



International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS)

www.iasir.net

Network Analysis Using GIS

Praveen Kumar Rai, Prince Kumar Singh, Abhishek Kumar Singh, Kshitij Mohan
Department of Geography, Banaras Hindu University,
Varanasi-221005, India

Abstract: Network Analysis helps in identifying optimum locations for services to be provided. In the present study, hospitals and road in part of Varanasi city area have been selected for network Analysis. Complicated networks of roads require analysis to improve the movement of people, goods, services and the flow of resources. To demonstrate the use of network analysis, this paper focused on determining the optimal route between two or more destinations based on a specific travel expense. Geographical Information System (GIS) software is used to determine the quickest way or the shortest way between those locations. The attribute data of the road network is collected to develop the database of road network and an optimum route. An optimal route representing the total cost of route in meters as well as in minutes are developed. The result of analysis includes the directions to travel on that route.

Keywords: Network Analysis, Attribute data, GIS, IKONOS data, Varanasi.

I. 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. Geographic Information System (GIS) technology is more useful in management functions and decision support systems which are more helpful in the planning process of urbanization. Instead of finding the optimal solutions for urban problems, bold approaches must be developed on the usage of heuristic problems, making it capable of supporting the dynamic requirements of the urbanization. According to that when the spatial entity is associated with the non-spatial attributes; it can be useful to achieve the sustainable infrastructure planning or strategy [1]. This is a key factor for applying GIS technology as a tool in supporting transportation network analysis or planning. In the GIS platform, the database of transportation network is normally extended by integrated with attribute and spatial data [2][3]. As roads are the only means of transport available to the urban settlements, it plays an important role in the comprehensive development of a society. It acts as the lifeline of the urban economy and society. Urban transport network is very prominent sector for the growth of urbanization. The urban growth includes all aspects of development including settlements, education, industries, trade and other facilities and these all facilities depends on good transportation network [3]. In transportation planning by using GIS applications, mapping tools for a primary data like toposheet as well as the Satellite and airborne images can be used. The various applications of GIS can be used for identification of road network area and change detection in road. It can also be used to detect the distance between the one place to another place. It not only detects the distance but also used to show the shortest path between two or more than places [4]. These applications of GIS can be used in traffic control to generate the traffic control mechanism that provide fastest route. The traditional planning is not sufficient in urban transport [4]. The new approaches have to be used to present or identify serious issues on planning or analyzing urban transport network in a scientific way.

II. Literature Review

The Line feature is more important in the maps, because it represents a major map feature. There are many GIS software that provides a Line Feature Generalization facility. The geometric operations are involved in this generalization like selection, merge, symbolization, elimination etc. But there is no proper definition for generalization. In Arc GIS 9.3, a point remove tool uses Douglas-Peucker (DP) algorithm. This algorithm is most popular algorithm, which is used in many applications like Road, river, coastal line generalization [5].

The following operations are required to generalize a road network.

Classification: It identifies an object and makes groups according to properties. For easier selection and more accurate roads depends on the good classification. It minimizes the complexity. Ex. road width.

Selection: Select particular road class at the target scale.

Elimination: Eliminate shorter road of a certain length.

Simplification: selected roads can be simplified to reduce the details. Ex. Remove extraneous bends of roads.

Typification: This is manual editing approach. It reduces the Network density and simplifies the distribution and the pattern of the network.

Symbolization: To represent features on maps, graphic marks are used. Ex. Road Name, Road Number.

Role of Transportation Network Model and Network Analysis is in transportation system (road network system)

is an important part of GIS workspace [4]. 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.

III. Objectives of Study

- To identifying most efficient routes or paths for allocation of services.

IV. Study Area

The study area is geographically located in the in the south-east corner of Varanasi City territory between 25.326°N and 82.985°E to 25.264°N and 82.995°E (Figure 1 & 2). It covers an area of 30.10 sq. km. which is almost 5% share of Varanasi City. It shares the 10th ward road network with DLW Road, Sankatmochan Road, Sunderpur, Khojwa road etc., of Varanasi city, which gives it maximum concentration of traffic.

Figure 1 Location of the Study Area

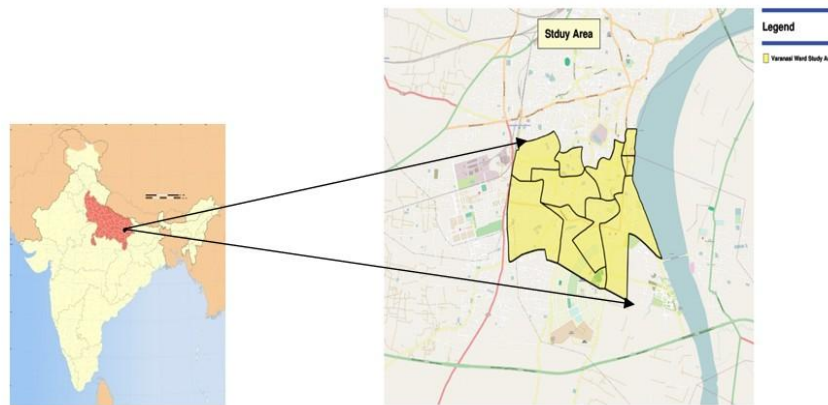


Figure 2 Study Area as View on IKONOS satellite data



V. Data Sources 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 and freely accessible data source worldwide. This Paper is a pilot study and free data is used for the work.

Field Collected Data

Field data is also collected and are very helpful to identify the location of features both in the field and on satellite data.

Web Collected Data

Apart from field survey, data from web sources are used for this study. Mainly place of interest, Street name 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 below:

Road Network Dataset- With the help of web/field collected data and basic imagery, digitization of road network has been done.

Network Dataset- Network dataset has been created with the help of network data tool option and its attributes in Arc Catalog.

The data such as topographic sheets of 1:50,000 scale and high resolution satellite images are used. Transportation network and other GIS layers are digitized with a defined zoom level in GIS platform using ARC GIS-9.3 software. In next phase, GPS survey is performed to identify the existing known roads and important places. By using GIS software, important spatial and attribute data about – the road, road type, bus stops support infrastructure and land use, administrative/ constitutional boundaries etc. are extracted. Using topology rules in Arc GIS, errors are removed, so the accuracy of the data will be good and it can be used for further processing. After the generalization process, the topological rules have to be applied in the Arc GIS-9.3 environment. After successful completion of topological rule, error is removed. Now this network is perfect for the analysis. By using this layer as a network data set, a junction should be created. This will be provided a total number of edges and total number of vertex in the selected network. After this process, it is possible to calculate the network analysis index. It also provides a network analysis tools to find the shortest path.

VI. Discussion

Shortest Route Analysis

Problem- Shortest Route Analysis from One location to another location at emergency time.

Description- The given problem is very common in urban areas. In that condition, finding shortest route to the destination is very helpful in saving the travelling time (Figure 3 & 4).

Solution- With the help of shortest route facility of Network Analyst option available in ArcMap, the problem of the errors is solved.

Closest Service Analysis

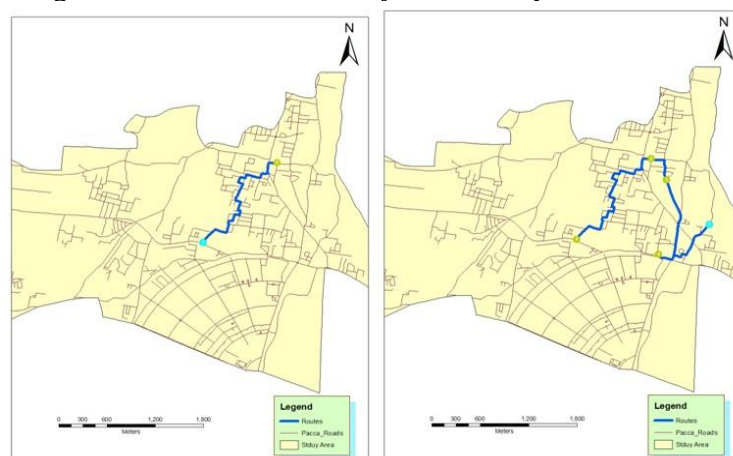
Problem- Shortest Route Analysis from an Accident spot to a hospital.

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 Arc Map, problem of the errors and modeling has been solved.

Digital road network data of the study area are extracted from IRS-1C LISS III satellite data in conjunction with high resolution IKONOS satellite data. From the perspective of accessibility modeling, it is important that such details identify different classes of road (e.g., district road, national highway etc.) and ideally distinguish between sections in urban or rural areas. These road network data are very important to calculate the shortest distance between each hospital to the villages. Shortest distance between each Government health care units in each development blocks are calculated, which is based on Network analysis. Details of measured shortest distance between government health care units in each development blocks are shown in the Table 1. In this table, Baragaon development block has shown 5 stop count (first health care unit to the fifth health care unit), and shortest distance between first stop to the last stop is 34.80 km. whereas in Kashi Vidhyapith block shown only 2 stop count to reach on health care units to another and shortest distance between both health care units is 12.14 km.

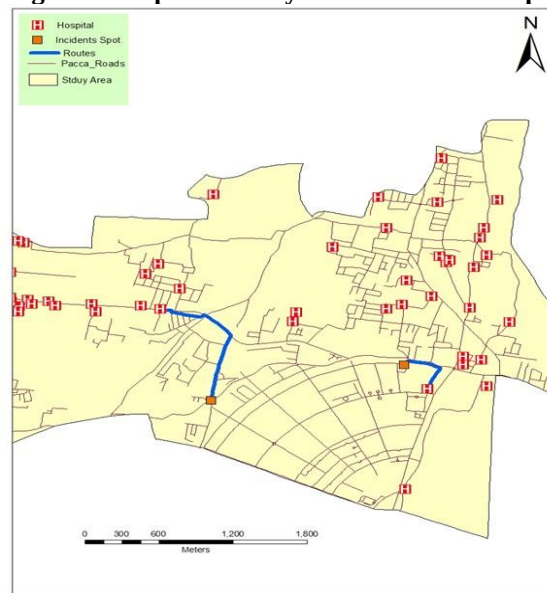
Figure 3 Shortest Route Facility from One Spot to the Another



Development Block	Stop Count	Shortest Distance Between Each Health Centre (km.)
Baragaon	5	34.80
Pindra	3	12.95
Cholapur	3	21.0
Chiraigaon	4	50.40
Harhua	2	17.62
Sewapuri	4	24.02
Araziline	6	35.14
Kashi Vidhyapith	2	12.14
Varanasi City	11	29.75

Table I. Shortest Distance between One Government Health Care Centers to another Centre in Each Development Blocks of Varanasi District

Figure 4 Hospital Facility from an Accident Spot



VII. Conclusion

Whole study of this paper has been done with the help of field survey and GIS data. All parameters and methodology has been used according to the current road network problem and their condition. Important parameters like transportation network and health centres are considered in this 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.

VIII. References

- [1] Ajay D. Nagne, Bharti W. Gawali, 2013. Transportation network analysis by using Remote Sensing and GIS a review, International Journal of Engineering Research and Applications (IJERA), May-Jun 2013.
- [2] Rao Lakshmana K.M. and Jayasree K., 2003. Rural Infrastructure Planning with emphasis on road network connectivity by Coplanar Concurrent Theory, *Map India Conference*.
- [3] Weiping Hu, Chi Wu, 2012. Urban road network accessibility evaluation method based on GIS spatial analysis techniques, School of Geography, South China Normal University, Remote Sensing and Spatial Information Sciences, Vol. 38, Part II.
- [4] R. Nijagunappa, Sulochana Shekhar, B. Gurugnanam, P.L.N. Raju and Prabir De, 2007. Road Network Analysis of Dehradun City Using High Resolution Satellite Data And GIS, *Journal Of The Indian Society of Remote Sensing*, Vol. 35, No. 3.
- [5] Arnold, P., Peeters, D. and Thomas, 2004. Modeling a Rail/Road Intermodal Transportation System. *Transportation Research* (40), 25-52.