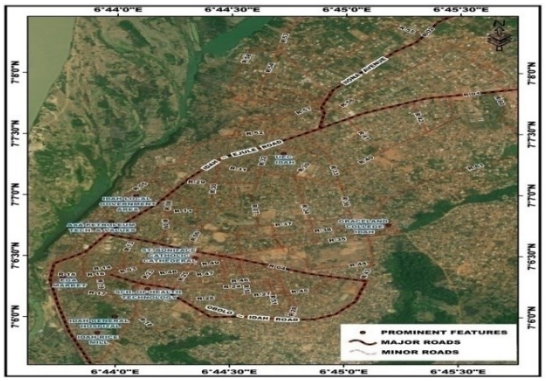

Fig.6: Idah showing distribution of Road Network

Source: Authors' Field Work,(2024)

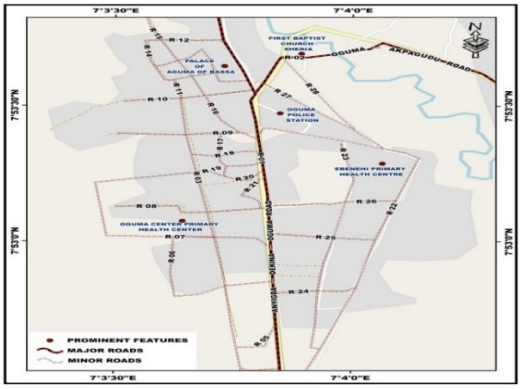

Fig.7: Oguma showing distribution of Road Network

Source: Authors' Field Work,(2024)

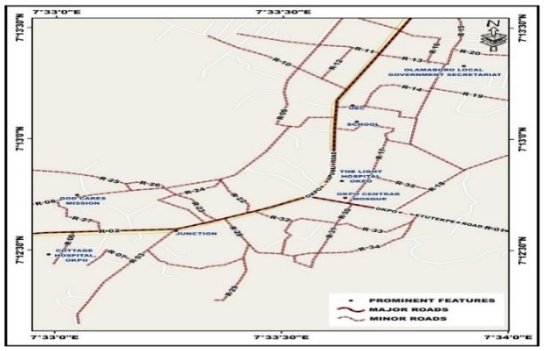

Fig. 8: Okpo showing distribution of Road Network

Source: Author's Field Work,(2024)

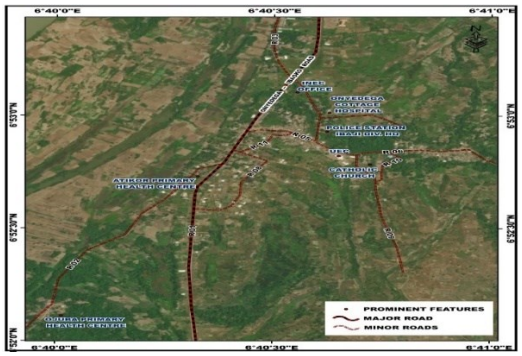

Fig. 9: Onyedega showing distribution of Road Network

Source: Author's Field Work,(2024)

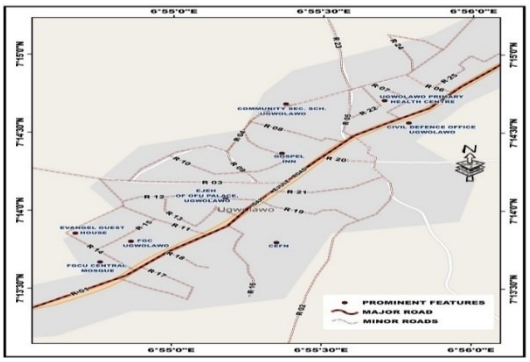

Fig. 10: Ugwolawo showing distribution of Road Network

Source: Author's Field Work,(2024)

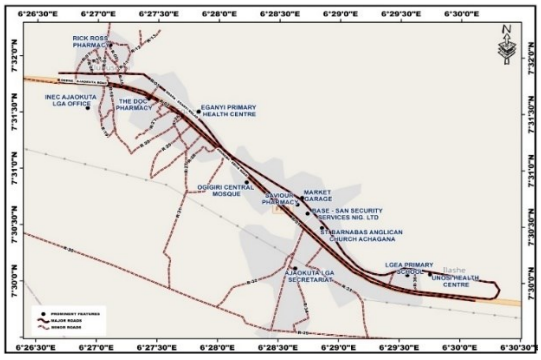

Fig. 11: Adago showing distribution of Road Network

Source: Author's Field Work,(2024)

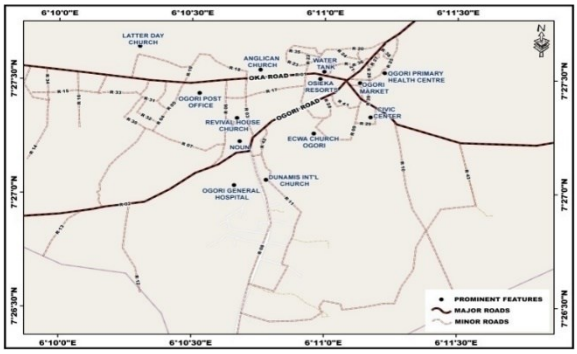

Fig. 12: Akpafa showing distribution of Road Network

Source: Author's Field Work,(2024)

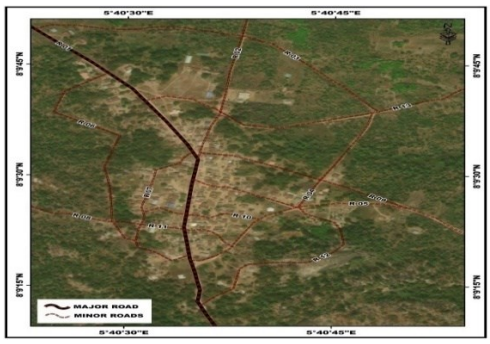

Fig. 13: Isanlu showing distribution of Road Network

Source : Author's Field Work,(2024)

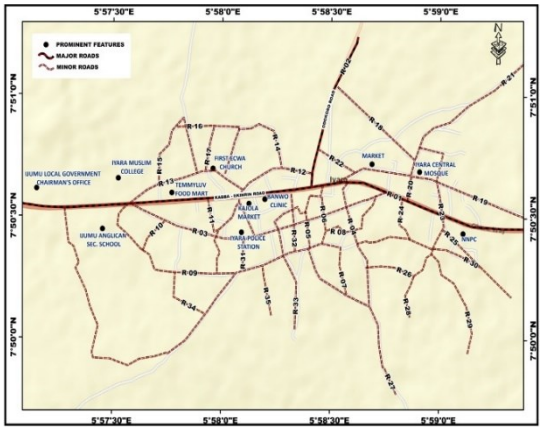

Fig.14: Iyara showing distribution of Road Network

Source: Author's Field Work,(2024)

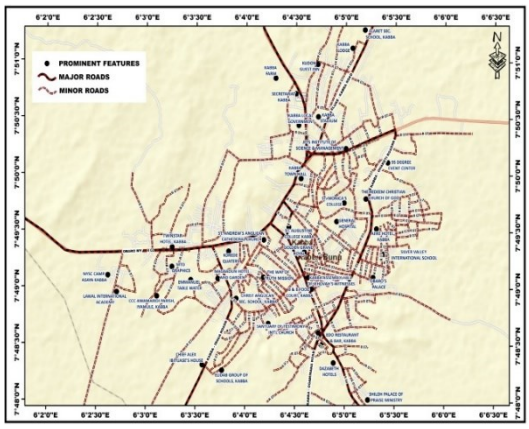

Fig.15: Map of Kabba showing distribution of Road Network

Source: Author's Field Work,(2024)

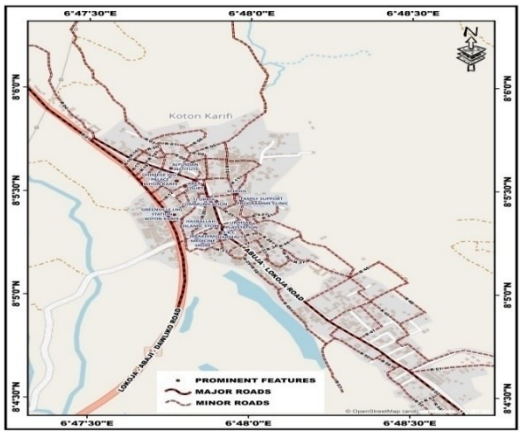

Fig. 16: Map of Koton-Karfe showing Road Network

Source: Author's Field Work,(2024)

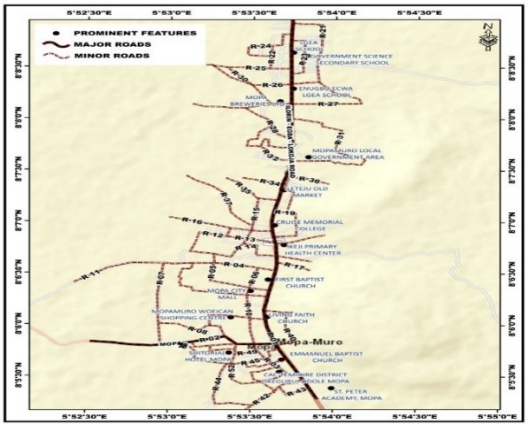

Fig. 17: Map of Mopa showing Road Network

Source: Author's Field Work,(2024)

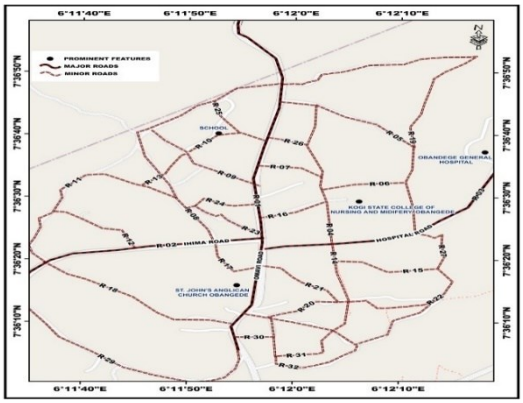

Fig. 18: Obagende showing distribution of Road Network

Source: Author's Field Work,(2024)

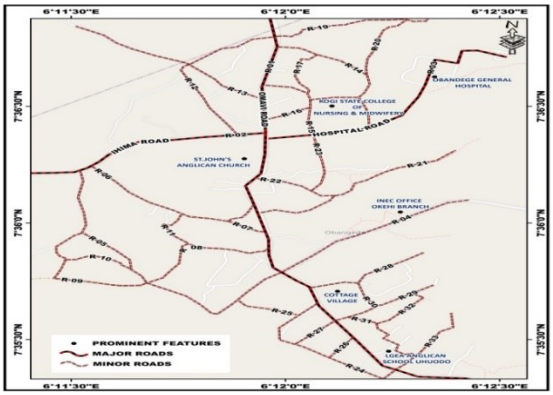

Fig.19: Ogaminana showing distribution of Road Netwok

Source: Author's Field Work,(2024)

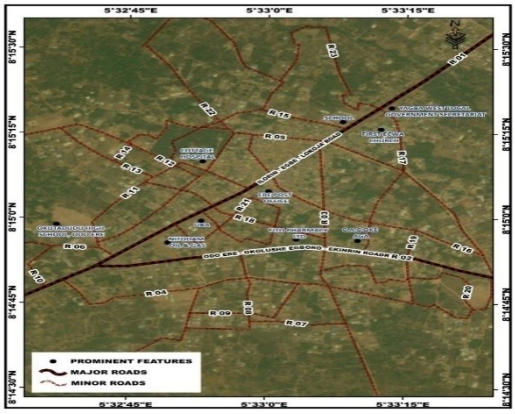

Fig. 20: Odo-Ere showing distribution of Road Network

Source: Author's Field Work,(2024)

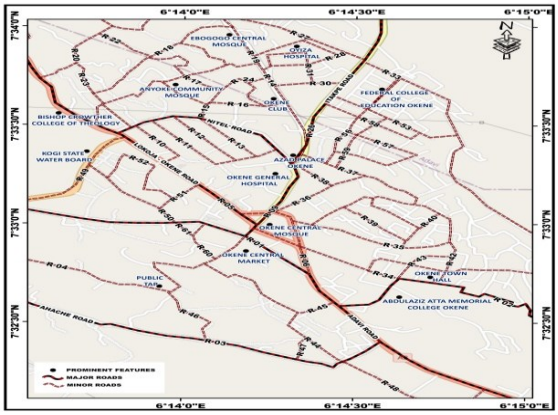

Fig. 21: Kabba showing distribution of Road Network

Source: Author's Field Work,(2024)

Despite the availability of road network in the SSUCs, the perception of respondents on quality of the road network in the SSUCs was obtained.

Table 1: Quality of Road Network in SSUCs in Kogi State

S/N	Variable	Scale points	Freq. (370)	Percent (100%)	Mean	(SD)	CV %
1	**Road Network of SSUCs in Kogi State**	E	20	5.41	2.75	0.81	29.5
		VG	30	8.11			
		G	160	43.24			
		F	125	33.78			
		P	35	9.46			

***E = Excellent, VG = Very Good, G = Good, F= Fair, P = Poor, (SD) = Standard Deviation, M =Mean, CV = Coefficient Variability**

Source: Author's Field Work, (2024)

Table 1 indicates the quality of road network of the SSUCs in Kogi State. The results show (M=2. 75, SD= 0.81, CV = 29.5%) of the respondents. The coefficient of variability suggests moderate variability and the data exhibits moderate fluctuations in the respondent's opinion. The table shows majority of respondents' 43.25% perception of the road network of SSUCs in Kogi State is good, 33.78% perception of the road network is fair and 9.46 percent perception of the road network is poor. And, 8.11% and 5.41% perception of the road network of the SSUCs in Kogi State is very good and excellent respectively. The study shows that less than 50% respondent perception of the quality of road network agree that it is good. This suggests that the road network in the SSUCs in Kogi State needs further improvement for the growth of the SSUCs. According to Gofran, Hamid & Ahmed (2021), road network enhances the connectivity of people with the local facilities. Equally, Dam, Alaci, Atser, Ujoh & Gyuse, (2020) affirms that the structure of road network connectivity

in any community or region can promote or reduce market opportunities, increase or reduce agricultural productions, social and cultural interaction, improve business and employment opportunities.

Conclusion and Recommendation

Transportation infrastructure is a critical component of development in any emerging economy and urban centre. Apparently, road transport is the major mode of transport in urban centres. Urban mobility is enhanced by the quality and structure of the road network. Most small size urban centres (SSUCS) are becoming the centre of development in developing countries and the nature of their road network needs to be ascertain in other to determine the extend at which its need further improvement. Therefore, all stakeholders in the transport sector should improve the quality of road network in the (SSUCs) in Kogi State. This can be achievable by investing in road construction and rehabilitation, implementation of road maintenance programs and establishment of road agency in the state. However, the study has laid the foundation for further research on the effect of road network connectivity on the development of rural communities in Kogi State.

Competing Interests

Authors have declared that no competing interests exist

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