http://dx.doi.org/10.4314/bajopas.v9i1.14

Bayero Journal of Pure and Applied Sciences, 9(1): 87 - 92
Received: June, 2015
Accepted: June, 2016
ISSN 2006 – 6996

ROAD NETWORK: THE SILENT TREASURES OF KANO METROPOLIS

[1]Ibrahim, A. M. and [2]Mohammed, M. A.
[1]Department of Environmental Management,
[2]Department of Geography,
Nigeria, Faculty of Earth and Environmental science, Bayero University, Kano,
wadeconsult2@gmail.com and mansur_mhmmd@yahoo.com

ABSTRACT
The paper appraised the available road networks in Kano metropolis in relation to their nature; spatial distribution; connectivity index; accessibility index of the Kano urban terrain; and functional wellbeing. The methods used include analysis of secondary data generated from the 2011 satellite imageries (at 0.5m resolution) with the aid of Quantum GIS; road stock inventory; road classification and mapping; as well as field observation. The result shows that, Kano metropolis is well stocked with all sorts of road networks and majority of which (72%) conformed to planning standards and urban environmental quality. The road network density is very high (about 22.72Km/Km^2), there is high connectivity index (1.3 Beta Index), and conducive mobility status. The road network structure is made up of two main patterns: a circular and grid topologies. Inadequate road maintenance culture and weak development control measures are the major challenges facing road network performance and development in Kano metropolis. The study concluded that apart from being a medium of mobility, road network in Kano metropolis is also a treasure to current and future generations. It was therefore, recommended that: the scope of Kano State Road Maintenance Agency (KARMA) should be increased to take care of full road revitalization; KNUPDA should come up with stringent measures against erection of detrimental features along road sides; and also scope of Kano State Road Traffic Agency (KAROTA) should be increased so as to take care of road vandalization, destruction and mutilation.
Keywords: Kano, Metropolis,Network, Road,Treasure,

INTRODUCTION

Infrastructural facilities especially road network is among the basic indexes of measuring the quality of urban wellbeing. Generally, road network forms the most basic level of transport infrastructure within urban areas, and link with all other areas, both within and beyond the boundaries of the urban area. It therefore facilitates social interaction through easy movement of people. Also empirical studies have revealed that 'investment in road networks reduces the travel time between two locations, increase the robustness of the transportation network and hence reduce the travel costs' (Hanson, 1986;Egunjobi, 1991; Horner, 1992; and Levinson and Yerra, 2006). Thus, according to Xie and Levinson (2007) 'road network plays a dual role in providing both accesses to property and travel mobility. Local streets emphasize the land access function, arterial roads emphasize a high level of mobility for through movement, and collectors offer a compromise between both functions'. They concluded that 'arterial roads (including freeways, major highways, and undivided arterials) are essential in an urban transportation system with regard to mobility'.

In another direction, road network stimulates the development of certain areas in terms of commercial activities, urban development, and jobs creation etc. On the other hand, non availability of road network in most cases leads to remoteness, backwards and underdevelopment of an area, region or even nation. Thus, it is in realization of the basic roles of road networks towards all aspects of human endeavors, that many nations of the world dedicate huge efforts and resources in order to develop road network. As at 2013, it has been reported that the world had a total road length of 64,285,009Km (CIA World Factbook, 2013). Out of this figure United State of America (USA) contributed the highest amount of 6,586,610Km road length and ranked first followed by India and China with 4,689,842Km and 4,356,200Km and ranked second and third respectively. Nigeria is ranked 28th (180,549Km) at global level and second in the African continent after South Africa (362,099Km). At urban level, Kano metropolis is also among the top four urban centers in Nigeria that are highly endowed with road network of various categories. It is in line with this, that some commercial actors viewed the road stock of Kano metropolis as a treasure; political actors viewed it as political magnate; media commentators sees it as liabilities; and social and environmental analyst such as geographers see it as a measure of relations between areas. This paper aimed at appraising the road network in Kano Metropolis with a view to ascertain the standard scenario based on environmental perspectives.

MATERIAL AND METHODS

Kano metropolis is the capital city of Kano state, Nigeria. It is located between latitude 11°59'59.57''N to 12°02'39.57"N and longitude 8°31'19.69"E to 8°33'19.69"E, with a total urban land area of 137Km^2 and 499Km^2 metropolitan area. It is made up of six Local Government Areas (Dala, Fage, Gwale, Municipal, Nasarawa, and Tarauni) and some parts of Kumbotso, Ungogo, and Tofa Local Government Areas. Kano metropolis has an estimated population of over 4 million people with a male – female ratio of about 1 to 1.32 (Ibrahim, 2014a). Over 70% of the adult workforces draw their livelihoods off agriculture. Kano is the biggest commercial and industrial centre in Northern Nigeria. It has 43 existing marketplaces and over 400 privately owned manufacturing industries (Ibrahim, 2014a).

Kano metropolis is about 481 meters (or about 1580 feet) above sea level. The climate is a hot, semi-arid type with an annual average rainfall of about 690 mm (27.2 in); majority of which falls from June through September. The temperature is generally very hot throughout the year, though from December through February, the city is relatively cool. The average nighttime temperatures in the cold months range from 11° to 14°C. The vegetation therefore, is a savanna type. Jakara, Kano and Challawa rivers are the major water bodies that drained the metropolitan area.

The method used involves analysis of secondary data generated from the 2011 satellite imageries (at 0.5m resolution) and a topographical map of scale 1:100000 obtained from Kano State Ministry of Lands and Physical Planning. The topographical map and the imagery were geo-rectified in the Quantum GIS to geographic co-ordinates. The boundary of the study area and the in-built road networks were digitized in polygon and polyline respectively. The road junctions were digitized as points. The study area was calculated in square kilometers and the length of each road was determined in kilometers. Road classification and mapping were conducted in order to establish causation and relationships.

The road density which is defined as the road length per unit area was calculated by dividing the total road length (RL) with the total area (A): Road density = Total Road Length (RL) divide by Total Area. This has been compared with the standard road density specified by Odaga and Heneveld (1995) to explain the road density in the study area. The connectivity of the road network was determined using Beta index of connectivity developed by Kansky (1963) and adopted by Vinod, Sukumar, and Sukumar (2003). The Beta index (BI) for connectivity is a simple measure of connectivity which is derived by dividing the total Arcs with the total Nodes: BI=Arc/Nodes. The nodes are the number of road junctions while the arcs are connections (straight lines) between the nodes as straight lines. The Beta Index ranges from 0.0 for network with only nodes without any arc through 1.0 and greater where the networks are well connected (Vinod, Sukumar, and Sukumar, 2003).

RESULTS AND DISCUSSION

Road Network Inventory

The data set generated from the 2011 satellite imageries with aid of quantum GIS reveled that Kano metropolis is networked with a sum total road length of 3,112,848.07 meters (3,112.85 Kilometers) at 11,841 total counts. Based on road categorization index, the inventoried roads are classified into ten classes. About 60% are secondary major roads; 11% primary roads; and 6.8% dual carriage roads. The detail finding is presented in Table 1 and Figure 1 below.

Table 1: Classes of Road Network in Kano Metropolis

Category	A. Number	T. Length (M)	%
Arterial	6	35060.92426803000	1.13
Axis	42	91996.28083592500	2.95
Dirt	66	33023.96669974310	1.06
Dual	113	210956.70334103300	6.78
Major	33	53024.08738334100	1.70
Nursery	1576	277841.67410455600	8.93
Primary	300	349712.73457928600	11.23
Primary Ram	13	1481.62887541360	0.05
Proposed	3	19577.42906024000	0.63
Secondary Major	8402	1868692.74760671000	60.03
Secondary Minor	1287	171479.89588674100	5.51
Total	11841	3112848.07	100.00
Density (Overall)	-	22721.52m/km^2	-
Rail way	15	46308.59044824610	

Source: Derived from Analysis of 2011 Satellite Imagery Key: A = Absolute; T = Total; M = Metre

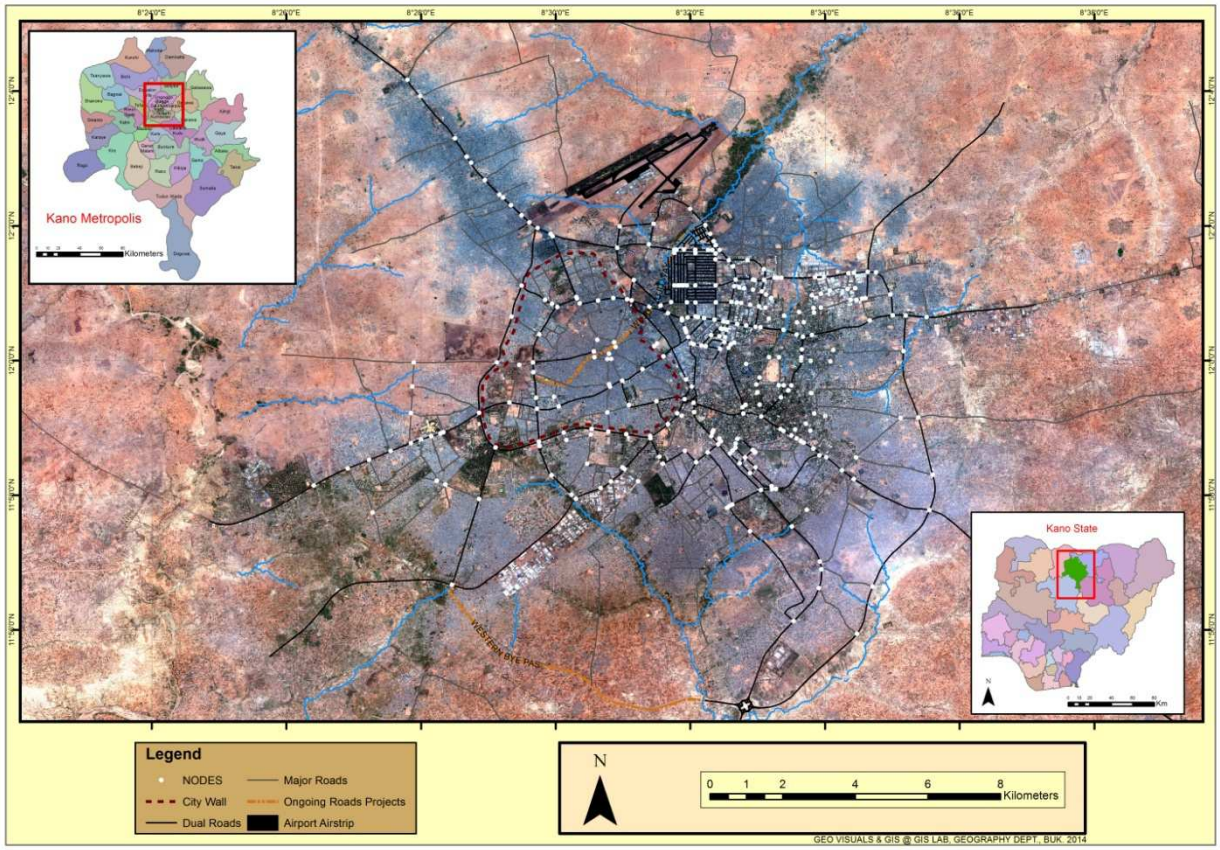

Figure 1: Satellite Image of Kano Metropolis Source: Kano State Ministry Lands (2011)

Road Density

Road density is the road length per unit area; it connotes how dense road network is in a particular area. It is derived by dividing the total road length (RL) with the total area (A). Thus the sum total road length of 3,112,848.07 meters when divided with the total area of urban Kano of 137km^2 gives a general road density of 22721.52m/km^2 (about 22.72Km/Km^2). This going by the road density index proposed by Obafemi et al. (2011) that 'road density is high when it is more than 120 meters per square kilometers, medium when it is more than 30 meters and less than 120 meters and low when it is less than 30 meters per square kilometer', road density in Kano metropolis, on general terms, is extremely high. On a specific term, however, major secondary road is leading with a density of 13640.07 meters per square kilometer (about 13.64km/km^2), followed by dual carriage with 1539.83 meters per square kilometer. Arterial is the least with 255.91 meters per square kilometer in the asphalted category. Among the non-asphalted category on the other hand, primary and nursery roads recorded the highest densities of 2552.65 and 2028.04 meters per square kilometer followed by minor secondary roads with 1251.68 meters per square kilometer. Primary Ram has the lowest density of about 10.81 meters per square kilometer. The detail finding is presented in Table 2.

Table 2: Road Density in Kano Metropolis by Categories

	Asphalted			**Non-Asphalted**	
Type	Density	Score	Type	Density	Score
Arterial	255.91	V. High	Nursery	2028.04	V. High
Axis	671.51	V. High	Primary	2552.65	V. High
Dual	1539.83	V. High	Primary Ram	10.81	V. Low
Major	387.04	V. High	Dirt	241.05	High
Secondary Major	13640.09	V. High	Secondary Minor	1251.68	V. High
Proposed	142.90	V. High	Total	6084.23	V. High
Total	16637.28	V. High	-	-	-
-	-	**%**	-	-	**%**
Total Count	8599	77.99	Total Count	3242	22.01
Total Length	2279308.796	73.19	Total Length	833539.9003	26.81

Source: Derived from Analysis of 2011 Satellite Imagery

Table 2 shows about 77.99% of total road counts and 73.19% of the total road lengths in Kano metropolis are asphalted while the remaining 22.01% of total road counts and 26.81% of the total road lengths respectively are non-asphalted. This among other things entails the motorability conditions of road network in Kano metropolis; very high mobility index; and high level of infrastructural development which presumably represent the silent treasures of Kano metropolis.

Connectivity Index

The density of road network in some cases does not always matter in a social network analysis but rather the connectivity to one another. Thus, in order to assess the connectivity level of road network in Kano metropolis, a Beta Index of connectivity was used. In the first instant dual carriage ways (prominent roads) that run throughout the metropolis as presented in Figure 2 were taken into consideration. The result revealed a total of 62 arcs and 44 nodes. This going by Beta Index (BI = A/N) gives a value of 1.41; which indicated a high level of connectivity.

A further analysis involving all asphalted roads in the metropolis as indicated in Figure 3 reveals a total of 457 arcs and 352 nodes with a Beta Index of 1.3. This also indicated a very high connectivity; which among other thing can be attributed to few or absence of barrier and incorporation of planning principles along the trend of infrastructural development. This in turns promote great linkages between residential, commercial and industrial areas in the metropolis and high accessibility level of the entire Kano urban landscape, most especially in relation to the efficiency of the delivery of social services and human mobility. In another direction the high level of connectivity entails that, the road network on general terms is evenly distributed spatially. A study by Obafemi et al. (2011) revealed similar findings: 'that the road network in Trans-Amadi Industrial Layout was an organized network and evenly distributed'.

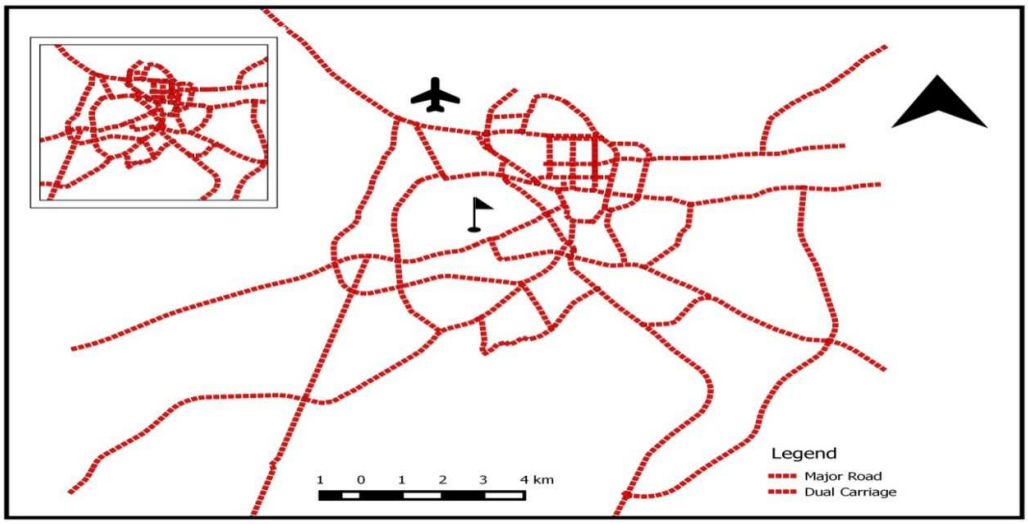

Figure 2: Prominent Roads in Kano Metropolis Source: Derived from Satellite Images, 2011

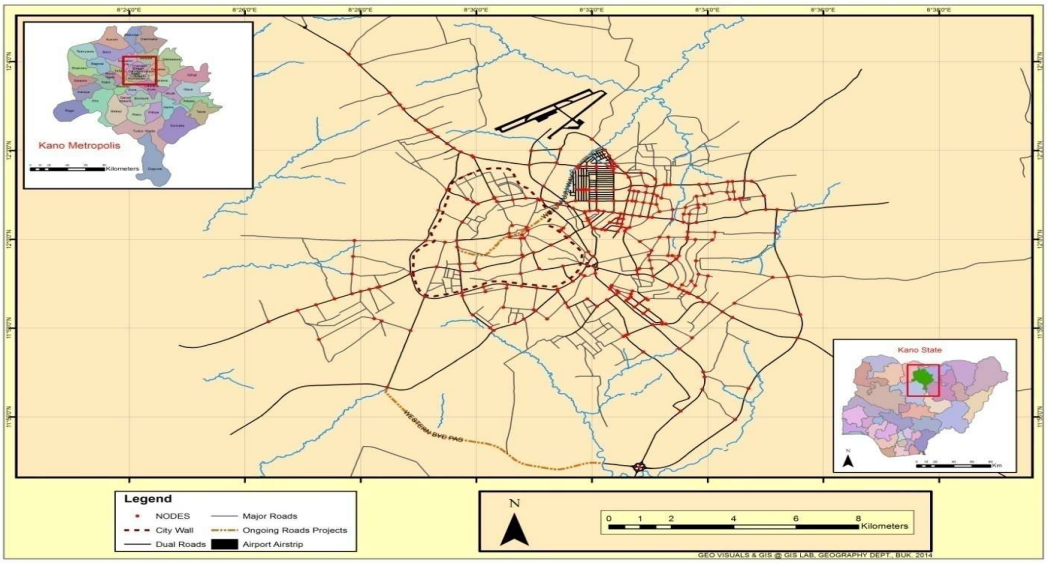

Figure 3: Road Map of Kano Metropolis – Showing Nodes Distribution Source: Derived from 2011 Satellite Images

Structural Index

Road network structure is usually measured in terms of heterogeneity; connection pattern; and continuity. Thus, the structural characteristic of road network in Kano metropolis exhibits all these attributes. The road network system of Kano metropolis as portrayed earlier, is consist with 10 different categories of road and each category is serving a different or a particular purpose or function and as well forms part and parcel of the entire road network system. Therefore, these functional or operational differentiations of roads in a network with regard to their relative importance to the network are referred to as network heterogeneity. It is usually evaluated by a collective statistical measure of entropy which serves as a measure of how close a system is to equilibrium - that is, to perfect internal disorder. A separate study by Ibrahim, (2015a) has adequately evaluated that. However, a cursory view of the road network patterns in Figure 2 and 3 shows a circular and grid topologies respectively. Thus, the dual carriage ways which form the prominent road network in Kano metropolis exhibits a circular typology. This among other things connotes a very flexible and coordinated transport flow.

Therefore, the metropolitan dual carriage ways serve as the main transportation arteries in Kano metropolis; they are the dominant link between commercial areas; residential areas; industrial areas; local and regional surroundings. Moreover, the circular pattern exhibited by dual carriage ways in Kano metropolis on a road safety index, reduces chances of unnecessary traffic hold-ups and accidents. The grid typology, on the other hand, featured prominently in and around residential areas. This in its own sphere connotes high level of accessibility and in cooperation of planning principles in the residential areas. However, it should be noted that these attributes featured prominently in planned areas of the metropolis. Accessibility in the traditional city area and unplanned low income residential areas, is still very critical (Ibrahim, 2015b).

Road Expenditure Analysis

The huge number of road networks in Kano metropolis represents the amount of expenditure dedicated to road infrastructure by government and to some extent by individuals and institutions. Generally, the cost of building roads costs a lot but the cost of not building them costs more. This means if it will cost about N40 million, for example, to construct a one killometre road (single lane), the cost of not doing so may amount to over N60 million or more. Therefore, it is on this background that most decision makers aligned their rational in dedicated huge public funds on roads expenditure.

On deductive reasoning, the cost expended on about 2,279.309 Km of the asphalted roads length in Kano metropolis, for example, has saved the metropolis about 50% or more of the cost of not having such expenditure which on liberal economic ground can be regarded as investment, since it has attracted and is yielding some dividends. This according to Bruser (1991) can be geographical (mobility); technical; political; social; or economic. A typical example of such investment is the dualization/reconstruction of Sabuwar Kofa to School for Arabic Studies (SAS) at the total contract sum of N288,485,219.26 (Kano State Government, 2013). The road serves as a gate-way between traditional Kano city and the modern set up; a domain for the conservation of historical monuments (*Badala* – Old City Wall); a major link between traditional city residents with educational institutions and Sharada industrial area; and a potential recreational site. Moreover, it is easing smooth traffic flow and sustains low chances of road accident as against its former situation prior to the reconstruction - an average of 3 incidences of road accident weekly (Kano State Road Safety Unit, 2013). Therefore, the cumulative benefits of Road User Saving (RUS); low Vehicle Operating Cost (VOC) and Internal Rate of Return (IRR) or the Present Value (PV) among other things, makes road networks in Kano metropolis a multi-dimensional treasure. For example, from economic view, a study by Ibrahim (2014b) on the evolutionary trend of markets development in Kano metropolis revealed that 'the asphalted road infrastructure raises land value and promotes the development of neighborhood trading and services outlets (un-conventional markets)'.

Moreover, on urban environmental quality on the other hand, infrastructural development is one of the indexes of measuring urban wellbeing. Thus, the observed very high road network density (about 22.72Km/Km^2); high connectivity index (1.3 Beta Index); and conducive mobility status (motorability) in Kano metropolis are good indicators of urban physical wellbeing that can allow Kano metropolis to stand along with the standard urban centres in terms of road infrastructure.

Challenges

In spite of the above astonishing features of road network development in Kano metropolis, there are still some encumbrances that need to be manage adequately. In the first instance, the issue of road maintenance is not only critical to Kano metropolis but also to all developing countries. For, if not adequately maintained, the road value will degenerate, the road user cost (RUC) will increase and road safety may not be ensured. Minor secondary roads in and around residential areas in Kano metropolis are currently not being adequately maintain to the extent that some are not motorable during wet season. Most of the roads in Sabon-Gari residential/commercial areas; Bompai residential and industrial areas; Kawo and Badawa areas are good examples.

Inadequate development control measures are also negatively affecting road network performance in Kano metropolis; the right of way (a set-back of 10m and 15m in residential areas and high-way respectively) along some roads has been significantly reduced, in some cases, to less than one metre. Most of the roads that runs through the old Kano city have less than 5m set back as against the standard of 10m and above, due to encroachment of residences and commercial outlets. This to say the least negates smooth mobility and increase chances of road accidents and road dilapidation. Other negative activities are dumping of refuse and hawking along road sides, illegal construction of impediments and lying of water pipes across some roads, and vandalization of road installation and traffic sign post.

CONCLUSION

From the above it is evidently clear that road network density in Kano metropolis is very high, well connected and evenly distributed with a high corresponding spatial mobility index. Moreover, the road network investment scenario in Kano metropolis and its political disposition may debunk the notion that 'the ongoing road expenditure is a mere liability' but rather a life resource. Thus, it can be concluded that road network in Kano is a treasure to current and future generations. Therefore, in order to protect the huge investment in road network in Kano metropolis and as well sustain the derivable benefits, the above identified challenges should be adequately managed. It is therefore recommended that the scope of Kano State Road Maintenance Agency (KARMA) should be increased to take care of full road revitalization rather than minor works on drainage and foot-path. The authority concerned with Kano urban planning and development control (KNUPDA) should come up with stringent measures against erection of detrimental features and structures along road sides and to safeguard the right of way. Moreover, the scope of Kano State Road Traffic Agency (KAROTA) should be increased to take care of not only traffic offences but also road side hawking, road vandalization, detraction and mutilation.

Acknowledgement

I wish to acknowledge the support and contribution of Kano State Ministry of Lands and Physical Planning and Abdulkadir M. Cartography Unit Geography Dept. BUK towards the success of this research work.

REFERENCES

Bruser A. (1991) Economic aspects of road transport projects.The Courier N° 125 Jan-Feb 1991 - Dossier: Roads - Country reports: Congo

CIA World Factbook (2013), List of Road Network by Countries. Rank Order - Roadways CIA World factbook(accessed on 12 March, 2013)

Egunjobi L. (1991) Road transport and the underdeveloped status of the Oyo North region in Nigeria. The Courier N° 125 Jan-Feb 1991 - Dossier: Roads - Country reports: Congo.

Hanson, S. (1986) The Geography of Urban Transportation. New York: Guilford

Horner, S. (1992)The EDF and African roadsThe Courier N° 131 Dossier The urban crisis-Country Report: Dominican Republic

IbrahimA. M. (2014a) How Far is too Far? The Facts and Figures on Human Population in Kano State *International Journal of Humanities and Social Science Invention Volume 3 Issue 4 || April. 2014 || Pp.61-64* www.ijhssi.Org

IbrahimA. M. (2014b)Evolutionary Trend, Spatial Distribution of, and Issues Associated with Markets in Kano Metropolis.*Journal of Research on Humanities and Social Sciences Vol.4, No.28, 2014* www.iiste.org

IbrahimA. M. (2015a) Social Road Network Analysis in Kano Metropolis (in Press)

IbrahimA. M. (2015b) Beauty of the Ugly: Housing among the Low Income Groups in some parts of Kano Metropolis (in Press).

Kano State Government, (2013) The 133rd Kano State Executive Council Meeting Prepared by Council Affairs Directorate, Office of the Secretary to the State Government, Government House, Kano.

Kano State Road Safety Unit (2013) Annual Report Records, Kano Office, Nigeria

Kansky, K. (1963) "Structure of Transportation Networks: Relationships between Network Geometry and Regional Characteristics." Research paper 84, Department of Geography, University of Chicago, Chicago

Levinson, D., and Yerra, B (2006) "Self Organization of Surface Transportation Networks." Transportation Science 40(2), 179–88

Obafemi A. A., Olatunde S. E., Dozie R. O.(2011) Road Network Assessment in Trans-Amadi, Port Harcourt in Nigeria Using GIS*International Journal for Traffic and Transport Engineering, 2011, 1(4): 257 – 264*

Odaga, A.; Heneveld, W. (1995) Girls and Schools in Sub Saharan Africa: From Analysis to Action. Washington D.C.: World Bank. 4p.

Vinod, R. V.; Sukumar, B.; Sukumar, A. (2003) Transport Network Analysis of Kasaragod Taluk, Kerala Using GIS, *Indian Cartographer* 23: 1-9.

Xie F. and Levinson D. (2007) Measuring the Structure of Road Networks. *Geographical Analysis* ***39*** *(2007) 336–356. The Ohio State University*