

Route Analysis of Hyderabad City Using Geomatics Application—A Case Study



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Abstract Surveying technology is enhancing the process of old method of collecting geospatial data, through coming new hardware and software. Previously, the data collection and handling both are very tedious work, but nowadays, both are going to be easier and faster for a trained person. If data quality is good as per user demand and makes the availability of data is easy to some extent. So, it will be a new era for real analysis of ground in any field. Compared to other parts of the world, urbanization in India is rapidly growing. At present, due to urbanization and population growth, urban transportation system and its management is a challenging task for all over the world. However with the development of a proper methodology and its systematic approach, transportation problems can be resolved. Network Analyst tool provides a network-based spatial analysis tool for solving complex routing problems. Network Analysis data can be shared through the server to improve data analysis and its productivity. Route problems can be solved using a topologically correct network dataset. The study of Hyderabad City area is basically done to keep in mind about the problem faced mostly in the unprecedented developing urban areas, where the population is growing blindly in an unsystematic manner due to socio-economic issues. If the transportation system are not maintained properly and the current ground reality of transportation are not accessed quickly, then it may be difficult to rearrange it systematically in future for any growing city and also make a challenge for coming smart city.

Keywords Geospatial data · Network · Analysis · Diminishing · Unprecedented · Transportation

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J. K. Ghosh and I. da Silva (eds.), *Applications of Geomatics in Civil Engineering*,
Lecture Notes in Civil Engineering 33, https://doi.org/10.1007/978-981-13-7067-0_28

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1 Introduction

In topographical map, we are always seeing the most important and useful linear feature like roads. Roads are an essential part of transportation in any country, which creates a link between source to destination places, it may be village to village, city to city, state to state or from one country to another country.

Due to rapid growing urban infrastructure, it is a necessity of our society that we should follow a proper and systematic transportation system. In GIS technology, Network Analysis is a common tool, which is used in large scale for improving the transportation system.

Town and urban planners always designed a best road network, so that it should optimize the transportation safety, cost, land use and other environmental issues. The basic problem in transportation is to find out the optimal path between different locations on a network.

Here for our study, Arc Map is used as the main application software. In the Arc Map Network Analyst extension—Dijkstra's algorithm is used for finding shortest paths in route network.

The classic Dijkstra's algorithm solves the shortest path problem. To find a shortest path from a starting source location '*a*' to a destination location '*b*'. It picks the nearby unvisited node (vertex) and calculates the distance for each nearby node (vertex), and updates the nearer distance if smaller. The whole algorithm works until solving the nearest path from '*a*' to '*b*'.

Hyderabad is the largest city and capital of the southern state Telangana (India). The estimated population of Hyderabad is 8.7 million (approx.) in 2014, which makes it the fourth most populated city in India. It is a rapidly growing urban metro city with a huge road infrastructure, so in this study, it has been made to analyse the road network of the surrounding Hyderabad City (Telangana, India) area.

2 Objective

The study of this paper is to develop and create a best possible route network in metro cities. It is very helpful for future city/urban planning and healthy city development.

3 Data

3.1 Documents/Data Used

- Hyderabad Guide Map of edition 2014 (Survey of India).
- Soft Copy of Hyderabad Guide Map of edition 2000.
- Survey of India OSM Sheet No. E44M 6, 7, 10, 11 of Scale 1 : 50,000.

- Imageries downloaded from Google Earth Pro for digitization/update.

3.2 Hardware/Software Used

- A high configuration computer system to carry out the project. (Processor-i3, Hard Disk-500 GB, RAM-2 GB, Latest Monitor Screen with keyboard and mouse).
- HP Design jet 500PS Plotter to take a hard copy of imageries/Map/necessary plots.
- Arc Map software available/new version, Erdas Imagine 10.1, Microstation V8.
- Internet connection for downloading imageries (if latest imagery not available for update).
- All software tool of Microsoft office available/new version.

4 Study Area

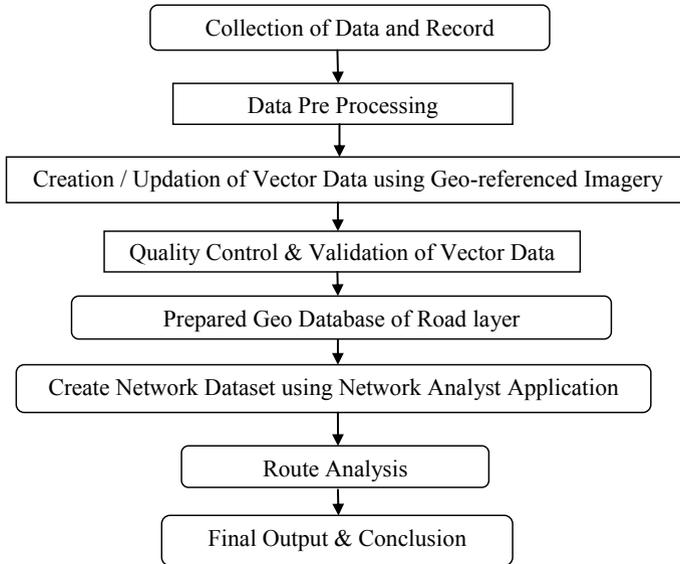
The study and analysis area of this paper is the surrounding Hyderabad City, Telangana India, and the area is lying between latitude of 17 : 15 : 00 and 17 : 37 : 00 (approximately) and longitude of 78 : 15 : 00 and 78 : 43 : 00 (approximately). It covers an area of 2290 Km². The area falls in Survey of India OSM Sheet No. E44M 6, 7, 10 and 11.

5 Methodology

Proper planning was done before the initialization of this study. Geospatial data has prepared using software Microstation V-8 and Arc GIS for specified area.

Geo-referenced Hyderabad city Guide Map and update with the help of Mosaic and Geo-referenced Google imagery. After update of vector data, quality control and validation were also completed for the whole vector data. Then prepared GIS layer like road and railway. Finally, Route Network Analysis has been done of different parts of the study area.

The study was executed in a number of systematic stages as shown in the workflow diagram:



5.1 Network Analysis

A network is a system, where elements are connected through points and line on junction. It helps to find out the location and the possible routes of different places.

Analysis is a systematic examination of something in detail in order to understand it better. Network analysis is a method of solving network problem using network connectivity.

Networks include many features like highways connecting to cities, streets are interconnected to each other at street junctions, sewer and water lines that connect to residential, commercial and industrial sectors.

Connectivity is important in order to travel over the network. Network elements, such as edges and junctions, must be interconnected properly to allow navigation over the network. These elements have their spatial properties to control navigation on the network. To do network analysis first, a network dataset was created with the help of topologically validated spatial network database. It is used to find the shortest path between the source and destination.

5.2 Network Dataset

Spatial data from Geographic Information System database is being used more and more in transportation planning due to the convenient structure. They provide for entering, viewing and manipulating spatially oriented data.

An application of GIS in the traffic safety area has been limited mostly to visual representation of accident locations. Network dataset is built mainly from two GIS data layers. They are major road network which is captured as line features, and junctions and important landmarks that are captured as point features. These two are playing a prominent role in keeping the network alive at all times.

Road network is properly connected in GIS with junctions and important landmarks. Necessary attribute data such as name of roads, length of roads, name of the junctions and important landmarks have been given as input in network dataset.

5.3 Route Analysis

Route analysis can be found out quickly, after selection and giving proper impedance input during analysis. Shortest path is only where least cost with lowest impedance. To find out best route, any cost attribute can be used as the impedance. If the impedance is time, then best route is quickest route, but if impedance is time attribute with live, then best and quickest route is dependent upon the date and time of the day or historical traffic.

5.3.1 Route Analysis Layer

All the inputs, parameters, and results of a route analysis stored in route analysis layer. A route analysis layer can be created from the Network Analyst toolbar—**Network Analyst** → **New Route** (Fig. 1).

Figure 2: The route analysis layer appears in the Table of Contents as a composite layer named Route. There are five feature layers—Stops, Point Barriers, Routes, Line Barriers, and Polygon Barriers, has default symbology, it can be modified using Layer Properties dialog box.

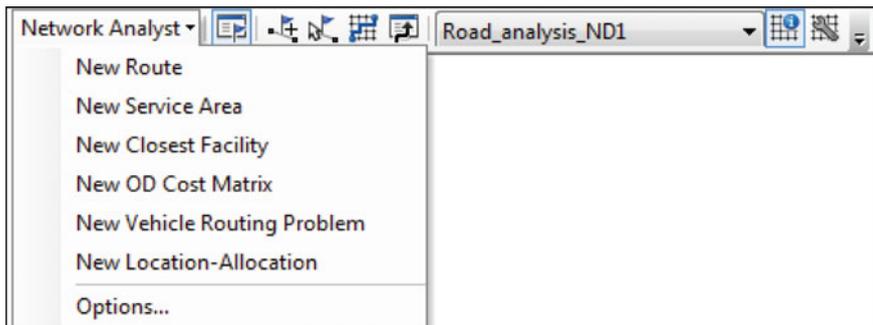


Fig. 1 Network analyst applications



Fig. 2 Route (table of contents)

5.3.2 Route Analysis Classes

The route analysis layer is classified into different network analysis classes—stop class and stop properties, route class and route properties, point, line and polygon barrier.

Stops Class

Stop class stores the network locations that are used as stops in a route analysis. The Stops layer has four default symbols: located, unlocated, errors, time violations (Fig. 2).

Stop Properties

In network analysis, stop properties are only available when a start time is defined or time windows are enabled. Time window is an attribute table which has information about start time, end time, arrival time, and drive time for different routes.

Routes Class

The Routes class gives the output of routes only. It gives the output when the route analysis is complete. Once the best route is found, it is displayed in the Network

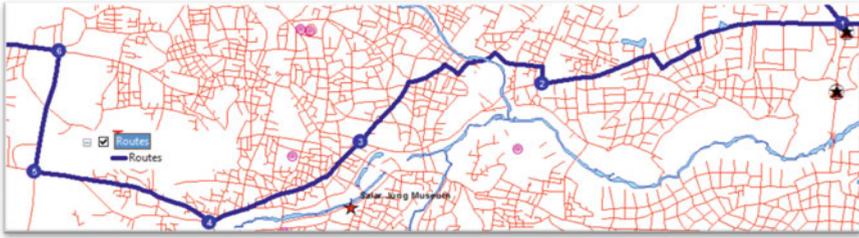


Fig. 3 Routes after analysis

Analyst window. The Routes class stores the resulting routes. Symbology can be changed from its Layer Properties dialog box (Fig. 3).

Routes Properties

The route properties are ObjectID, Name, FirstStopID, LastStopID, StopCount, Total_[Impedance], TotalWait_[Impedance], TotalViolation_[Impedance], Start-Time, EndTime.

5.3.3 Point, Line, and Polygon Barriers

Point, Line and Polygon barrier are basically used for diversion of the traffic. It temporarily restricts the route network. If it is compulsory to add barriers, then barriers are allowed by the network analyst to restrict particular place (it may be point or line or polygon barrier) as per ground reality.

5.4 Route Analysis Parameters

Route Analysis parameters are set on the Layer Properties dialog box (Fig. 4).

5.4.1 Impedance

For finding out the best and shortest route, any cost attribute can be selected as impedance. Impedance plays an important role to select best possible routes during network analysis.

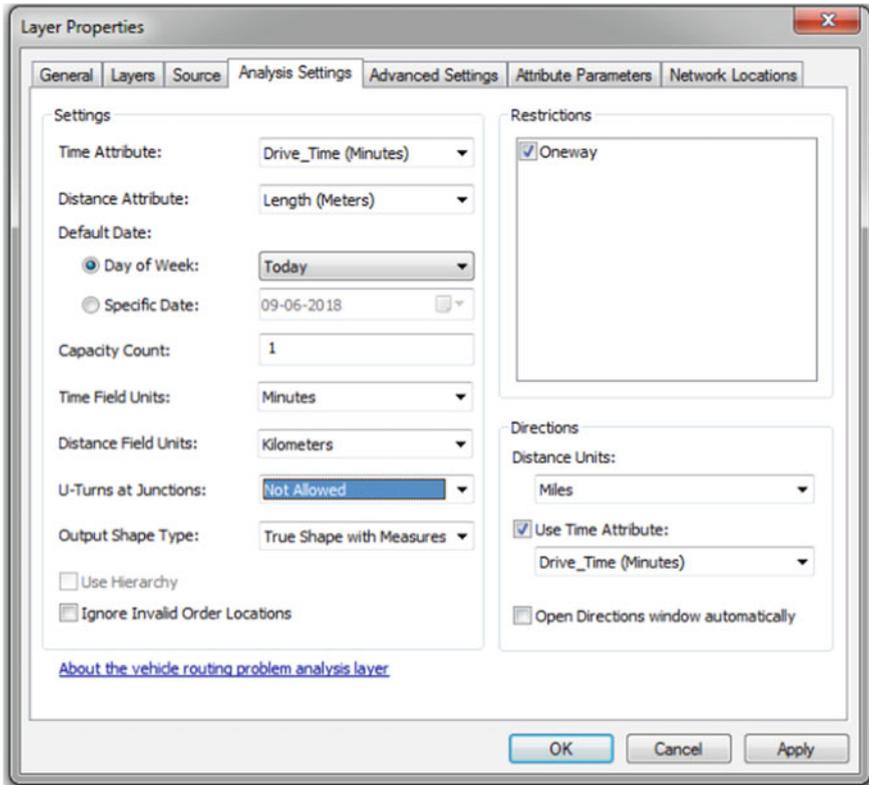


Fig. 4 Layer properties window (analysis settings)

5.4.2 Restrictions

At the time of solving network analysis restriction attribute can be selected. The restriction may be caused on any route due to point, line or any polygon barrier. It attributes are like One-way, U-turn, Height limit, Weight limit, avoid certain roads or bridges, etc. Mostly, restrictions cause roads to be prohibited. As per suitability restriction, attribute can be set during network analysis.

It depends upon the network analyst solver that U-turns can allow everywhere or nowhere as per ground reality, or only at dead ends or only at intersections and dead ends. U-turns allows that vehicle can turn around at a junction and double back on the same street.

5.4.3 Directions

Directions properties can be set at the time of creating new network dataset, set the units for display length and time attribute, to open directions automatically after the generation of a route. If display of direction property not required, unselect the direction window button  (Fig. 5).

6 Observation

Nowadays with developing urbanization, the systematic and well planned road network system can play an effective role to customize the transportation system in a planned way. Therefore, it is necessary that the Agencies/Organizations, those who are maintaining the geospatial data of whole country, if that geospatial GIS layer of different features are available with free from topological error and linked with GPS services and authenticated web server then it will be helpful to detect and analyse many transportation and other problems in an organized way.

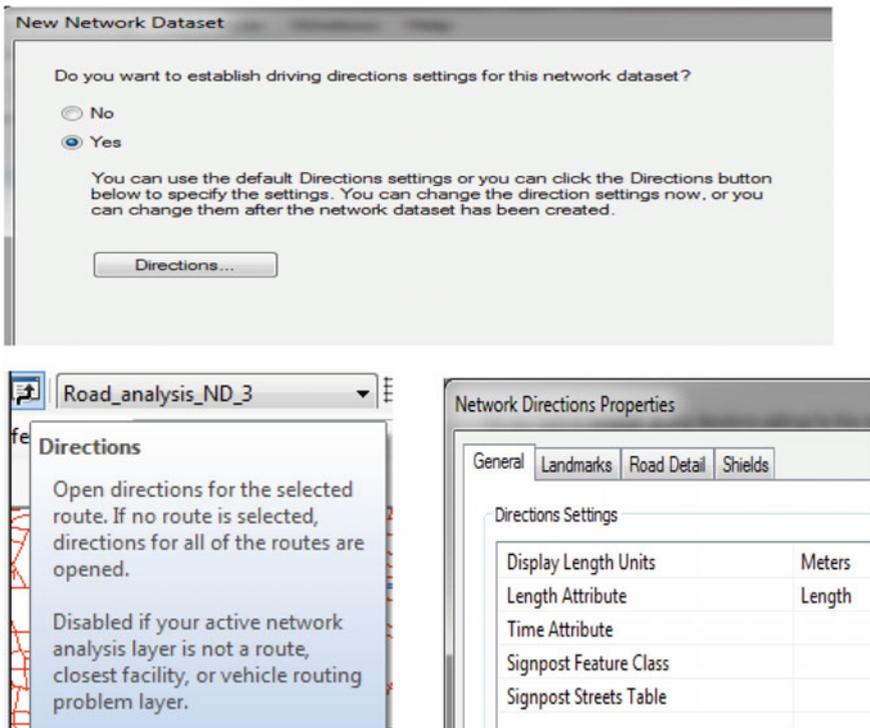


Fig. 5 Network directions setting windows

7 Scope of Paper

- Route analysis will be very useful for Crime Route analysis, and is also used to solve vehicle routing problem.
- Geo coding can also be done. For example, we can find out the details of every house by telephone no.s/mobile no. It is easy for tax collection and development funds.
- We can also add and analyse another layer into this geodatabase like Water Pipe line, Sever Line, Gas Pipe Line and underground electrical lines, etc.

8 Final Output

The outputs of Route analysis are as follows (Figs. 6, 7, 8, 9, 10, 11 and 12).

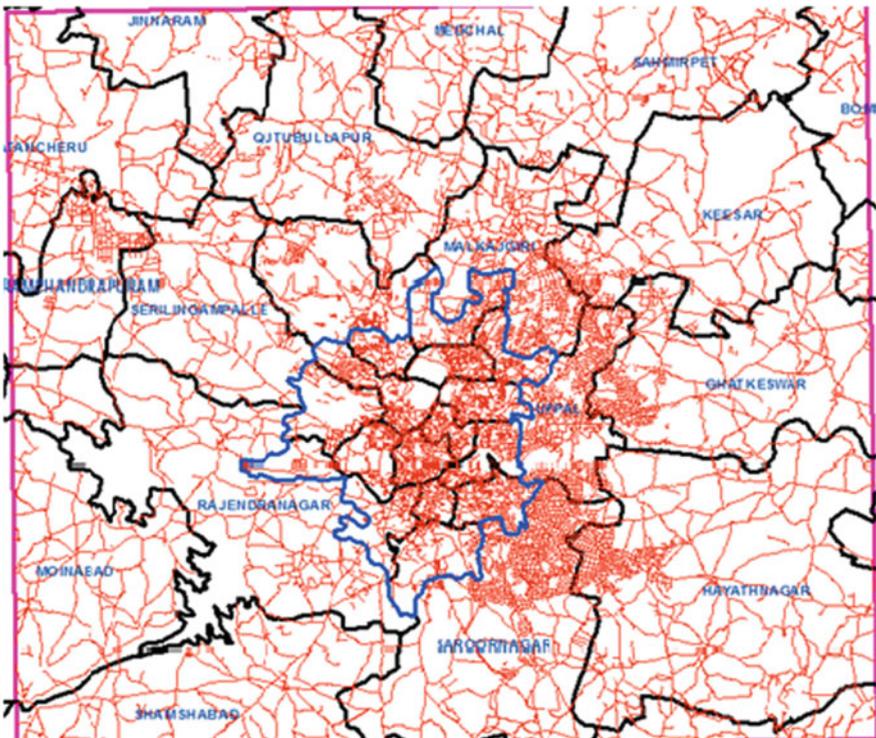


Fig. 6 Study area with mandal boundary

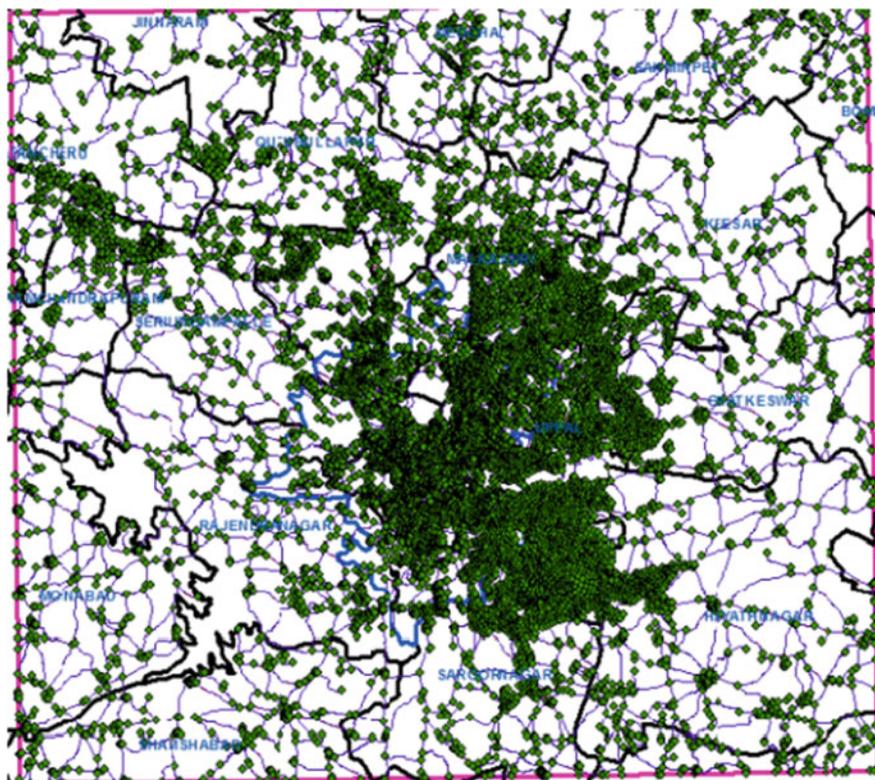
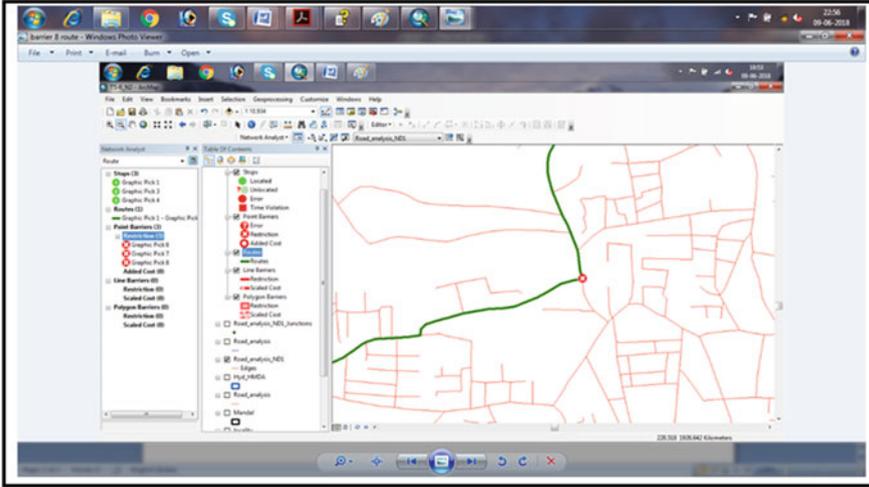


Fig. 7 Network dataset output

(a)



(b)

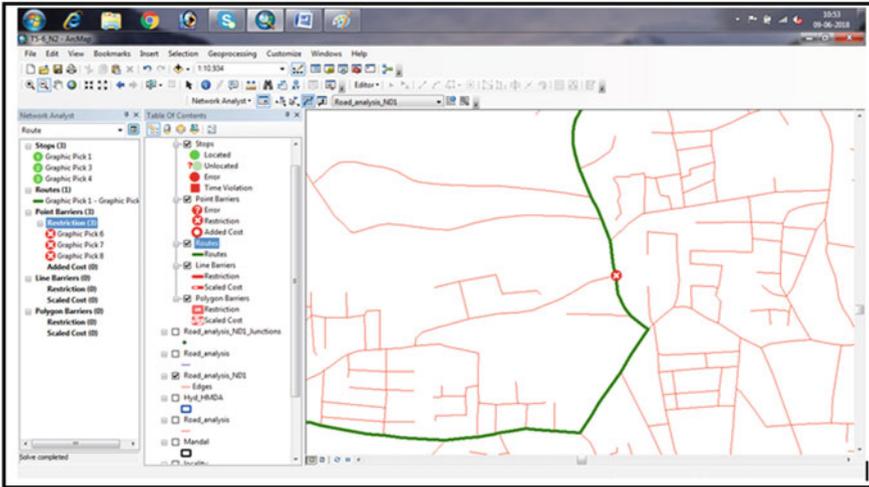


Fig. 8 Point barrier output

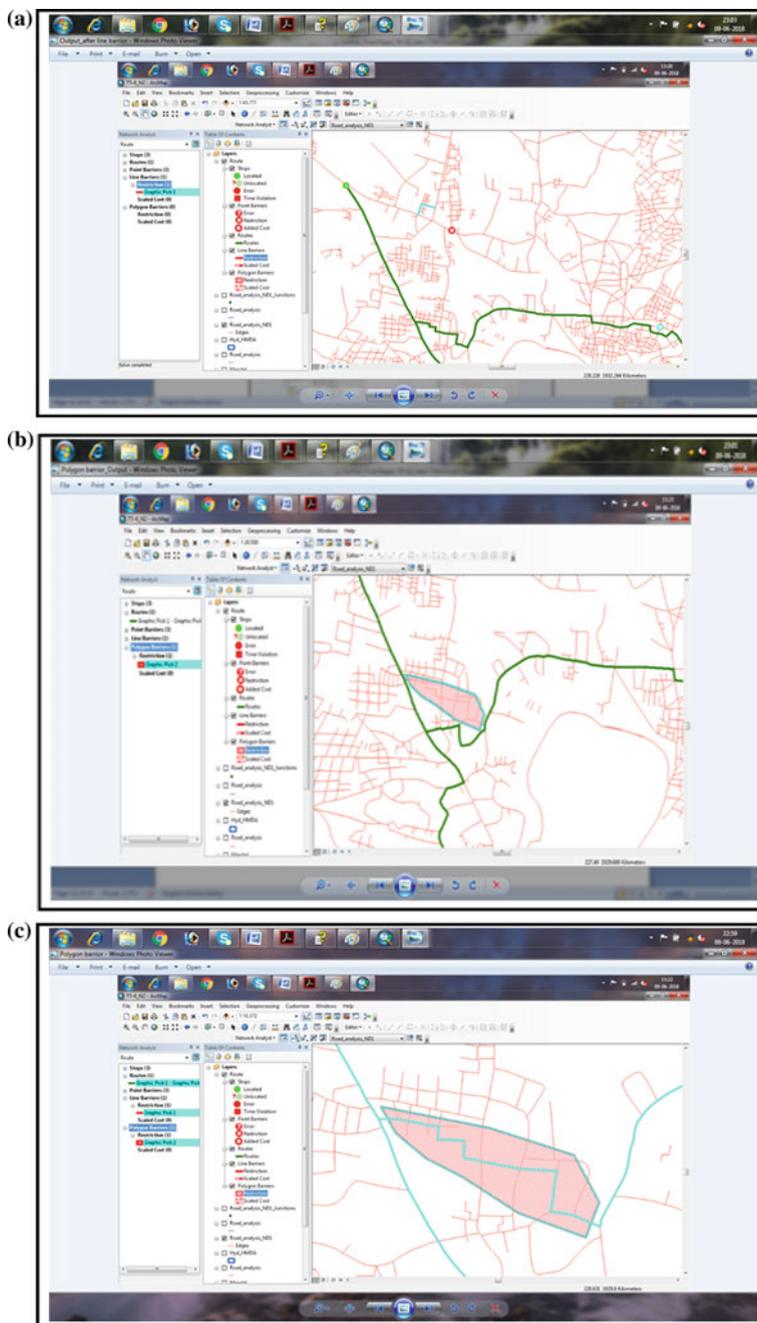


Fig. 9 a Line barrier output. b, c Polygon barrier output

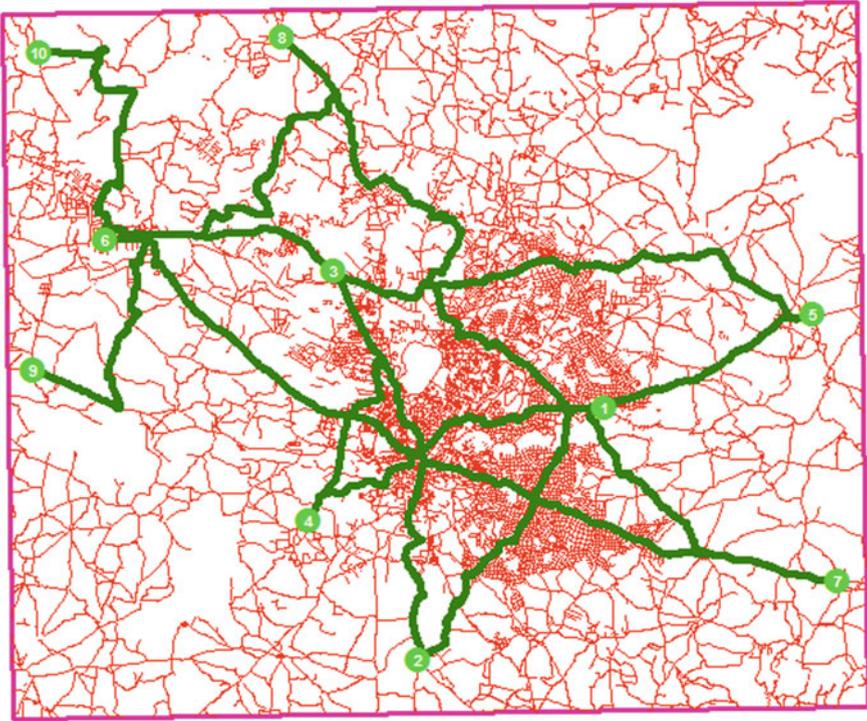
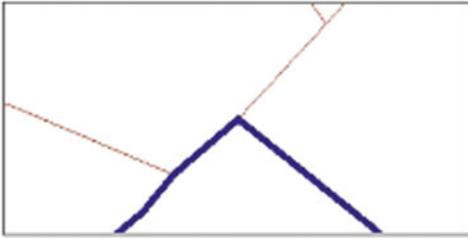
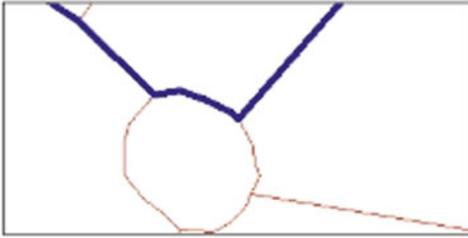


Fig. 10 Different routes network

12: 6936.1 m Turn left to stay on Primary 760.0 m 14 min



13: 7696.1 m Turn right on Primary and immediately turn right on Primary 291.1 m 5 min



14: 7987.2 m Turn left to stay on Primary 709.2 m 13 min

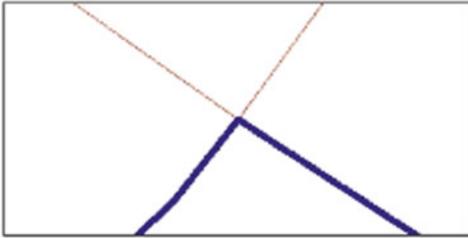


Fig. 12 Route with direction distance and drive time

9 Conclusion

In this study and analysis, it demonstrated about the network analyst applications of new route. Shortest path analysis has given the optimal path between two destinations, when there is some obstruction in route. When this data is web-enabled along with GPS services, then online queries can be made all over the world. On having topologically correct geospatial data from any part of the country/world and along with proper impedance parameter, this study can be expanded on a large scale.

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