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# IMPLEMENTING GIS-T THROUGH ROAD NETWORK MAPPING: A CASE STUDY OF THE FEDERAL POLYTECHNIC IDAH, KOGI STATE NIGERIA.

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## ABSTRACT

This study made use of the integration of Remote sensing imagery, GPS and ArcGIS 10.1. The Road network of the developed portion of the federal polytechnic was mapped. Road junctions were referred to as Nodes while the roads as lines were called Arcs. Simple descriptive analysis was used to describe the road conditions, pavement and types of the road network in the study. The Road Density was computed with respect to the length and found to be low. The connectivity was determined using Beta Index (B I) and found to be a little above average. In terms of road conditions, the study revealed that6365.97m.was major and 2225.31m was dualized.

**Key Words**: Imagery, Arc, Nodes, Beta Index, Density.

## Introduction

Many development projects seriously dependon transport network because transportation is the factor determining the speed of growth and development of a place which can occur through roads, rails, airways, waterways, pipelines, etc. (Vinod et al., 2003). Whatever the purpose of journey, mode of transport,available route to take, type of vehicle are some of the factors to be considered. Accurate information on the transport infrastructure is the fundamental requirement for many decision making processes; therefore information is required to be reliable, updated, relevant, easily accessible and affordable (Fiatornu, 2006). Transportation is a requirement for every nation, regardless of its industrial capacity, population size or technological development. Moving of goods and people from one place to another is critical to maintaining strong economic and political ties between regions in the same state; roads came into being to facilitate the movement of wheeled vehicles which in turn, fostered the development of regions. However, the National Transport Policy for Nigeria (2003) states that the road is the primary right of way to accommodate and ensure the safety of all modes - bus transit, automobile, walking and cycling hence, priority must be given to the maintenance and improvement of roadways, sidewalks and arterial roads. The survey also shows that the state of Nigerian roads remains poor for a number of reasons such as faulty designs, lack of drainage and very thin coatings that were easily washed away, excessive use of the road network given the under-developed nature of waterways and railways among others. The most important role of both government and individual citizen is to find a solution for managing existing roads even before new ones are constructed but managing modern roadways is a complex business especially at this time when economic growth has come close to a halt in Nigeria. Thus, the creation, updating, maintenance and general management of road information and network in terms of spatial and non-spatial data are needed but the voluminous nature of data involved for proper record keeping is indeed cumbersome, and cannot effectively be handled by a traditional system of record keeping. The analogue system remain inflexible resulting in data storage in fixed forms and formats; however, the system becomes less useful for many purposes and is rarely updated because of the costs implication. The maps are easily displaced or destroyed because many different people at different locations use them. An alternative approach to maintaining a coherent database for roads in a scientific and efficient manner is therefore required and consequently, geographic information systems (GIS) will be advantageous. Hence, there will be improvements in planning, implementation and operation of the road sector through provision of timely, reliable, sufficiently and accurately detailed data which will facilitate the decision making activities. Uluocha (1998) notes that if the noble objective of mapping for proper utility design and maintenance is to be satisfactorily achieved, the more sophisticated computer-based Automated Mapping/Facility Management (AM\FM) or a Geographic Information System (GIS) must be embraced. According to Miller and Shaw (2001), Geographic Information System for transportation (GIS-T) can play a central role in the new environment for public land-use and transportation decision-making by allowing a wide-range of information to be integrated based on the location and fostering (but certainly not securing) a holistic perspective on complex land-use and transportation problems. Miller and Shaw (2001) explain further that GIS-T allows analytical and computational tools to be used in conjunction with detailed representations of the local geography, allowing analysis and problem-solving to be tailored to the local context. GIS-T can also greatly reduce the gulf between analysis and n communication, allowing greater public input into analytical decisions such as the choice of data, modelling assumptions and scenario development. This study therefore assessed the road types, conditions; and also measures the road density and road connectivity level in the study area with optimal use of GIS. The reason being that proper network mapping of a region can efficiently reduce traffic congestion and/ or bottlenecks, create easy access to places that are far and near, reduce transportation time and increase accessibility of industries to their targeted customers. In addition, proper analysis and mapping of road network cannot be underestimated because this serves as a key to economic development in terms of per-capita income and expenditure of the community.

**Aim and Objectives.**

The aim of this study was to create a comprehensive Road Network Mapping of the Federal polytechnic Idah to assist in transportation planning and the objectives included the following:

1 Establishment of ground control points and collection of the coordinate values of those points.

2 Collection of the imagery of the federal polytechnic using Google Earth PRO.

3 Georeferencing of the imagery using the established ground control points.

4 Digitizing of the imagery and creation of geodatabase and feature classes as appropriate using arc GIS 10.1 software

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**Materials and Methods.**

**Study Area.**

The federal polytechnic, Idah, formerly College of Technology, is a federal government owned tertiary education institution that was established in 1977 in Idah, kogi state (Obahopo, 2014 &Abah, 2015). It is approved by the National Board for Technical Education and it also offers National Diploma and Higher National Diploma courses at undergraduate levels with the aim of training competitive manpower for development.

**Methodology.**

The imagery was downloaded from Google Earth PRO of 2016. This was georeferened using GPS coordinated points and had a residual error of 0.02m using ten (10) points. It was further rectified and projected.

The image was exported into ArcGIS 10.1 software and a geodatabase was created as Road Network Mapping. Under this, other feature classes' namely major roads, dualized untarred road, dual carriage way, untarred road, foot paths, frame work and prominent buildings were created.

The on - screen digitizing method was adopted for each feature class and coordinates of points were generated as the cursor was used in tracing over the features. The database of each of the digitized feature was automatically generated and saved in the system.

To make the database answerable to queries, all the individually generated databases for each road feature class were merged as one comprehensive database named Road Database.

Lastly cartographic embellishment such as using of appropriate symbols, insertion of scale, north direction etc. was done.

**Results**

The database generated is amenable to queries and to every query raised, a corresponding answer was generated. A query for any particular road (ShaibuMailafiya) showed the road highlighted with all its attributes. A query for all the major roads within the campus showed such, while a query for untarred roads showed as required. Similarly a query for foot paths also showed. A query for roads within a certain range of length (i.e. above 200m) showed the roads as 48 out of 155 roads. Further this Road database was processed in MS Excel software and the following lengths were generated:

**Description of the Current State of the Roads in the Study Area, Types and Condition of Road Networks**

Total length of all Roads = 29113.53m.
Length of all Major Roads = 6365.97m.
Length of Untarred Roads = 5591.56m.
Length of Dual carriage way = 1649.91m.
Length of Dualized Untarred Roads = 575.40m

The area was calculated in meters and converted to kilometres. The total length of roads calculated in meters was also converted to kilometres. The road density was determined and this is defined as the road length per unit area. The formula used to calculate this is (Eq. (1)):

Road density = Total Road Length (RL)/Area. (1)

The road density explains how dense the road network is in the study area. The road density is compared with the standard road density specified in Odaga and Heneveld (1995) which states that road density is high when it is more than 120 m per square kilometres, medium when it is more than 30 m and less than 120 m and low when it is less than 30 m per square km. The total length of the roads was converted to kilometres (km) from meters (m). In addition, the connectivity in the road network of the study area was tested using Beta index of connectivity developed by Kansky (1963) and adopted by Vinod et al. (2003). Beta index (BI) for connectivity is a simple measure of connectivity which can be derived from the formula (Eq. (2)):

BI=Arc/Nodes (2)

Where the nodes are the number of road junctions and arcs are connections (straight lines) between the nodes as straight lines. Beta Index ranges from 0.0 for network which consists of nodes without any arc through 1.0 and greater where networks are well connected (Vinod et al., 2003). The beta index analysis helped to decide the connectivity level of the roads.

**Determination of the Road Densityof the Study Area**

The road density of the study area is calculated by relating the total density to the total area.
This is represented mathematically as Eq. (1), that is:

29.114 km/ 2020sq km = 0.0144 km = 14.41m

This analysis showed that the road density was low comparing it with the standard as highlighted in (Odaga and Heneveld, 2009).

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**The Road Connectivity Level**

The connectivity level of the road network in The Federal Polytechnic Idah was determined by a connectivity index through a Beta Index.

Beta index is a measure to determine the level of connectivity in road networks (Eq. (2)).

In the case of this study, Arcs = **37**, Nodes=**68**

Therefore, the beta index= 0.54.The result from the beta index shows that the connectivity of the road network is high in the study area.

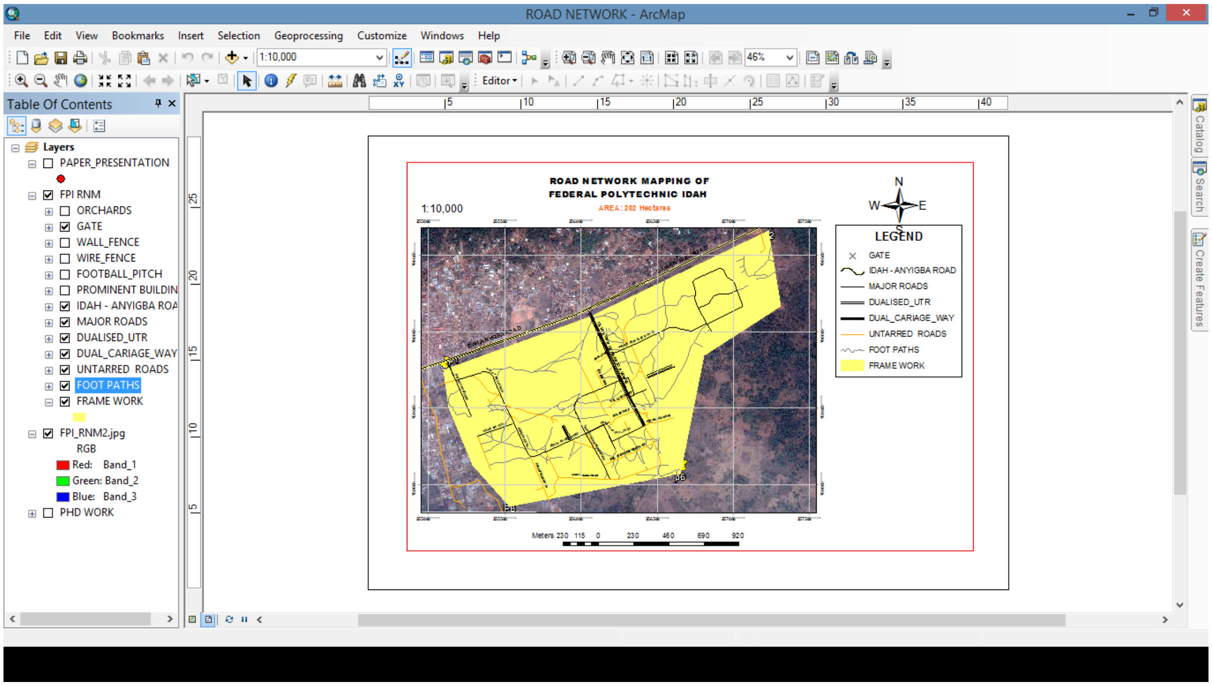


**Fig. 1:**

*The Imagery of the Study Area Showing the Boundary and Road map*

*Source: Google Earth, 2016*

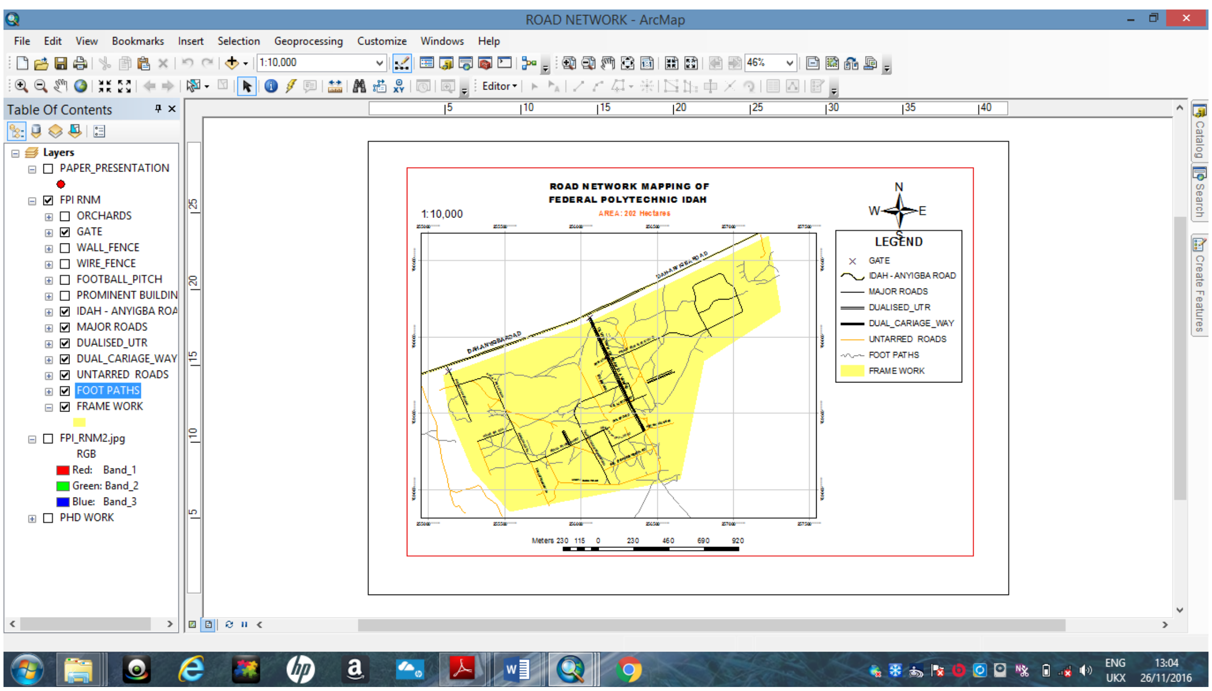


**Fig. 2:** *The Map Showing the Road Network of the Study Area*

## Conclusion and Recommendation

Following Obafemi et al (2011), the efficiency of a GIS is clearly evident in this study in terms of road network analysis. The technique was used to assess the road network system in The Federal Polytechnic Idah in terms of the present condition of the road, pavement, road type and its connectivity. Therefore, it can be concluded that road network of the study area is in good condition and the connectivity level is still high. Thus the following recommendations are made:

1. The government is encouraged to embrace keeping and managing of spatial data with the use of a GIS.
2. There should be regular maintenance of these roads in the study area and the untarred area and foot paths should be repaired to reach the standard of a 100 % good road network.
3. There is a need for training and re-training programmes among the government staff on GIS.
4. This study can be carried out on a larger scale and other attributes like the drainage system, vehicular movement, impedance analysis, least route cost should be studied among other things.

## References


Abah, Adah (2015) 'Idah: Traditional Capital of Igala Kingdom'. Leadership Newspaper – Nigeria's most influential newspaper. Retrived 13th September 2015.

Fiatornu, S. Y. 2006. GIS a Tool for TransportationInfrastructure Planning in Ghana, A Case Study to the Department of Feeder Roads, in Proceedings of the 5th FIGRegional Conference,1-14.

Kansky, K. 1963. Structure of Transportation Network: Relationships between Network Geometry and Regional Characteristics, Research Paper 84. Chicago: University ofChicago. 155 p.

Miller, H. J.; Shaw, S. L. 2001. Geographic Information Systems for Transportation: Principles and Applications. New York:Oxford University Press. 470 p.

National Transport Policy for Nigeria. 2003. Draft Document, Transport Sector Reform Committee Bureau of Public Enterprises.Abuja: FG of Nigeria. 54 p.

Obafemi A. A.,Eludoyin, O. S. and Opara, D. R. , Road Network Assessment in Trans-Amadi, Port Harcourt in Nigeria Using GIS

Obahopo, Boluwaji (2014) Fedpoly Idah Registrar kidnapped vanguard Retrieved 13thSeptember 2015.

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

Uluocha, N. O. 1998. Mapping for Utility Management in Nigeria in Cartography and Challenges of the 21st Century in Nigeria, 183-192.

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