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Case Report

Optimizing Transportation with Spatial Databases Using Google Maps in Ado-Ekiti

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Abstract: Transportation is the movement of man, goods and services from one place to another. A database is an organised collection of logically structured data, while spatial databases are enhanced databases capable of storing and querying data that represents objects defined in a geometric space. Databases offer transportation planning and management the capacity for operation planning – Best & Alternative Route Planning (BARP), Transport Intelligence, Fleet Management, Freight Payment and Billing, Carrier Sourcing and Visibility. Using Ado-Ekiti as a case study, this works discusses the role of databases for transportation planning and management, it identifies the need for spatially enabled transportation databases to facilitate commuting. Transportation, building transportation databases, database analysis and functionalities for transportation were discussed. The work further implements the use of Google maps as an open spatial database in determining best and alternative routes in Ado-Ekiti. Results obtained shows that readily available spatial databases will make transportation easier, smarter and more cost-effective. The work concludes and recommends the need for continued integration of accurate geospatial data with transportation management for effective transportation service delivery. It further advises the need to promote crowdsourcing, volunteered geographic information and open-source approaches to mapping the environment as veritable sources of data for spatial databases.

Keywords: Database, Spatial Database, Transportation

1. Introduction

The movement of man, goods and services from one place to another is termed transportation. This involves the management of data and information about means of transportation, transportation route, commuters, managers and time of transportation. Managing transportation in the 21st Century has become impossible without the use of computer systems. Modern transportation systems use a database management system in the planning, designing, monitoring and evaluation of transportation practices. While database systems offer better solutions to transportation challenges, spatially-enabled database systems in the form of GIS give optimal management to transportation in the 21st century.

A database can be referred to as an organised collection of logically structured data. This means it has the capacity for storage, indexing, querying, backup and implementing security measures to protect data and information. The term is often differentiated from "Databank" which is a collection of data in a logical or illogical; structured or unstructured; organized or disorganized format. A spatial database is commonly defined as a database that is enhanced to handle the storing and querying of data that represents objects defined in a geometric space [1–5]. In addition to the capabilities of databases indicated above, geographic databases have the capacity for map data loading, editing, analysis and graphical information presentation. It is the representation of simple geometric objects such as points, lines, polygons, rows and columns. The above characteristics of databases make database efficient in producing cost-effective, non-redundant, and fit for purpose solutions to problems, and challenges of man, including transportation management.

To describe the prospects, challenges and opportunities of database applications in transportation management, Ado-Ekiti in Ekiti state was selected and some projects related to transportation planning and management was implemented in the study area. Below is a graphical description of the study area:

Figure 1. *Study Area Map showing Ado-Ekiti, Ekiti State, Nigeria.*

2. Transportation Management with Spatial Database

Transportation is rapidly evolving. It is a field where new technologies, techniques and policies are constantly introduced. Recent activities in transportation include the following among others; Accident Analysis and Prevention, transport policy, the economics of transportation, choice modelling, logistics or transportation, etc. [6]. If the sustainable development of urban transport must be ensured, a robust database is necessary to support the transport policy-making processes of all levels of governments [7].

Transportation can be of many types, which include; Air, Land and Water. Most utilized of the above is land transportation, where motor vehicles, motorcycles and tricycles are the active means. This paper is meant to discuss the role of database applications in transportation. The focus on land transportation is not a misdirection, but a concentration on the often utilized, and hence, alarming means of transportation, especially in the study area. With the recent rapidly growing economy, a dramatic increase in the total number of vehicles which leads to urban traffic congestion, environmental pollution, and energy issues have been observed. The most promising way to solve the challenge is public transportation. [8].

Urban transport data can be derived from several databases. These data are stored for policymaking, transport planning, and evaluation. A publication by [8] documents some of the sources of online databases.

2.1. Information System for Transportation

The product of the database is information. Many development projects have a serious dependence on the transport network. Authentic information on the transport infrastructure is important to decision making to ensure the reliability and relevance of such infrastructure. The demand for authentic information requires better ways of acquiring, managing and communicating transport-related data. Data and information needed for transportation management include; traffic information, accident data, construction and maintenance data, bridges, pavement and bus top information, right of way surveys among others. These data and activities leading to them are mostly uncoordinated within the organizations and across the organizational boundaries. Because of the lack of coordination or of the narrow concept of data use and application, data collected for one purpose is rarely usable for others. These data need to be well managed at a central location to reduce redundancy of the data and interoperability of all the systems requiring the data. The above need identifies the need for the continuous development of spatial databases for managing transportation [9].

2.2. International Transport Database Systems

A very good case study of this is the International Traffic Database (ITDb), designed because of the Problems that exist in the reuse of traffic data, with various data formats, the different aggregations of this data, and the various densities of metainformation [8]. The International Traffic Database (ITDb) was developed to deal with the above problems by applying data-name matching or translation to form a comprehensive standardized data pool, which can improve the efficiency of the database. ITDb is a database focusing on the collection and provision of urban traffic data (vehicle speed, traffic volume occupancy, etc.) for cities worldwide [10].

Their goal is to help research and developments in transportation and traffic management. The author is not exposed to any transport database currently being designed or developed for Ado-Ekiti, hence, the google maps openly available to users of all categories is used in the implementing the use databases with capability for managing transport-related situations in Ado-Ekiti. While databases exist on the international scale, it is necessary for countries, states and even Local Governments to implement a transport database that can be more accurate and comprehensive for its environment.

2.3. Geospatial Data and its Components

Geospatial data can be described as location data i.e. data describing the location of features beneath, on or above the earth's surface. It can as well be referred to as information about objects, represented by numerical values in geographic space. Such data include:

i. Geographic Coordinates: (Latitude and Longitude).
ii. Projected Coordinate: (Eastings and Northings).
iii. Placename.
iv. Postcode.
v. Distance and Bearings.
vi. Description.

Managing a database is the responsibility of an information system. All transport databases are eventually managed by information systems with capability for creation, storage, manipulation, analysis and presentation of information with the user-specific requirement.

Implementing a GIS for any application, especially transportation requires the effective and efficient integration of the five (Hardware, Software, Procedure, Organisational Structure and Data) or six (Plus Network) components.

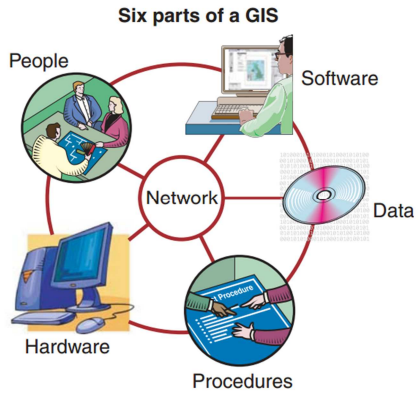

Figure 2. *Components of a GIS Source [11].*

The core data model of a GIS or DBMS defines the object types and relationships in the application.

2.4. Database Analysis & Functionalities for Transportation

An effective transportation system requires the reduction of freight costs, optimization of service levels, and automation of processes so that logistics operations can be run more efficiently. As identified by Oracle, database applications can be utilised in several ways for transportation in the ways listed but not limited to the below [12]:

2.4.1. Operation Planning

The role of databases in operation planning cannot be over-emphasized. In operation planning, the use of databases advances the robust and advanced optimization engine for finding the most appropriate solutions for logistics needs with cognizance to business requirements and trading partner capabilities. This helps to;

i. Plan routes (Best and Alternative Route Planning).
ii. Create a more efficient and higher velocity logistics network.
iii. Plan and execute domestic and international shipments.
iv. Lower rates and efficient management of equipment.
v. It aids the optimization and consolidation of cubic capacities and orders respectively. It aids the streamlining of location flow and delivery calendars.

2.4.2. Transportation Intelligence

Databases aid transportation intelligence. Transportation intelligence is a logistics dashboard for an entire enterprise, it helps in managing effectively transportation data metrics. Its specific uses include to:

i. Tracking of items, orders, and shipments of various customers.
ii. Making changes to maximize service profits and minimize costs.
iii. Receiving preemptive alerts when approaching milestones, or when missed.
iv. It likewise aids the monitoring of transaction and occupational metrics against targets, benchmarks, and forecasts.

2.4.3. Fleet Management

Managing fleet without sacrificing carrier efficiency or fleet utilization is another efficacy of database applications in transportation. This includes:

i. Managing all aspects of the fleet: drivers, tractors, and trailers.
ii. Simultaneously considering fleet resource capabilities, while optimizing contracted carrier rates.
iii. Measuring and controlling financial performance with costing, payables, billable, cost accruals, and dispute management.

2.4.4. Freight Payment and Billing

Improving operation performance by eliminating administrative activities (Reducing human interaction) so freight payment and billing is void or reduced of bureaucratic bottlenecks, thereby improving efficiencies and focus on the big picture (Transportation Efficiency). This makes the below under-listed easier.

i. Automate manual procedures associated with freight bill payment and audit.
ii. Transportation rates, including surcharges and discounts, are easily reduced.
iii. Makes payment for all forms of services easily

achieved.

2.4.5. Carrier Sourcing

Database applications enhance the accuracy of bid packages and reduce the time and overhead it takes to run a procurement cycle. That is:

i. It helps in the management and negotiations of cost with carriers and logistics service providers.
ii. Quantify the effects of proposed rate changes before being made.
iii. Carrier sourcing aids the reduction of transportation costs through the optimisation of bid execution and service provider rates negotiation.

2.4.6. Visibility

Gain visibility into items, orders, and shipments so superior services can be delivered in transportation, thereby aiding confident planning.

i. Visibility helps to pre-empt orders by following automated milestone monitoring.
ii. It aids the assessment of on-hand and in-transit inventory levels across the broad supply chain.
iii. Track and trace each stage in the lifecycle of global shipments.

3. Results and Discussion

The result below shows the best & alternative routes between Dave Hotel, Ado - Iworoko - Ifaki Road, Ado Ekiti, and the Federal Polytechnic Ado-Ekiti Continuous Education Center, NTA Road, Ado Ekiti. The analysis was carried out on Ado-Ekiti metropolis, Ekiti state, Nigeria. Using Google maps application, determination of best route can be performed seamlessly. The information required includes:

i. Directions from (Place of Departure).
ii. Direction to (Place of Arrival).
iii. By (Means of Transportation).

Below is an analysis carried out to determine best and alternative routes from Dave Hotel, Ado - Iworoko - Ifaki Road, Ado Ekiti, to the Federal Polytechnic Ado-Ekiti Continuous Education Center, NTA Road, Ado Ekiti, when using vehicular means of road transportation.

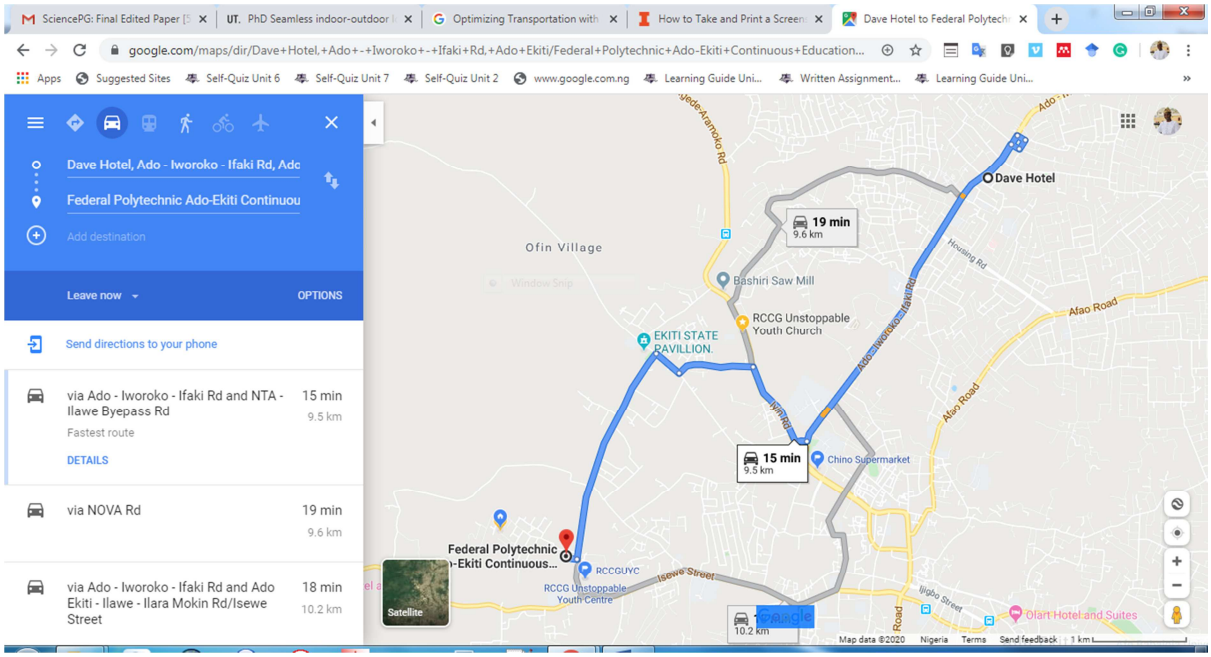

Figure 3. *Best Route Analysis between Dave Hotel and the Federal Polytechnic Ado-Ekiti Continuous Education Center on Google Maps [13].*

While the best route (15mins – 9.5 Km) is shown in blue, two alternatives routes are shown in ash colours. Where alternative 1 = (19mins – 9.6km), and 2 = (18mins – 10.2km). Below is a description automatically generated from the Google maps:

Table 1. *Best Route Analysis Result on Google Maps [13].*

	Description (9.5 km. About 15 mins)	Road Length
1.	Head southwest on Ado - Iworoko - Ifaki Road toward Prince Afolabi Street Pass by Melting Point (on the left)	3.7 km
2.	Slight left toward Ado - Iworoko - Ifaki Road/Obada Street	29 m
3.	Turn left onto Ado - Iworoko - Ifaki Road/Obada Street	9 m
4.	Slight right onto New Iyin Rd - Ado Ekiti	65 m
5.	Turn right to stay on New Iyin Rd - Ado Ekiti Pass by Ekiti State AIDS Control Agency (on the right)	2.2 km
6.	Turn left onto NTA - Ilawe Byepass Rd	2.3 km
7.	`Turn right Destination will be on the left	0.1 km

The results obtained shows that Google map was able to suggest the best route and two other alternative routes. The best route is the shortest of all three routes that were suggested. This is a feat that could be very difficult for the human mind to achieve but for a spatial database. Unlike the human mind that could take days determining the best route to be plied at a particular time of the day, the app was able to determine the best route and present the information to the user in real-time. Furthermore, the tool is freely available on all android phones which is the most common within the study area, this makes the tool readily accessible to prospective users.

4. Conclusion & Recommendations

Managing transportation with spatial databases helps to handle the voluminous, complex and diverse information required for better service delivery in the sector. Transportation services will be more efficient if data about the location are integrated with a spatially enabled database. This work describes the application of database for transportation planning, operation and management. It specifically states operation planning, transport intelligence, fleet management, freight payment and billing, carrier sourcing and visibility as the key applicability of databases for effective transportation service delivery. It further implements the use of google maps to determine the best route and alternative routes for transportation planning in Ado-Ekiti, Ekiti State. Based on some pieces of literature reviewed and results obtained, the following recommendations are made:

i. Accurate and reliable geospatial data should be continuously acquired to aid effective transportation service delivery at a large scale.
ii. To achieve the above, crowdsourcing, volunteered geographic information and open-source approaches to mapping the environment should be encouraged to further strengthening the robustness of freely available spatial databases for the use of man.
iii. Geospatial Data Infrastructure should be more implemented to leverage adequately on the potentials of spatially enabled databases for transportation service delivery.

Conflict of Interest Statement

The authors declare no conflict of interest.

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