TRANSPORTATION NETWORK MODEL AND NETWORK ANALYSIS OF ROAD NETWORKS

Aman Arora¹, Manish Kumar Pandey²
Geographical Analyst, Lepton Software Export & Research Private Limited, Gurgaon, Haryana, India. Senior Research Fellow, Banaras Hindu University, Varanasi, U.P., India.
aman.july07@gmail.com, manish7sep@gmail.com

Abstract:

Network Analysis aims at finding solutions to routing problems related to traversibility, rate of flow, and network connectivity. It helps in identifying optimum locations for services to be provided. The current work is basically a pilot project and only free Google data, of not very good accuracy, has been used for this study. In the present study, distribution of ATMs of different banks and Hospitals of a part of South West Delhi Area have been selected for network Analysis. This kind of study is very uncommon for even highly developed metropolitan cities of India like Delhi, Mumbai etc. During field survey it was noticed that SBI (State Bank of India) and Axis Bank ATMs are well distributed while that of PNB (Punjab National Bank) are poorly distributed. There are 5 hospitals in the area and are well distributed, within 3-5 minutes of accessibility. The road network and connectivity in the study area is of appreciable standard.

If this sort of study is undertaken for the area with very high resolution data of fine accuracy level and supplemented with extensive field surveys, which is a very costly enterprise, the study can be of immense applicability to Public Transport Corporations, Health service providers, Emergency Response agencies as well as departments under the jurisdiction of home ministry.

About the Author:

Mr Aman Arora, Geographical Analyst, Lepton Software
Mr Aman is currently working as a Geographical Analyst in Lepton Software Export & Research Pvt. Ltd having ~3 years of experience in GIS field. He has completed his graduation with Geography hons and P.G. Diploma in Remote Sensing and GIS from Banaras Hindu University, India. Currently he is pursuing Master’s in RS and GIS through distance learning.

He has a good knowledge of GIS and Image Processing software e.g. ArcGIS, Erdas Imagine etc. and good experience in land base and navigation GPS project. he has also worked for 6 months as a GA (Geographical Analyst) with NAVTEQ. he has been involved in many projects like MPLR (Madhya Pradesh Land Records), HPLR (Himachal Pradesh Land Records), TTSL (Tata Telecom Service Ltd.) Landbase project, BRIC (Building Roof Intersection Capturing), INSPIRE, POI collection, Village Information System etc.
The work he intends to build his career in Network Analysis field

E mail ID: aman.july07@gmail.com

Contact No: +91 – 9891817657

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General Introduction

The Transportation System is a critical component of urban infrastructure and the lifeline of the city. It plays a key role in the economic growth of that region. It also displays region’s economic condition as well as planners’ dedication for their region. An efficient route planning and accessibility facilitate sustainable development. This paper introduces the reader to current status of the transportation system in New Delhi.

Current Status of Delhi Road Networks

Delhi is predominantly dependent on road transport. The road network in Delhi is being developed and maintained by NHAI (National Highway Authority of India), PWD (Public Works Department), MCD (Municipal Corporation of Delhi), NDMC (New Delhi Municipal Council), Delhi Cantonment Board and DDA (Delhi Development Authority). The road network in Delhi was 30985 kms (including 182 kms of National Highways with PWD and excluding highway of NHAI) as of March, 2008. (Economic Survey of Delhi 2008-2009)

The road network has increased from 8380 km in 1971-72 to 30985 km in 2007-08 (3.7 times), while the number of vehicles has increased from 2.14 lakh in 1971-72 to 56.27 lakh in 2007-08 (26.29 times). The imbalance between growth of vehicles and road network in Delhi emerged in heavy traffic congestion and reduced vehicle speed.

(Economic Survey of Delhi 2008-2009)

Literature Review

GIS has been defined as,

“an integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial processes. A GIS provides a framework for gathering and organizing spatial data and related information so that it can be displayed and analyzed.” (ESRI)

It provides us a sustainable framework and user-friendly environment for assessment, analysis and manipulation of input and applying output as an application.

This paper will focus on role of Transportation Network Model and Network Analysis in transportation system (road network system), a part of GIS workspace. When integrated they can provide a very strong framework to transportation departments to upgrade their techniques and analysis system. The system will not only provide info on the length, type, location and connectivity of roads, but also address complex road network problem, ensure better connectivity, shortest and quickest route etc.

Transportation involves the movement of people and shipment of goods from one location to another. Streets are the ubiquitous network. Streets have two-way flow, except for situations such as one-way streets, divided highways, and transition ramps.

They form a multilevel network—while most roads are at surface level, bridges, tunnels, and highway interchanges cross each other in elevation; a simple overpass has two levels, and a highway interchange typically has four.

With geographic information system (GIS) software, you can analyze a transportation network to support planning goals such as relieving congestion, mitigating pollution, optimizing delivery of goods, and forecasting demand for transportation.

Some transportation related GIS tasks include the following:
Main Aim and Objectives
The main aim of this paper is to develop a coherent methodology for the formulation of transport planning alternatives. In order to reach this aim the following table of questions and objectives was formulated.

<table>
<thead>
<tr>
<th>Expected Output</th>
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<td>optimal routings under the studied vision.</td>
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<td>solve shortest routing and least-cost routing problems for transport agencies.</td>
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<tr>
<td>Development of criteria that can be inferred from RS data. (or data based on it).</td>
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<tr>
<td>Development of network and routing algorithms for road networks can be used for transportation planning. And can be used by any other departments.</td>
</tr>
</tbody>
</table>

Table No:1-Main Aims and Objectives

Study Area
The study area for this paper is geographically located in the south-west corner of Delhi (Capital of India) territory between 28.36° N, 77.02°E to 28.28°N, 77.16°E. It covers an area of 55.20 sq. km., which is almost 3.7% share of Delhi capital area (1484 sq. km.).

It shares the Gurgaon boundary in south-west corner with Delhi Gurgaon Expressway (A major part of National Highway 8) which gives it maximum concentration of traffic.

This study area also covers vasant kunj colony roads, mehrauli-badarpur road and other major streets of South-west Delhi region.
Data Description and Methodology:

The data used in this paper can be broadly divided into four categories: Remotely Sensed Data: Google Earth Data (Satellite Imageries), Field Collected Data (FCD), Web Collected Data and GIS Datasets (Which consists of data derived from remote sensing and/or field measurements and surveys). The following sub-sections describe this in detail.

- Remotely Sensed Data (Google Earth Data)
Google earth data is an easily accessible data source worldwide. This Paper being a pilot study, free data has been used.

- Field Collected Data
Field data has been collected through walks and through two/four wheeler rides.

- Web Collected Data
Apart from field survey, data from web sources has been used for this study. Mainly POI names, Street Names and road width have been taken out from the web resources.
-GIS Data
Due to the cross disciplinary nature of the methodology, a diverse variety of data sources were accessed. A brief description of the datasets is given herein.
Road Network Dataset- With the help of web/field collected data and basic imagery, digitization of road network has been done. POI (Point of Interest) - POIs also collected from same resources.
Network Dataset- Network dataset has been created with the help of network data and its attributes in ArcCatalog.

Software Used:
The study has been implemented using ArcGIS software. Digitization, calculations, attribution, removal of topological errors, modeling of digitized data, building of network dataset and network analysis of the data have been done with the help of ArcGIS software and its useful resources. The softwares used in the study are as follows,

- ArcGIS 9.3-Used for digitization, topology and network analysis of the data.
- Google Earth 6.0.3.2197- Used for downloading the data.
- Global Mapper (Evaluation copy)- Used for merging of downloaded data.
- Erdas Imagine 9.2- Used for georeferencing of the merged data.
- MS Excel 07- Used for making of attribute table of collected data through web survey and field survey.
- MS word 07- Used for write up of the Paper.

Results:

1) Closest Service Analysis

Problem- Shortest Route Analysis from an Accident spot to a hospital

Description- The given problem is very common in urban areas. In that condition finding shortest route to the nearest hospital saves patient’s life and valuable time.

Solution- With the help of closest service facility of Network Analyst option available in ArcMap, this problem has been solved. Figure is given below.
Fig:3-Closest Hospital Facility from an Accident Spot

2) Accessibility of services

**Problem:** To compare ATMs' services accessibility of four banks Axis Bank, ICICI Bank, Punjab National Bank and State Bank of India.  
**Description:** In corporate sector everyone wants to be winner, This option tells about their product or service condition in respective area. In this example the following ATMs services have been taken for their accessibility analysis.

<table>
<thead>
<tr>
<th>Name of ATM Services</th>
<th>Total Available ATMs</th>
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<tbody>
<tr>
<td>Axis Bank</td>
<td>15</td>
</tr>
<tr>
<td>ICICI</td>
<td>11</td>
</tr>
<tr>
<td>Punjab National Bank</td>
<td>14</td>
</tr>
<tr>
<td>State Bank of India</td>
<td>14</td>
</tr>
</tbody>
</table>

Table No:2-Numbers of ATMs services

In above table the maximum numbers of ATMs services available of Axis Bank is 15 while other has 11, 14 and 14 simultaneously. The analysis was made on the basis of cut off value of 1, 2 and 3 minutes cost in term of polygon features.  
**Solution:** With the help of New Service Area option of Network Analyst available in ArcMap, the problem has addressed. Resultant Map is given below.  
Looking at the result map we can see the actual services of ATMs’ services on the ground. The result shows that axis bank’s ATMs are not as well distributed as SBI’s ATMs. SBI’s ATMs are well distributed and covering almost whole study area within maximum three minutes distance.  
In other services ICICI Bank’s ATMs comes on second spot because in only 11 ATMs it is covering 75% of the total area. Poor distributions of PNB’s ATMs mark it on fourth spot in the race.
Fig:4- Accessibility area of Axis Bank’s ATM

Fig:5- Accessibility area of ICICI Bank’s ATM
Conclusion:

Basically whole study for this paper has been done with the help of field surveyed and web sourced data. With these free costs of data this paper provided 85% accuracy in its resultant analysis. All parameters and methodology has been used according to the current road network problem and their condition.

Because of the limited time and scope of this paper, only the most important criteria, that were available, were considered in the analysis.

This paper also proves that the use of remote sensing, GIS and Network Analysis techniques can readily yield the oft-repeated (but as yet, unsatisfied) demands of professionals associated with transportation planning and development, of effective planning tools and funding for a more effective network dataset which can provide enormous benefits for urban planning.

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