Development of GIS-Based Road Transport Information Management System for Adamawa Central, Adamawa State, Nigeria

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Abstract
This study was conducted on the Development of Gis-Baesd Road Transport Information Mamagenmet System for Adamawa Central, Adamawa State, Nigeria. The study covered Adamawa central which comprises of seven local government areas nanell; Yola North (Jimeta), Yola South, Fufore, Gerei, Song, Gombi and Hong. Satellite images, road transport map, road transport documents, as well as the bridges and the roundabout coordinate were all used to obtain the final results for the study. The satellite images were Spot image of 2012 and Google Earth image of 2013. The satellite images and road map were used in updating the road transport map, the road transport documents as well the road, bridge and roundabout picture were used as an inventory in building the geodatabase for the development of the GIS-Based road transport iformation management system and some of the roads, bridge and roundabout coordinates were used for hyperlinking the pictures to the spatial reference.ArcGIS 10.1, Microsoft 2013 and AO scanner was used for the entire thesis work, the thesis critically observed the process involved in Developing a GIS-Based road transport information Management system for the various road transport Infrastructures for Adamawa central, analysis were performed for proper decision-making on how to manage the road transport infrastructures. The result reveals that Geographic Information System as a very important system can be used in data collection, entry, development, management and analysis. The research also show that the process of converting the traditional database system to a Geographical Information System (GIS) does not require the hi-tech knowledge and equipment common in science fictions and movies, but what is required in the planning will and commitment. It is recommended that government should establish GIS unit in the federal and state ministry of transports board and also encourage the local government areas to do the same for proper planning and development of road transport infrastructure and management for easy management and control of its facilities.
Keywords: ArcGIS 10.1, GIS, Road Transport, Road Transport Inventory, Road Transport Map, Road Transport Documents, Geodatabase. Sport Image, Google Earth Image

INTRODUCTION

Geographic information systems for road transport information management system can be defined as interconnected hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analysing, communicating and managing particular types of information (i.e., transportation systems and geographic regions) about the Earth (Vonderohe, 1993). They went on to say, GIS based road transport information can be viewed as the product of the interaction between improved concepts of both geographic information system (GIS) and transportation information system (TIS).

GIS based road information management system applications are currently used broadly by transportation analysts and decision makers in different areas of transportation planning and engineering, from infrastructure planning, design and management, traffic safety analysis, transportation impact analysis, public transit planning and operations to intelligent transportation systems (ITS) such as Advanced Traveller Information Systems (ATIS) and Commercial Vehicle Operations (CVO) (Vonderohe *et al,* 1993).

Road transport information system is the system that collects, organise and store data about the road network, and provide facilities for reports to be produced on these data, in a variety of formats (Robinson, R., Danielson, U. and Snaith, M., 1998). Road Transport information which include: road inventory, traffic statistics, construction, maintenance data, etc. could be organized and integrated properly by using GIS techniques. Roads transport are networks that connect infrastructure facilities and accommodates lifeline facilities. The provision, operation and maintenance of the physical infrastructure of a transportation sector and its related social services require a prior knowledge and manipulation of GIS (Hassanain, *et al*, 2003).

Road transport is by far the most dominant mode of transport in the country, carrying well over 90% of passenger and freight traffic and serving as a true backbone for Nigeria's economy (Transport Research Board, 2004). Because a well maintained road transport asset is very important for the economic development of the nation, Road Management Information System is a prerequisite for the successful management of road transport. Geospatial data are foundation for relevant and critical information for planning, engineering, asset management, and operations associated with every transportation mode at all levels of government and administration, (TRB, 2004).

Transportation is one of the fastest growing of many fields in which GIS is used Rodrigue *et al* (2006). Diverse areas of transportation, including high way and rail way infrastructure management, international shipping, airport management, fleet logistics, traffic management and intelligent transportation systems (ITS), transit bus and rail service planning, transportation modeling, supply chain modeling, and others, are applying GIS to their work, ESRI (2003). The breadth of the field of integration of GIS and transportation system provides large opportunities for the development of new and innovative applications in transportation system of different transportation organizations Curtin (2003). Since GIS have a seamless relation with space and location, given that their main objective as a tool is to store, retrieve, and facilitate the analysis of spatial data (Goodchild and Janelle, 2004), they have become one of the most powerful tools to support transportation studies and applications. The liaison between GIS and transportation is indeed quite natural, given that transportation itself is linked to space organization on the development of networks in space and time, just like geography itself (Haggett, 1965). Capitalizing on this relationship both academics and practitioners have focused their attention on research/work that makes use of GIS in transportation applications. "GIS and Transport" has been of importance in the academic world since the early 1990s (Miller, 1991; Kamal et al., 1994). However, besides some early contributions, which aimed at explaining the role of GIS in transportation planning (Sutton, 1996), no major efforts were made. A relevant attempt to collect and organize studies about GIS and Transport was made in 2000 by the academic journal *Transportation Research C* (reviewed by Fotheringham, 2002, Shaw, 2002). In several cases, it is sometimes formally required that public authorities with an interest in transportation build a GIS framework to handle and manage transportation data and projects. For example, the American Association of State Highways and Transportation Officials, together with the US Department of Transportation (DoT) have been organizing a GIS-T symposium for the past 22 years, in order to give practical support to government and private industry organizations interested in the use of GIS for transportation purposes. This shows that in transportation science the spatial approach is naturally integrated, contrary to other disciplines where there is a need to identify the particular role of "geographically oriented sub disciplines" in a distinct way. As an example, transportation scientists have been key players in the application of GIS (Goodchild, 2000; Thill, 2000). GIS have influenced a variety of aspects of transportation science. Goodchild (1998), after recognizing in the discrete entity model and in the network model the GIS data models that are most interesting for transportation purposes, identifies the paradigms leading to their extensive use in transportation modelling. These are: digital map production, inventory and data management, integration of data, spatial analysis, and dynamic modelling, we adopted this simple paradigms. He continues (Goodchild, 2000) by differentiating three stages in the evolution of GIS-T: the map view (mainly concerning network visualization and interoperability issues); the navigational view (connected with network modelling and algorithm resolution); and the behavioural view (linked to the use of the network by people and vehicles, which implies the dynamic modelling of transportation phenomena).

The understanding of GIS based Road Transport management Information System, effective use of geographical information and the knowledge of their advantages is critical to the planning and decision making process for asset management and transport departments.

This study is important and timely because Adamawa central still faces problems of traffic congestion, high road accidents, lack of road transport geospatial database, weak institutional support leading to poor definition of the problem at hand and differing technology transfer priorities in problem resolution. This could be linked to the non-availability of adequate information on road transport due to increase urbanization, growth of commercial activities and increase road development that is spatially integrating activities. This development comes up with different characterisation of transport infrastructure, operation methods, ownership, peak period moments and capacity volume ratio and even pollutant and environmental problems. This study will provide decisions makers with a system which could be used for road transport inventory, physical road maintenance, road traffic management as well as any other road-related management issues. The focus of this study is to develop a GIS based road transport information management system in Adamawa central, as support to the traditional pattern matching (majorly based on human judgement), that has been used over time. This is the gap in research and knowledge this study intend to fill.

The aim of this study is to develop a GIS based Road Information Management System for Adamawa Central, Nigeria. This were achieved through the following objectives which include to: Mapping the existing roads infrastructures in Adamawa Central, Build Geodatabase for the roads infrastructures in Adamawa Central and Use the Geodatabase to analyse and queries road characteristics and Characterise in form of road transport document, road transport map, table, statistic graphs, charts and ArcMap Documents.

THE STUDY AREA

The study area (Adamawa central) is located between latitude 8^{o}30'N and 13^{o}00'N of the equator and between longitude 10°30'E and 13°00'E of the Green meridian with an elevation of 135 metres. Adamawa central is bordered by Borno State and Shelleng LGA to the northwest, Demsa, Mayo-Belwa and Jada LGA to the southwest, Mubi north and Maiha LGA to the northeast, its eastern border also forms the national eastern border with Cameroon. Adamawa central is one of the largest central of Nigeria and occupies about 12,914 square kilometres respectively. See figure 1.1 for study area map.The Adamawa central which is the study area consists of seven Local Government Areas namely; Yola North, Yola South, Fufure, Gerie, Song, Hong and Gombi. The relief of Adamawa central is that of the cretaceous rocks overlying Bima Sandstone underlies restricted area of low-lying plains, (Carter et al, 1963).

Drainage nearly all water supplies are at present obtained from rivers and streams. Yola is drained by the Benue River which rises from the Cameroon Republic and flows from east to west along the northern borders of the area to join the River Niger at Lokoja. The climate of the study area is typical of the West African Savanna climate. Temperature in this climatic region is high because of the radiation income. A slight increase after the cessation of rain (October to November) is common before the onset of harmattan in December when the temperature in Yola reach 40^{o}C particularly in April (Adebayo et al, 1999).

Vegetation falls in the Sudan Savannah zone of Nigerian, most of which is subjected to regular cultivation. Restricted areas of anogeissus /combertum/ propopsdis woodland occurred but the farmland carry a mixed shrub dominated by pilostigma reticulation. Soils like most areas of northern Nigeria, most of the soils of the area have sub-surface horizons with high content of iron concretions and fissile iron stone occurring in many areas (Helen, 1994).

MATERIALS AND METHODS

The research methodology workflow is presented in figure 1.2

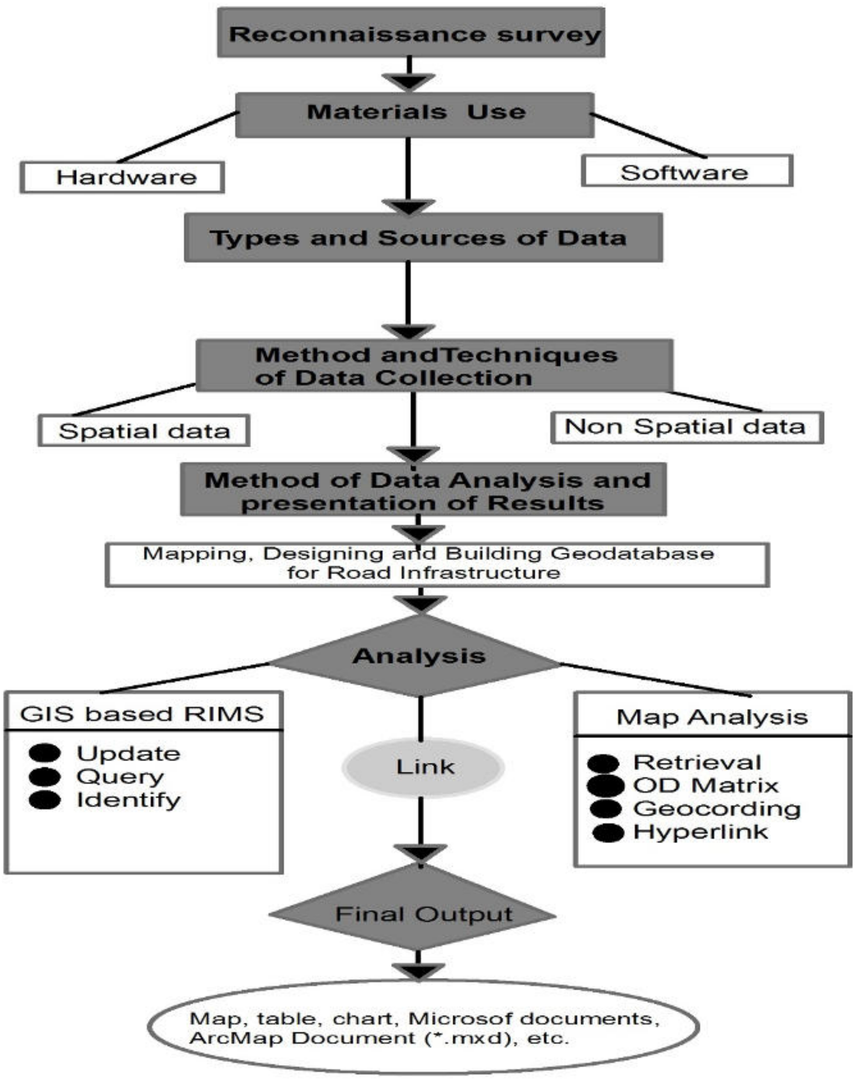


Figure 1.2: The workflow of the research methodology
Source; Design by (Thlakma, 2013)

Materials used for the Study

Hardware

The hardware used are show on table 1.1

Table 1.1 shows the hardware required and the usage

Hardware	Usage
A hand-held Garmin 76CSX GPS	Used for capture of control points of the road transport junctions (Y and T)
A digital camera	Used for capture picture of some road infrastructures
An A0 scanner	Used for scanning hardcopy topographic map of the study area in order to convert it in to digital format in ArcGIS 10.1 environment.
An A0 scanner	Used to print out hardcopy maps of the GIS based RTIMS
A digital electronic Laptop computer	Used for processing all the information gathered in this study

Software

The software to be used are show on table 1.2

Table 1.2 shows the software required and the usage

Software	Usage
Microsoft Word 2013	Used for compiling and documentation of the research document
ESRI ArcGIS 10.1	Used as for mapping, designing and creation of geosdatabase analysis, querying, and production of road transport maps, chart and tables of the Adamawa central.

Types and Sources of Data

In order to achieve the stated objectives, the following data were obtaind; Spot5 satellite images of 2012, with 1m resolution, road transport map of Adamawa state, documents on road information and attributes, GPS coordinates of the junctions (T and Y) and culvert of Adamawa central. See Table 1.3 for types, sources and usage.

Table 1.3 shows Data type, sources and usage

Dada required	Sources	Usage
Road transport base map	Ministry of Urban and Regional Planning Yola	Serve as base map from which to be digitize and delineate the roads for geospatial database creation.
Spot5 satellite images (2012) of 1m resolution	National Centre of Remote Sensing Jos	The base road map will be overlay on the image in order to update the road map.
Road information Documents (attribute data)	Ministry of Works, Yola.	It provide attribute data to be used as an inventory for creation and populating database
GPS Data (Spatial data)	Field survey	For taking coordinates points of the roundabout that were used for hyperlinking.
Digital camera data (picture)	Field survey	Provide road pictures for hyperlinking in order to see the nature of some of the roads and roundabout.

Method and Technique of Data Collection

Spatial data collection

Road map, is obtained from Ministry of Urban and Regional Planning Yola. Spot5 image of 2012 will be acquire from National Centre of Remote Sensing JOS and field work was carryout in order to take the coordinates of the roundabout GPS as well as snapping some of the road picture using digital camera.

Attribute data collection

Field work, these include the collection of road transport information documents from Ministry of Urban and Regional Planning Yola and Ministry of Works.

Methods of Data Analysis and Presentation of results.

Methods of data analysis and presentation of result adopted in this research work formed the basis for the mapping, building, creation and the development of a GIS based road information management system in Adamawa central.

Mapping the existing road infrastructures in Adamawa Central (Objective I).

In achieve that, Remote Sensing Data: Road base map will be scan, georeference, digitise to delineate the roads map and together with Sport5 (2012) with 1m resolution satellite images will be used to overlay the

two map in order to updating the roads transport map for Adamawa central so as to generate an up-to-date road map . Necessary spatial layers of road transport network will be generated from the sport5 image and road maps.
Designing and Building Geodatabase of road infrastructures in Adamawa Central (Objective II).

This is achieving through the use of ArcCatalog Tool. Designing and Building Geodatabase involve three stages; conceptual, logical and physical design.

Conceptual design; is the starting point of database design, the purpose of conceptual data modelling is to define in broad and generic terms the scope of a database (Lo, *et al*, 2007).

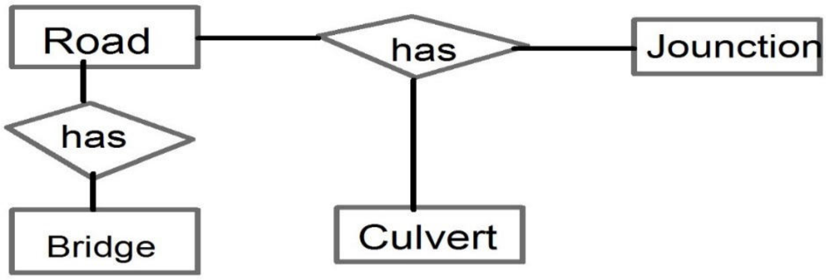


Figure 1.1 showing the proposed Entity Model of Database

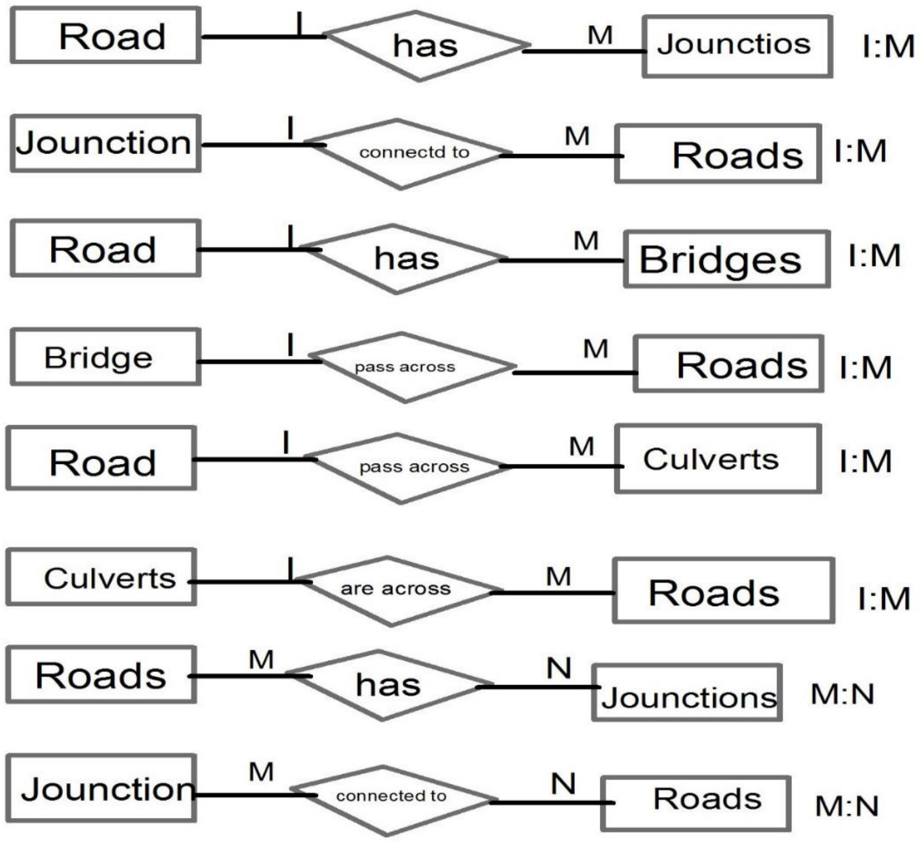


Figure 1.2 showing the proposed E-R Schema of the Database

The approaches to conceptual data modelling involve; Entity Relation (E-R) model (see fig 1.3), Entity Relation (E-R) schema (see fig 1.4), identification of attributes, determination of relationships and the drawing of an E-R diagram, as shows on Figure 1.5.

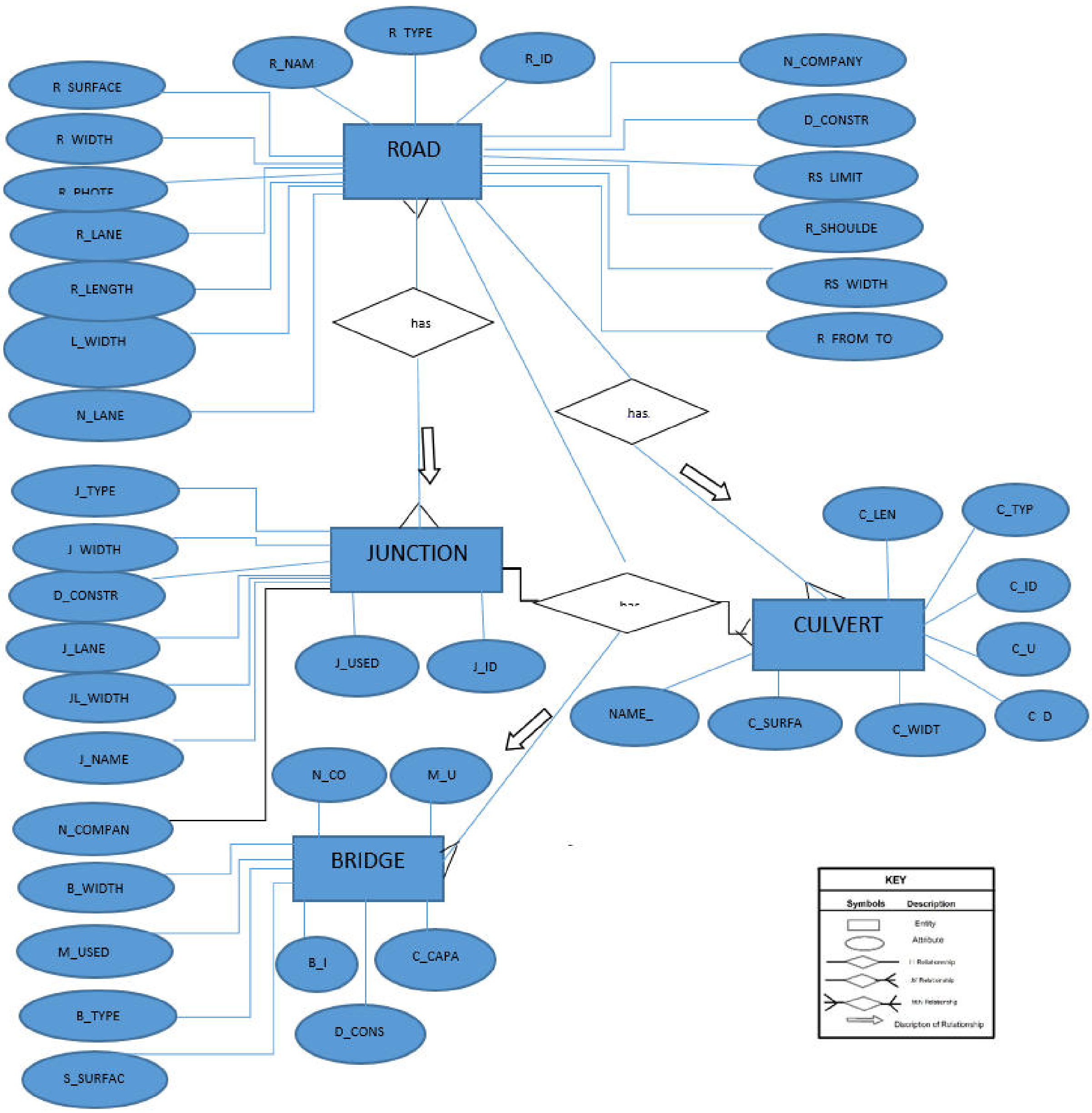
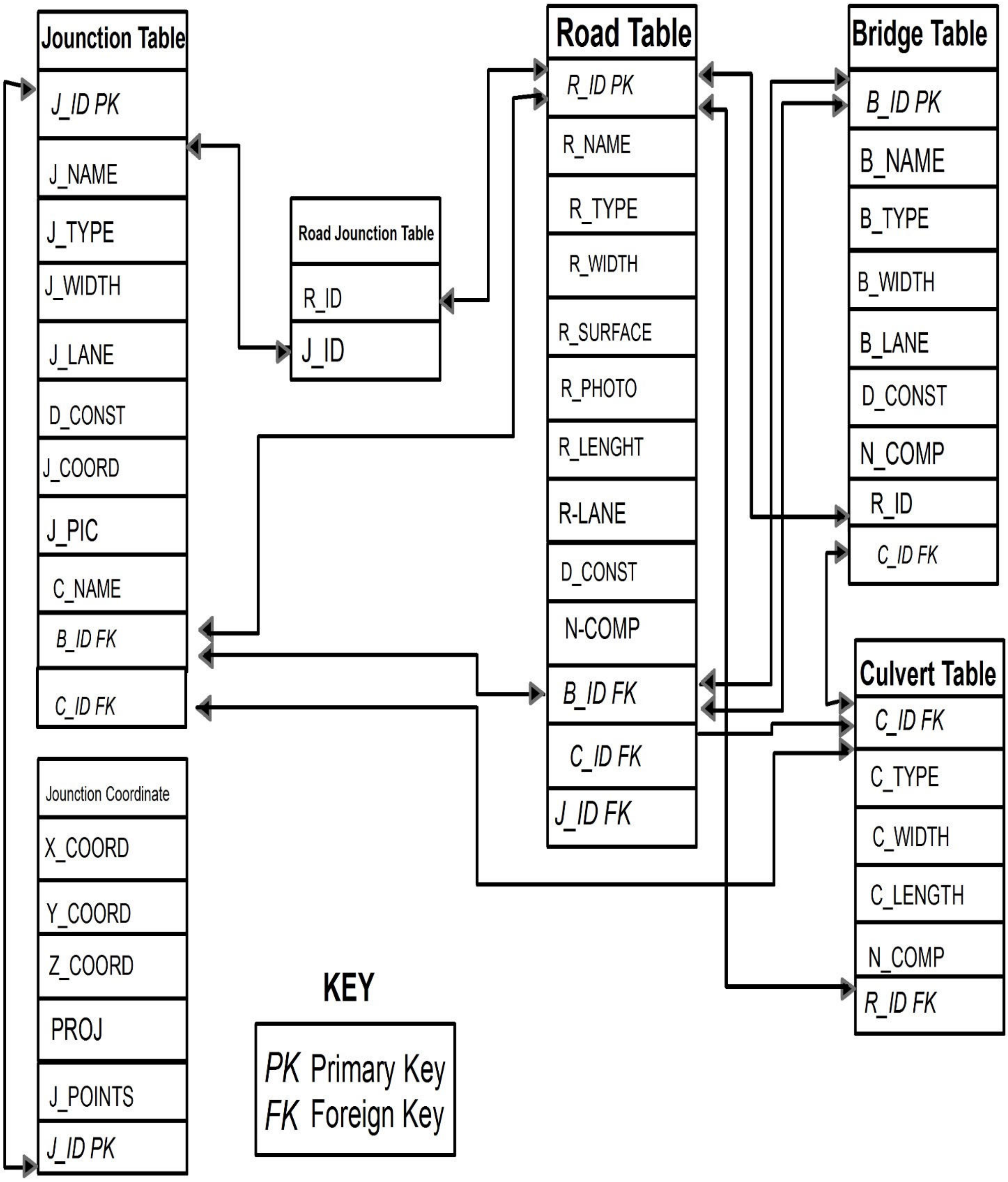


Figure 1.5 shows the proposed conceptual model of the geodatabase.
Source: Adopted and modified from the work of Lo, C.P., Albert, K.W., and Yeung, (2007).

Logical design, logical data modelling is the process by which the conceptual schema is consolidated, refined, and den converted to a system-specification logical schema (Lo, *et al,* 2007). It involved mapping the conceptual schema to the logical schema, identification of primary key, foreign key and normalising the attribute table as shown on Table 1.1.

Table 1.4 showing the proposed logical model of the Road Transport geodatabase



Physical design, the physical data modelling is concerned with defining specific storage structure and access paths to the database (Lo, C.P., Albert, K.W., and Yeung, 200)

Table 1.5 showing proposed characteristics of fields and attribute in the physical design of the Road Transport database. Created in ArcGIS environment.

Attributes	Field Name	Field Discription	Field Type	Domain	Fielf Length
		Road (feature class): Line feature type			
Road ID	R_ID	A unique Road Identification number of theRoad	Double	R_USE	10
Road Name	R_NAME	Full name of the Road	Text		25
Road Type	R_TYPE	Federal Road, State Road and L.G. Road	Text	R_TYPE	25
Road Width	R_WIDTH	Road Width (meter)	Numeric		12
Road Surface	R_SURFACE	Nature of the Road Surface (paved, unpaved),	Text		15
Road Photo	R_PHOTO	The Road Picture	Raster		<100kb
Road Length	R_LENGTH	The length of the Road	Numeric		10
Road Lane	R_LANE	Lane of the Road	Numeric		10
Lane Width	L_WIDTH	Width of the Road Lane	Numeric		10
Number of Lane	N_NAME	Number of Lane	Numeric		10
Road Shoulder	R_SHOULDER	Road Shoulder (yes or no)	Text		5
Road from - to	R_FROM_TO	Road Starting from and to	Text		20
Road Speed Limit	RS_LIMIT	The speed Limit of the each Road	Numeric		10
Date of Construction	D_CONSTRUCTION	Date of Road Construction	Date		Date
Name of Company	N_COMPANY	Name of the Company that Construct the Road	Text		30
Materials Used	M_USED	Materials used for the Road Construction	Text		30
Shoulder Width	S_WIDTH	Width of the Road Shoulder	Numeric		10
Subtype	SUBTYPE	Various road used type	Text		25
		Junctions (feature class): Point feature			
Junction ID	J_ID	A unique Identification number of Junction	Double		10
Junction Name	J_NAME	Full name of the Junction	Text		30
Junction Type	J_TYPE	(cycle, t-junction), others	Text	J_TYPE	30
Junction Width	J_WIDTH	Junction Width (meter)	Numeric		10
Date of Construction	D_CONSTRUC	Date of Construction	Date		Date
Number of Lane	N_LAME	Number of the Junction Lane	Numeric		Num
Lane Width	L_WIDTH	Width of the Junction Lane	Numeric		Num
Maretials Used	M_USED	Materials used for the junction construction	Text		Text
		Bridge (feature class): point feature			
Bridge ID	B_ID	A unique Identification Number of Bridge	Double		10
Bridge Width	B_WIDTH	The Bridge Width (meter)	Numeric		10
Carrage Capacity	C_CAPACITY	The carrage capacity of the Bridge	Numeric		10
Date of Construction	D_CONSRUCT	Date at which the Bridge was Constructed	Date		Date
Name of Company	N_COMPANY	The company that constructed the Bridge	Text		30
Material Used	M_USED	used for the Bridge	Text		30
Bridge Surface	B_SURFACE	The nature of Bridge surface	Text		20
Bridge Type	B_TYPE	The subtype of the Bridge	Text	B_TYPE	20
		Culvert (feature class): point feature			
Culvert ID	C_ID	A unique Identification Number of Culvert	Double		10
Culvert Width	C_WITH	The Culvert Width (meter)	Numeric		10
Culvert Type	C_TYPE	The subtype of the Culvert	Text	C_TYPE	20
Culvert Surface	C_SURFACE	The nature of Culvert surface	Text		20
Culvert Name	C_NAME	Name of the Culvert	Text		20
Culvert Use	C_USE	used for the Culvert	Text		30
Name of CC	NAME_CC	The company that constructed the Culvert	Text		30
Date of Construction	D_CONSTRUC	Date at which the Culvert was Constructed	Date		Date
		Jounction Coordinate (Feature class): Point feature type			
Coordinate ID	COORD_ID	A unique identification number of the coordinate	Double		20
XCoordinate	X_COORD	X Coodinate (Longitude) of the Jounction point	Float		20
YCoordinate	Y_COORD	Y Coodinate (Latitude) of the Jounction point	Float		20
ZCoordinate	Z_COORD	Z Coodinate (Hight) of the Jounction point	Float		20
Projection	PROJ	Coordinate system Projection (WGW_1984_UTM_Zone_32N)	Double		30

The GIS techniques were used in integrate the spatial and non-spatial data by linking the attribute data to created road layers so as to develop the GIS-based RTIMS.

Use the Geodatabase to analyse and queries road characteristics (Objective III).

This is achieve through the use Standard GIS functions tools such as (query, geocoding, selection by attributes and by location, identify tools, network analysis tool, Hyperlink tool, measurement tool etc.) will be to support data management, analysis and visualization needs.

Query tool: This tool applies an SQL query to a database and the results are represented in a layer or table view. It will be used for based services based on buffering and proximity analysis, shortest route, alternate route etc. based on network analysis during emergency situation like natural disaster, movement of civil authorities during election, shows kilometre sections of Adamawa Federal highway, State highway and local government road etc.

Identify tool: is used to identify the road system information like, picture showing the nature of the roads, type of the road, length, width etc.

Hyperlink tool: will be used to display a picture showing the nature of the road for proper management of the system once a road is click using the tool.

The Network Analyst toolbox: will be used to model transportation networks and perform route, and location-allocation network analyses on transportation networks. The tools will be used to perform an analysis on a transportation network.

RESULTS AND DISCUSSIONS

Research shows that about 70% of GIS task lies on editing and data compilation, starting from coordinate registration, mapping and geo-processing of spatial data, to attribute database development. The establishment of robust database is the cornerstone of every successful GIS, therefore, this chapter seeks to establish database manipulation for theme attributes, the information will however be used for query and analysis in the later part of this chapter. This chapter examines the objectives of the study by analysing the primary and secondary data collected. The primary data were collected using GPS and digital camera while the secondary data were collected using satellite imageries and road documents from the federal and state ministry of works and land and survey.

Mapping the existing road infrastructure in adamawa central. Figure 1.2 below shows the digitized up-to-date road transport map of Adamawa central at 1:800,000 scale which is updated from the Spot-5 image of 2012 and Google Earth images of 2013. The final output of the road map is printed in using AO scanner.

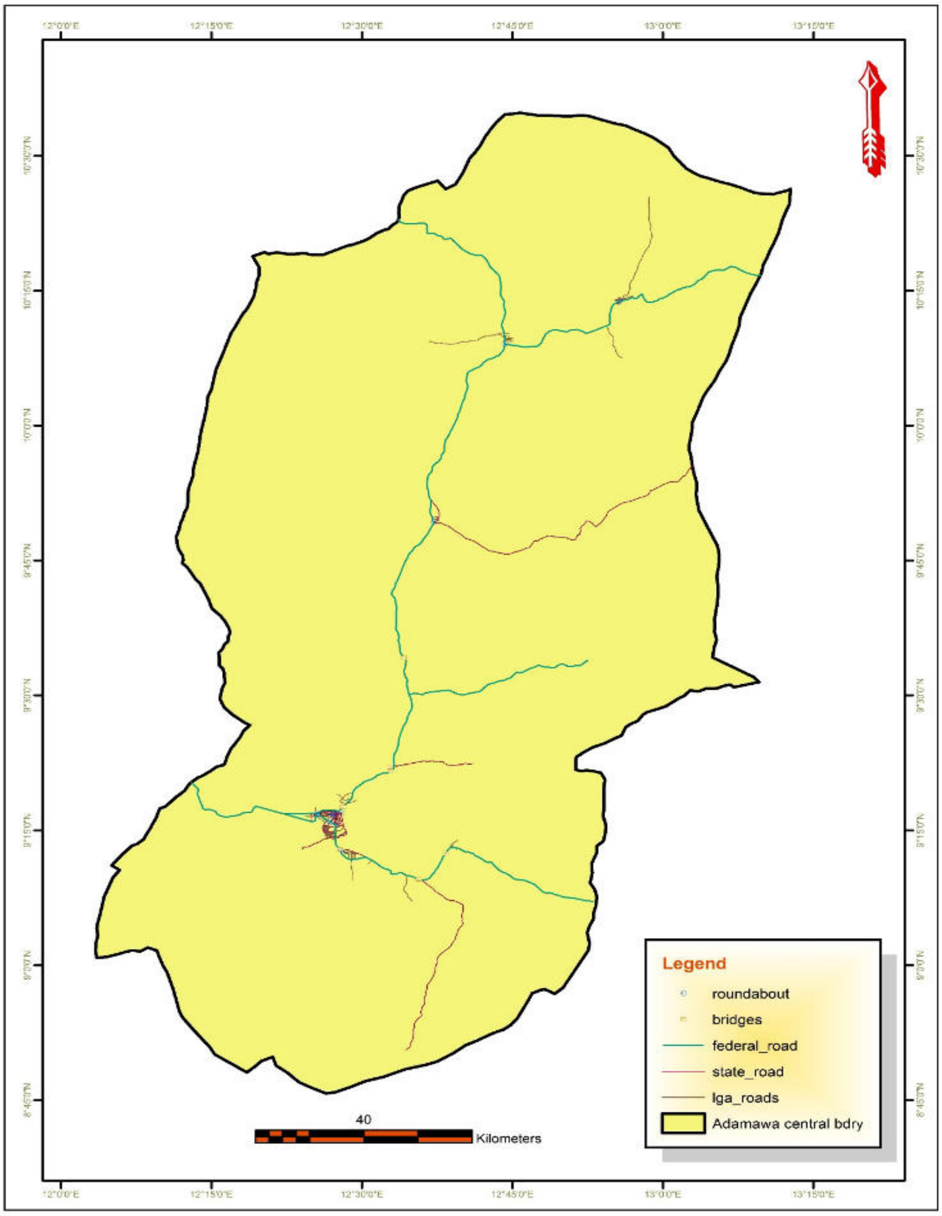


Figure 1.1 showing the up-to-date Road Transport map of Adamawa Central
Source: Author's analysis

Geodatabase of road infrastructures in Adamawa central. This involves all the design and building of

Database of road infrastructures in ArcCataloge environment in ArcGIS software. Table 1.5(a,b,c,d) below shows some of the database attribute information of road infrastructures with an attribute table; attribute of each theme interrelates with the themes once the theme is active as shown below in the table:

Table 5.1a showing some of the attributes of Adamawa central road transport geodatabase.

federal_road

FID	Shape *	OBJECTID	road_name	road_surfa	road_shoul	road_fron_	SHAPE_Len	Carage_cap	Road_type	surfacing
0	Polyline	2	Mubi bye pass	tired road	surface dress	mubi bye pass to gerei	0.632103	single	fed road	surface dres
1	Polyline	4	Dibra	tierd road	surface dress	dibra to gombi	0.144574	single	fed road	surface dres
2	Polyline	5	Gombi	tired road	surface dress	gombi roundabout to market	0.066054	single	fed road	surface dres
3	Polyline	6	Hong road	tired road	surface dress	gombi-hong to mararaba mubi	0.455246	single	fed road	surface dres
4	Polyline	7	Barkeje	tired road	surface dress	barkeje to song to Dibra	0.528117	single	fed road	surface dres
5	Polyline	8	Gombi	tired road	surface dress	gombi to garkida junction	0.352031	single	fed road	surface dres
6	Polyline	9	Abdulahi Bashir road	tired road	surface dress	police roundabout to yola town	0.04988	dual	fed road	surface dres
7	Polyline	11	Jambutu road	tired road	surface dress	roundabout mai doki to jambutu	0.004654	dual	fed road	surface dres
8	Polyline	12	Galadima Aminu road	tired road	surface dress	police roundabout to roundabout mai doki	0.03786	dual	fed road	surface dres
9	Polyline	13	Numan road	tired road	surface dress	mai doko roundabout to numan	0.065962	dual	fed road	surface dres
10	Polyline	15	Fufore road	tired road	surace dress	fufore to ribadu	0.075325	single	fed road	surface dres
11	Polyline	16	Ribadu road	tired	surface dress	ribadu to gurin	0.191212	single	fed road	surface dres
12	Polyline	17	Yola south	tired	surface dress	roundabout mai korya to fufore	0.240933	duai, single	fed road	surface dres
13	Polyline	18	Sorau road	tired road	surface dress	jeberu to sorau	0.323592	single	fed road	surface dres

Source: Author's Analysis

Table 1.5b showing some of the attributes of Adamawa central road transport geodatabase.

state_road

FID	Shape *	OBJECTID	name_of_ro	road_from_	r_type	road_surfa	road_lan	road_shoul	type_of_ma	remark	SHAPE
0	Polyline	1	Mubi byepass	mubi byepass to roundabout mai doki	state road	tired road	3	surface dress	not plan	good	0.00
1	Polyline	2	Mohammadu mustafa road	Galadima junction to noma da kiwo roundabout	state road	tired road	6	surface dress	not plan	good	0.03
2	Polyline	3	kashim Ibrahim way	moh mustafa rd to Abdullahi bashir road	state road	tired road	3	surface dress	not plan	good	0.06
3	Polyline	4	Ahmadu Bello road	moh mustaf junction to Ahmodu b way	state road	tired road	3	surface dress	not plan	good	0.02
4	Polyline	5	Mubi road	mubi roundabout to mubi byepass	state road	tired road	6	surface dress	not plan	good	0.00
5	Polyline	6	Mubi road1	mubi road continue	state road	tired road	3	surface dress	not plan	good	0.02
6	Polyline	7	Justice Buba Ardo road	police roundabout to KI WAY	state road	tired road	6	surface dress	not plan	good	0.01
7	Polyline	8	Jabali road	yola south to jabali	state road	tired road	3	surface dress	not plan	fair	0.39
8	Polyline	9	Toruwa Bolowa road	Abdulahi road to TB road	state road	tired road	3	surface dress	not plan	good	0.02
9	Polyline	10	Waziri road	Abdulahi road towaziri road	state road	tired road	3	surface dress	not plan	good	0.02
10	Polyline	11	Galadima Aminu way	Bekaji roundabout Galadima Away	state road	tired road	3	surface dress	not plan	good	0.0
11	Polyline	13	Modibo Adama way	mai koyya roundabout to MA way	state road	tired road	3	surface dress	not plan	good	0.04
12	Polyline	15	Barrack road	Abdulahi bashir road	state road	tired road	3	surface dress	not plan	good	0.0
13	Polyline	16	Nepa road	Ahmadu Bello way	state road	tired road	3	surface dress	not plan	good	0.02
14	Polyline	17	Jambutu street	jambutu street	state road	tired road	2	surface dress	not plan	fair	0.00
15	Polyline	18	Sarkin wuta street	sarkin wuta	state road	tired road	2	surface dress	not plan	good	0.00
16	Polyline	19	Guwa road	Guma road to	state road	tired road	2	surface dress	not plan	fair	0.01
17	Polyline	20	Gimba road	Hospital road	state road	tired road	2	surface dress	not plan	fair	0.01
18	Polyline	22	Bekaji road	Galadima aminu wat	state road	tired road	2	surface dresse	not plan	fair	0.00
19	Polyline	23	Jambutu street extention	mubi byepass	state road	tired road	2	surface dress	not plan	fair	0.01
20	Polyline	24	Bole street	moh mustafa road	state road	tired road	2	surface dress	not plan	fair	0.01
21	Polyline	28	Demsawo street	moh mustafa road	state road	tired road	2	surface dress	not plan	fair	0.01
22	Polyline	29	pariya road	Gerei to pariya	state road	tired road	2	surface dress	not plan	bad	0.13
23	Polyline	31	zumo	song to zumo	state road	tired road	2	surface dress	not plan	fair and bad	0.41
24	Polyline	33	Homa road	zumo to masagala to sorau	state road	untired	2	earth road/foot	not plan	bad	0.12
25	Polyline	34	song town road	song town to gombi road	state road	tired road	2	surfacedress	not plan	fair	0.05

Source: Author's Analysis

Table 1.5c showing some of the attributes of Adamawa central road transport geodatabase.

Table

lga_roads

FID	Shape	OBJE	name_of_	r_type	road_surf	surfacing_	c_capacity	number_o	road_sh	speed_lim	maite	SHAPE_Le	road_wid	shldr_wid	trfic_ligt	remarks	1
1	Polyline	2	Gurin road	lga road	not tire	surfaca dres	single	2	not	0		0.017466	0	1.5	no	poor	n
5	Polyline	12	Sebore roa	lga road	tired road	surfaca dres	single	2	dress	0		0.056287	0	1.5	no	fair	n
7	Polyline	16	Lamido Ad	lga road	tired toad	surfaca dres	single	2	dress	0		0.026882	6.3	1.5	no	fair	n
8	Polyline	17	Lamido roa	lga road	not tire	surfaca dres	single	2	dress	0		0.01869	6.3	1.5	no	fair	n
9	Polyline	18	Lamido mai	lga road	tired road	surfaca dres	single	2	dress	0		0.010361	6.3	1.5	no	fair	n
10	Polyline	19	Lamido La	lga road	tired road	surfaca dres	single	2	dress	0		0.009663	6.3	1.5	no	fair	n
11	Polyline	20	Sokoto stre	lga road	tired road	surfaca dres	single	2	dress	0		0.009684	6.3	1.5	no	fair	n
12	Polyline	21	nill	lga road	tiredroad	surfaca dres	single	2	dress	0		0.009265	6.3	1.5	no	fair	n
13	Polyline	23	Shehu stre	lga road	tired road	surfaca dres	single	2	dress	0		0.005189	6.3	1.5	no	fair	n
14	Polyline	24	nill	lga road	tired road	surfaca dres	single	2	dress	0		0.004578	6.3	1.5	no	fair	n
15	Polyline	25	sokoto stre	lga road	tired road	surfaca dres	single	2	dress	0		0.003078	6.3	1.5	no	fair	n
16	Polyline	45	shehu sree	lga road	tired road	surfaca dres	single	2	dress	0		0.00545	6.3	1.5	no	fair	n
18	Polyline	71	nill	lga road	tired road	surfaca dres	single	2	dress	0		0.018891	6.3	1.5	no	fair	n
19	Polyline	72	Dampa stre	lga road	tired road	surfaca dres	single	2	not	0		0.009996	6.3	1.5	no	fair	n
20	Polyline	73	Bishop stre	lga road	tired road	surfaca dres	single	2	not	0		0.016343	6.3	1.5	no	fair	n
21	Polyline	74	nill	lga road	tired road	surfaca dres	single	2	not	0		0.01243	6.3	0	no	fair	n
22	Polyline	75	Madaci roa	lga road	tired road	Bituminous su	single	2	not	0		0.02314	6	0	no	fair	n
23	Polyline	76	Jereng roa	lga road	tired road	Bituminous su	single	2	not	0		0.012297	6	0	no	fair	n
24	Polyline	77	Gassa roa	lga road	tired road	Bituminous su	single	2	not	0		0.01055	6	0	no	fair	n
25	Polyline	78	Kashim roa	lga road	tired road	Bituminous su	single	2	not	0		0.008726	6	0	no	fair	n
26	Polyline	79	nill	lga road	tired road	Bituminous su	single	2	not	0		0.007039	6	0	no	fair	n
27	Polyline	80	nill	lga road	tired road	Bituminous su	single	2	not	0		0.005051	6	0	no	fair	n
28	Polyline	81	Ngorere ro	lga road	tired road	Bituminous su	single	2	not	0		0.005146	6	0	no	fair	n
29	Polyline	82	Bangiram r	lga road	tired road	Bituminous su	single	2	not	0		0.006913	6	0	no	fair	n
30	Polyline	83	Lankaviri ro	lga road	tired road	Bituminous su	single	2	not	0		0.00963	6	0	no	fair	n
31	Polyline	84	Garba Che	lga road	tired road	Bituminous su	single	2	not	0		0.006682	6	0	no	fair	n
32	Polyline	85	Hong road	lga road	tired road	Bituminous su	single	2	not	0		0.010891	6	0	no	fair	n
33	Polyline	86	Pella road	lga road	tired road	surfaca dres	single	2	not	0		0.010036	6	0	no	fair	n
34	Polyline	87	Billa road	lga road	tired road	surfaca dres	single	2	not	0		0.003442	6	0	no	fair	n
35	Polyline	88	nill	lga road	tired road	surfaca dres	single	2	dress	0		0.012398	6	1.5	no	fair	n
36	Polyline	89	nill	lga road	tired road	surfaca dres	single	2	dress	0		0.006462	6	0	no	fair	n
37	Polyline	94	Tafawa Bal	lga road	tired road	Bituminous su	single	2	dress	0		0.011959	6	1.5	no	fair	n
49	Polyline	107	Guyuk road	lga road	tired road	Bituminous su	single	2	dress	0		0.015291	0	0	no	fair	n
63	Polyline	129	Guna road	lga road	tire road	Bituminous su	single	2	dress	0		0.003925	0	1.5	no	bad	n
64	Polyline	130	Demsa roa	lga road	tired road	Bituminous su	single	2	dress	0		0.002585	0	0	no	fair	n
65	Polyline	132	Bank road	lga road	tired road	surfaca dres	single	2	dress	0		0.007079	6	0	no	fair	n

Source: Author's Analysis

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Table 1.5c showing some of the attributes of Adamawa central roundabout geodatabase.

Table

roundabout

FID	Shape *	LATITIDE	LONGITUDE	latDD	lonDD	NAME_OF_RO	NAME_OF_LG	R_SUFACING	DATE_CONST	REMARKS	NAI
0	Point	9°12'43.8"	12°28'27.06"	9.212167	12.474183	Maikorya roubdabout	Yola south	surface dressed	<Null>	good	nill
1	Point	9°15'31.68"	12°27'23.22"	9.258778	12.45645	Police roundabout	Jimeta	surface dressed	<Null>	good	nill
2	Point	9°15'56.34"	12°26'49.38"	9.265639	12.44705	Bekaji roundabout	Jimeta	surface dressed	<Null>	good	nill
3	Point	9°16'39.72"	12°25'28.2"	9.277694	12.4245	Mai Doki roundabout	Jimeta	surface dressed	<Null>	good	nill
4	Point	9°16'54.48"	12°25'35.64"	9.281778	12.426567	Janbutu y-junction	Jimeta	Bituminous surfacing	26/05/2013	under construction	CW
5	Point	9°16'55.56"	12°27'56.88"	9.282083	12.4658	Noma da Kiwa roundabout	Jimeta	surface dressed	<Null>	good	nill
6	Point	9°16'44"	12°27'1"	9.278889	12.450278	Mubi roundabout	Jimeta	surface dressed	<Null>	good	nill
7	Point	9°16'31"	12°26'53"	9.275278	12.448056	Hospital roundabout	Jimeta	surface dressed	<Null>	require construction	nill
8	Point	9°16'43"	12°27'15"	9.278611	12.454167	Ibadan roundabout	Jimeta	Bituminous surfacing	26/05/2013	under construction	CW
9	Point	9°49'16.08"	12°37'10.56"	9.821111	12.6196	Song roundabout	Song	surface dressed	<Null>	fair	nill
10	Point	10°9'3"N	12°44'13.08"E	10.144	12.741	Gombi y-junction	Gombi	surface dressed	<Null>	fair	nill
11	Point	10°13'50.1"N	12°55'40.26"E	10.147	12.738	Hong y-junction	Hong	surface dressed	<Null>	require reconstruction	nill

bridges

FID	Shape *	OBJECTID	bridge_nam	bridge_wid	carrage_ca	date_of_re	name_of_co	bridge_sur	type_of_br	lga_name	c_capacity	remark	long
0	Point	0	Yola south	14	14	00:00:00		surface dress	iron bridge	Yola south	dual	require re	
1	Point	0	Babandi bridge	7	7	00:00:00		surface dress	iron bridge	Fufore	single	good	
2	Point	0	Gere bridge	7	7	00:00:00		surface dress	concreate bridg	Fofure	single	good	
3	Point	0	Jimeta bridge	14	14	00:00:00		surface dress	iron bridge	Jimeta	dual	good	
4	Point	0	Geride bridge 1	7	7	00:00:00		surface dress	iron bridge	Gerei	single	good	
5	Point	0	Geride bridge 2	7	7	00:00:00		surface dress	iron bridge	Gerei	single	under con	
6	Point	0	Gerei to song br	7	7	00:00:00		surface dress	iron bridge	Gerei-song	single	good	

Source: Author's Analysis

Using the Geodatabase to analyse and queries road characteristics. Since a comprehensive geodatabase is developed, it becomes easier to make decision as regards managing the road transport infrastructure in map. In this regard, the QUERY TOOLS, IDENTIFY TOOL, HYPERLINK TOOL, LOCATION ADDRESS TOOLS and FIND TOOLS, were used for the analysis.

This analysis seems to answer the following questions:

- How do I locate a roads, roundabout and bridges?
- How do I assess the quality of a road, roundabout and bridge in respect of their surfaces and remarks?
- How do I know roads that are single or dual carriage?
- How get informatio the roads surface that are not tired.
- How do I know the nearest roads that is 150m from a roundabout?
- How do I identify information on a particular road, bridge and junctions?
- Measurement of a road distances? Etc.

Analysis on the above questions, were carried out.

Analysis 1: locating of roads, roundabout and bridges address using SELECTION TOOL?

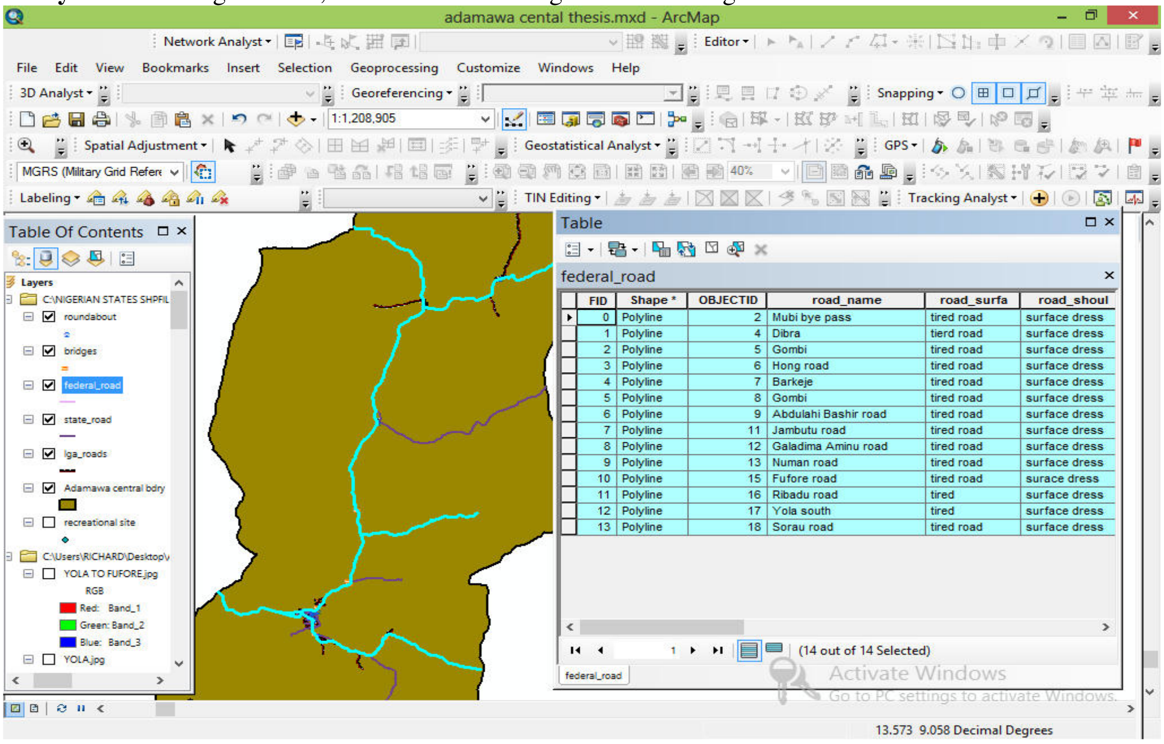

Figure 1.2. *showing all the federal roads in Adamawa central.*
Source: Author's analysis

Discussion of Results: The lines beryl green colour on map in the figure automatically found the location and attribute of the federal roads in the Adamawa central. Same processes can be used for the state and local government roads in order to know the extent of road for developments.

ANALYSIS 2. Showing the road surfaces that are not tired.

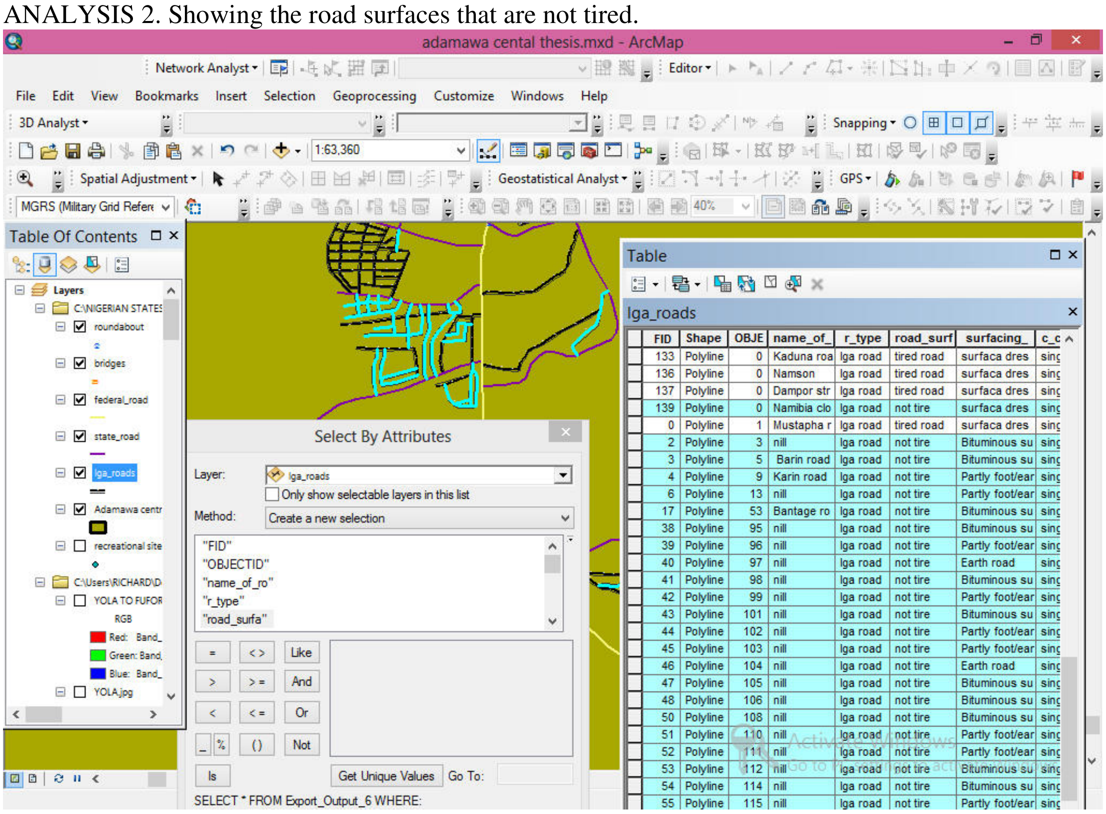

Figure 1.3. *Showing the roads surface that are not tired.*
Source: Author's analysis

Discussion of Results: By using the QUERY TOOL, the road surfaces that are not tired highlighted beryl green colour on the map and on the geodatabase table, while those that are tired are black and ultramarine colour on map and white colour on the geodatabase table. This analysis was carried out to provide necessary information on road surfaces that are not yet tired before allocating a contracts and for proper road transport information managements.

ANALYSIS 3. Identify information on a particular road, bridge and junctions using IDENTIFY TOOL.

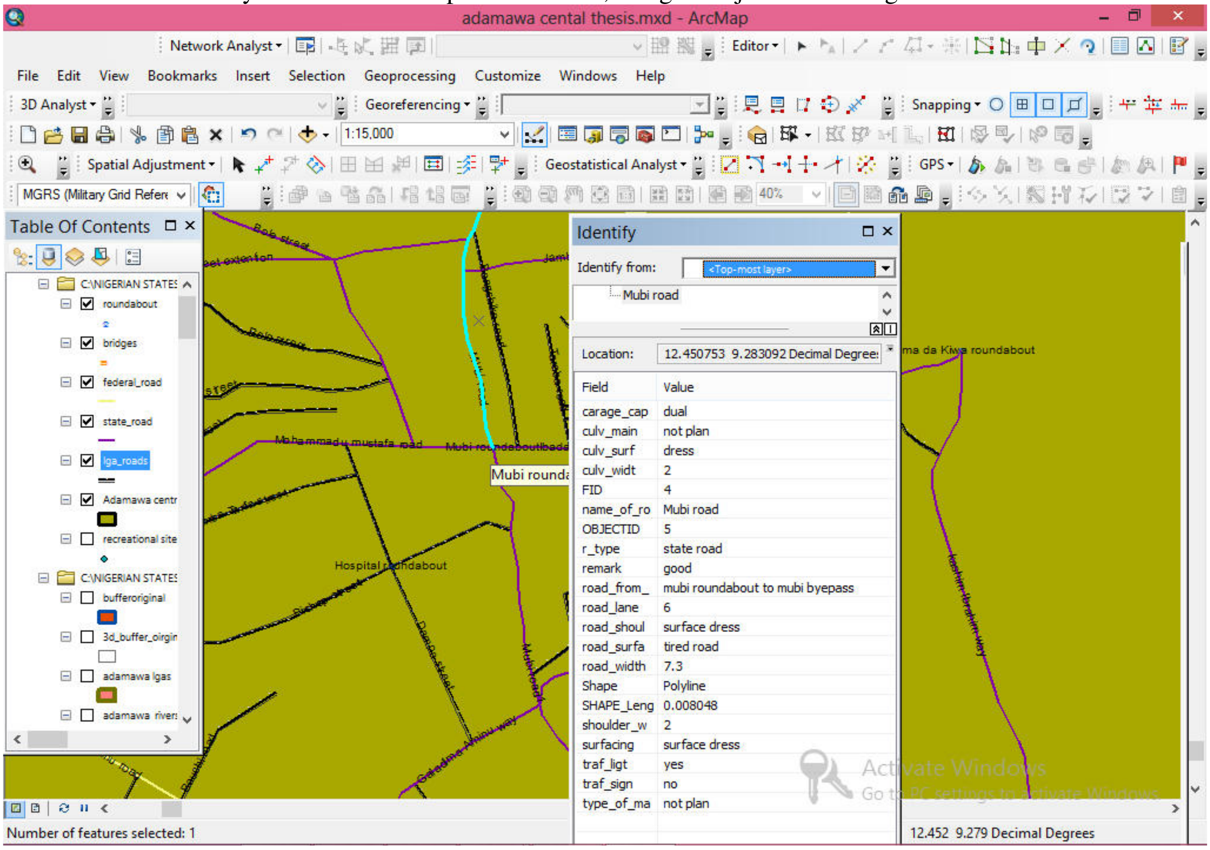

Figure 1.4. *Showing information about a particular road (Mubi road).*
Source: Author's analysis

Discussion of Results: As showing from figure 4.4.9 above, IDENTIFY TOOL was used in order to identify information's on Mubi road and the beryl green line on the map is the Mubi road while the geodatabase table beside it is the information about the road. This analysis will give information on how to manage and develop the road. The same analysis can be applicable to bridges and roundabouts.

ANALYSIS 4. Measure a road distances using MEASUREMENT TOOL.

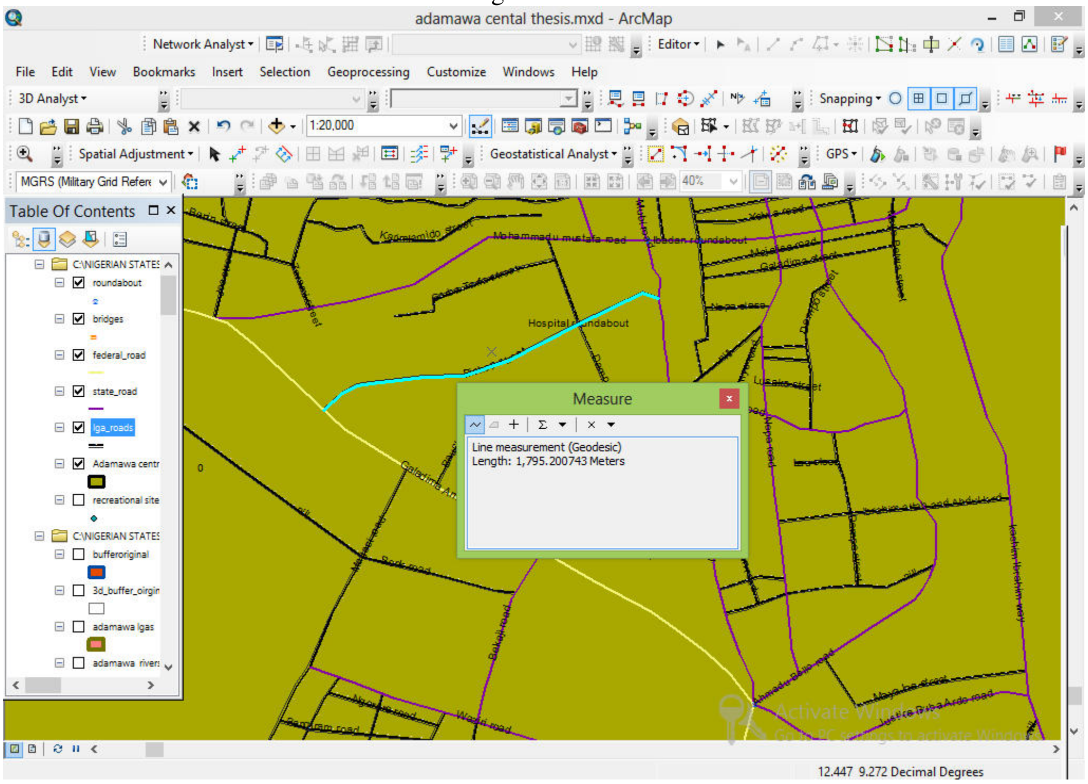

Figure 1.5. *Showing the length of a Bishop road.*
Source: Author's analysis

Discussion of Results: from the figure 1.5 above, measurement tool was to measure the Bishop road and this analysis shows the distance of the road which is about 1,795.200743 meters. This give measurement information on the road without going to the field for surveying in terms of development and allocation of found for the road infrastructure management when developing the road.

ANALYSIS 5. Selecting roads that are single or dual carriage?

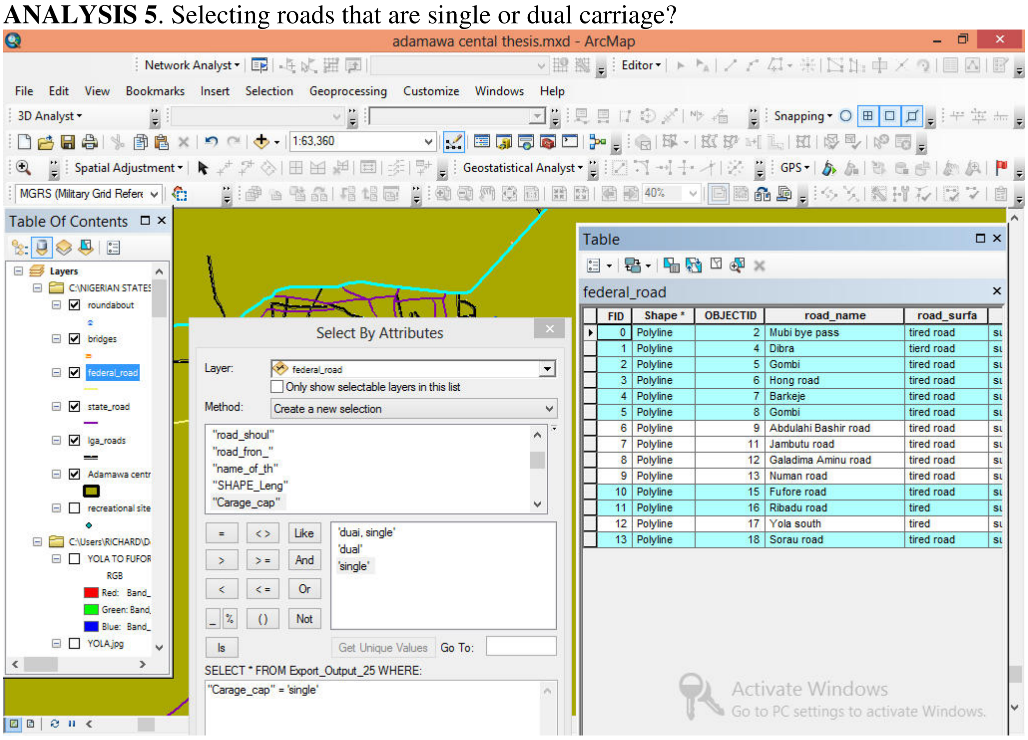

Figure 1.6 *Showing the federal roads that are single and dual carriage capacity.*
Source: Author's analysis

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Discussion of Results: The beryl green colour line on the map and geodatabase table in figure 4.4.7 showing the federal roads that has single carriage capacity, this query can help the road transport authorities, managers and decisions maker in terms of development in order to expand the road to dual carriage and the geodatabase table can help in showing the information and the number of federal roads that need to be expanded. The same analysis can be applicable to state and federal roads transports as the case may be. From the geodatabase table, the attribute in white colour is showing the dual carriage roads.

ANALYSIS 6: Finding the nearest roads that is 150m from a roundabout using BUFFERING

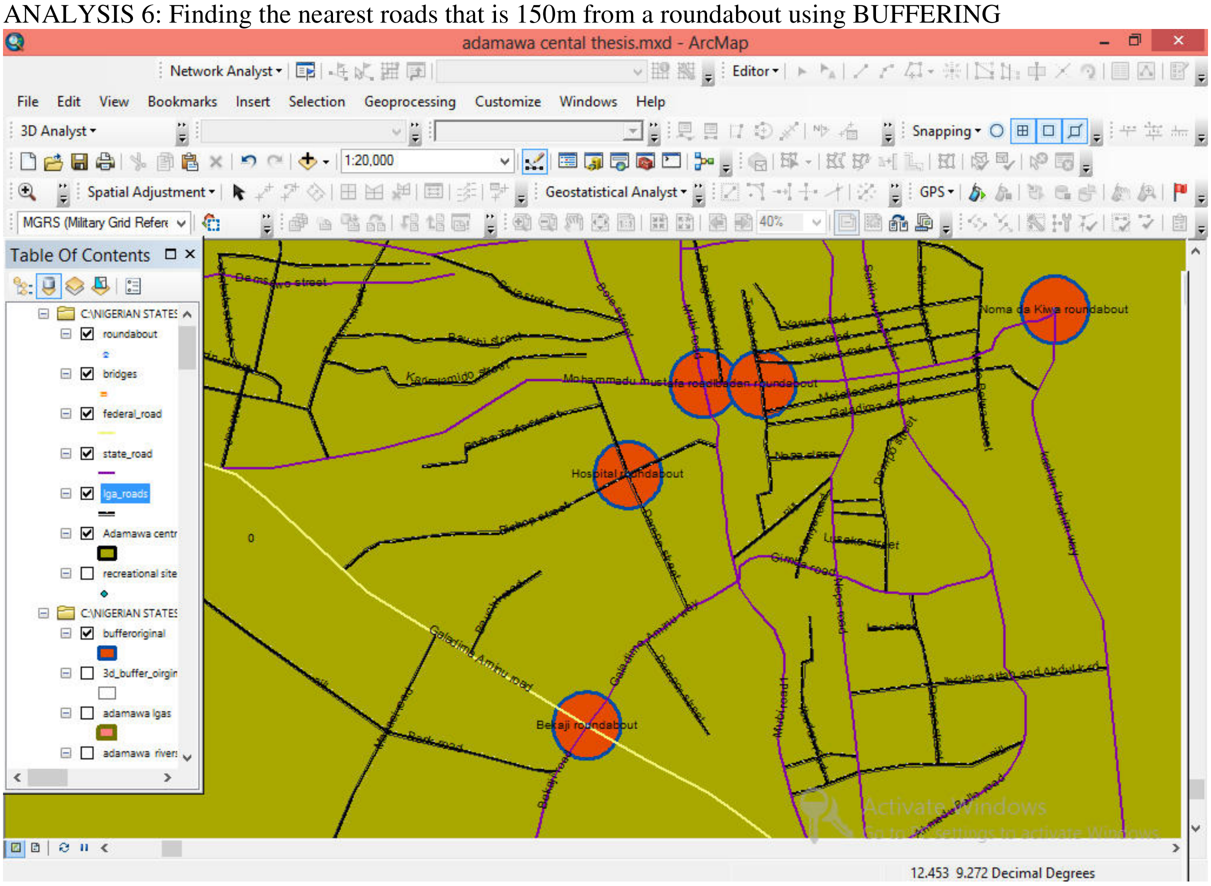

Figure 1.7 *Showing the area that fall within a radius of 150m around roundabout.*
Source: Author's analysis

Discussion of Results: By using the BUFFER TOOL, in the first figure, the roundabout that was highlighted red was the one selected for the analysis. The analysis was carried out to show how powerful GIS is in selecting features that are within a specific range for any decision pertaining road infrastructure development and management. This analysis was carried out to provide necessary information on the nearest roads and building around the roundabout within a distance of 150m which will help road transport planner with management information to know the various houses that will be affected within the 150 radius when allocating a contracts on expanding the roundabout for proper development and management.

SUMMARY

GIS could provide a mechanism for data integration, management and output generation in its spatial environment. In this study, federal roads, state roads, local government roads, bridges and roundabout depicting the availability, distribution and extent or abundant of physical features in the Adamawa central were derived using GIS technology, various maps, design and layer designed for the Adamawa central provide valuable records (information) for the assessment, management, monitoring and development of the physical features on the map. To start with, it can be used for making queries on the Geodatabase in a series of what lies here or there is this mode. A logical query has been translated into a series of what lies here and/or what lies there. The results received descriptive and analytical answers which are for road planners, managers and decision-making because the types of inference, deduction and conclusion made is left entirely with the road transport authorities. Since the geodatabase has not been officially implemented in the state planning board, it is difficult to ascertain the likely problem that may arise during the implementation.

Within this gedatabase, it is possible to compare themes without overcrowding screen with too much

information. For instance, the roundabout themes would be compared with the road themes and a simple result would be given unlike the present analogue system in use where for each theme, there is a separate map sheet, and the map sheets are not on the same scale. The identifier tool; in the GIS allows the attribute data for any spatial data to be displayed on the screen immediately the spatial data is clicked with the mouse.
With the use of find tool, the roads of any type could be located by nearly typing the road name. The GIS finds the road bringing it to the centre of the screen and changing its colours so that it appears different from the rest. The geodatabase could be queried and the query result displayed on the screen. Thus, if federal and state road of the Adamawa central were selected, then only the federal and state roads would be displayed. The Measurement tool lets you measure lines on the map. You can use the measurement tool to draw a line or polygon on the map and get its length or area, or you can click directly on a feature and get measurement information about it.

Database is an important way of organizing large amount of information. Computers are very power tool which facilitate decision-making process. Development of GIS-Based Road Transport Information Management System requires information on geo-physical features around specific areas. The most pressing problem faced by the road transport managers and authorities is the lack of reliable geodatabase informations, lack of funds, and insufficient qualified staff to process whatever information is available (Yonzon et al, 1991). For effective planning, management and development of road infrastructures, Geodatabase are required for analysis and updating spatial information quickly and efficiently.

CONCLUSION

Development of GIS-Based Road Information Management system could be viewed as integrated computer software and hardware package, in spatial context, using Geographical Information System (GIS) and Road Transport Information System (RTIMS), its functionality on geodatabase development and management, its analytical modelling, mapping and spatial tabular display together with a framework for the decision-makers and expert, it has certain characteristics (listed below) which differentiate it from any other software system.

a. It is designed to solve ill-structured or semi-structured problem i.e. where objectives, Geo-Spatial analysis cannot be fully defined or modelled.
b. It provides an interface, which is powerful and easy to use.
c. It enables the user (road managers, planners and decision-maker) to combine models and data into a flexible manner.
d. It helps the user and (road managers, planners and decision-maker) to explore the solution space (the various problems) by using the models in the system to generate series and feasible solution for decision-making.
e. It provides an interactive recursive problems solving environment (process) in which users (road managers, planners and decision-maker) proceed by multi proposed and also making use of his experience, knowledge and intuition.

The research has tried to show that the process of converting the traditional database system to a Geographical Information System (GIS) does not require the hi-tech knowledge and equipment common in science fictions and movies, but what is required in the planning will and commitment.

RECOMMENDATION

a. The government should establish GIS unit in the federal and state ministry of transports board and also encourage the local government areas to do the same for proper planning and development of road transport infrastructure and management for easy management and control of its facilities.
b. The government should encourage its ministries and other parastatals to use GIS for its decision-making tool because the system provides easy and flexible way of handling Geodatabase.
c. With the increase in population, there is the need to improve on the present way of planning and managements to a new digital format which is based on the use of GIS and remote sensing.
d. There is the need for a research like this to be carried out on areas such as pavement information system, roads accident information system, etc. for proper and adequate development of their Geodatabase for quick decision-making in the areas mentioned.
e. Development of a national Geo-spatial data clearing board in the federal, state and local government levels of the country.

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