

DEVELOPING A MODEL TO FIND SHORTEST ROUTE FOR INCIDENT POINT TO FIRE STATION USING GIS

Jayant A. Patil¹ (Asst Prof), Sushant S. Sathe²(UG Student), Akshay R. Gurav³(UG Student), Riteshkumar P. Bandgar⁴(UG Student), Akshay P. Kamble⁵(UG Student), Shubham S. Kumbhar⁶(UG Student), Pranil S. Kamble⁷(UG Student).

²⁻⁷*Students of Department of Civil Engineering, Ashokrao Mane Group of Institutions, Vathar, Kolhapur, Maharashtra*

ABSTRACT

The mission of fire service is to protect life, property, and natural resources from fire and other emergencies. With increasing demands, the fire service must utilize the best tools, techniques, and training methods to meet public expectations. Risk management, preparedness, and mitigation have taken on new importance with challenges facing fire departments today. One emerging tool that is helping the fire service optimize emergency services delivery is geographic information system (GIS) technology. In developed countries GIS has helped fire services reduce risk, increase efficiency, and improve outcomes. Now, more than ever before, fire service executives and information technology professionals are discovering new and creative ways to apply this proven technology to solve ever increasing fire service demands. Here we solve the problem of finding a closest fire station and its shortest path to reach in kolhapur city, Maharashtra State, India. They used the ArcGIS software and network analysis tool that provide the shortest path from one location to another for finding the nearest location of the Fire station from user's location. The calculations of the shortest path were based on road distances; traffic congestion and state of the roads were not considered. and lastly we create the road and important locations map of kolhapur city.

Keyword : - ArcGIS, network analyses, google Earth Pro, fire station etc.

1. INTRODUCTION

Geographic Information System (GIS) technology is one of the hottest research tools in the world recently and one of the fastest growing high technology of monitoring. It has been proven to be valid and efficient to solve real-life problems, such as responding and resolving emergency situations. GIS can bring all that data together quickly and enable users to analyze and visualize information in an efficient way. It has been used in several fields such as transportation management, emergency services, gas station mapping, Fire station and healthcare planning. The Fire services are not well organized in India. While fire safety requirements have multiplied in recent years, fire services have not developed at all and have not made much progress. The rapid installation of industrial plants with the widespread use of hazardous materials and the construction of large and tall buildings has exacerbated the fire problem. Fire hazards are no longer limited to large cities and manufacturing centers. Large quantities of hazardous goods are transported across the country in different modes of transport on a daily basis and create complex fire safety issues. The main objective of this research is to find the shortest route and representing this valuable spatial information to end-users in efficient way using GIS software. we worked on existing map (primary data) of kolhapur city which is given by Private sector. we created the road map of kolhapur city. In this paper we used the network analyst tool in ArcGIS to develop the shortest route between two point.

1.1 STUDY AREA

Kolhapur city is located between 16 ° 39' North to 16 ° 46' North latitude and 74° 10' 30" East to 74°17' East longitude. The present investigation is delimited to Kolhapur city. The city is well connected by rail and road with the major cities of India viz; Mumbai, Bengaluru, New Delhi and other important cities of Maharashtra like Pune, Satara, karad, Sangli, and Miraj. The distance of Kolhapur city is 395 km from the south of Mumbai. The main

system of the hill is the sahyadri, which run North South in the western portion of the Kolhapur. It is located in panchganaga river basin which is formed by the tributaries homely kasari, kumbhi, tulasi, dhamani and Bhogawati.

1.2 SCOPE OF PROJECT

When a fire occurs, any delay of responding fire companies can make the difference between the rescue of occupants versus serious injury or death. The critical time between fire containment and flashover can be measured in seconds. Fast access to critical information is essential. Tools that help firefighters pinpoint the emergency call location, assess the potential consequences, and determine the most efficient strategy will minimize property damage and better protect the safety of occupants and fire service personnel. Historically, first responders have relied on experience, good equipment, communication, and teamwork to achieve successful emergency response. However, with all the challenges confronting emergency crews today, effective response requires good planning, risk management, comprehensive training, and intelligent deployment through preparation. GIS technology has become a powerful tool for improving all aspects of fire service delivery systems. As populations and building development increase, the role of the fire service becomes more demanding and complex. As never before, fire departments are being called upon to deliver services with greater efficiency and economy. Citizen tax-reduction initiatives, burgeoning needs for different kinds of local government services, and a host of other factors have brought new demands to the desks of fire chiefs—most notably, the demands to "do more with less" and to do it "better, faster, and cheaper." GIS technology brings additional power to the process whereby hazards are evaluated, service demands are analyzed, and resources are deployed. In addition, GIS contributes to the speed with which emergency responders are able to locate, respond, size up, and deploy to an emergency. Fire officers are continually collecting data from a wide variety of sources to better perform their jobs. This data may come in many incompatible forms. By utilizing GIS, data can be quickly analyzed and displayed in different arrangements to allow patterns and trends to emerge. Fast access to needed data can save time, money, and lives

1.3 OBJECTIVE

The objectives regarding projects are:

1. To collect the data as per GIS software.
2. To create geodatabase of Kolhapur city for road map.
3. To create geodatabase of Kolhapur city for important location.
4. To find the shortest route from fire station to fire incident area.

1.4 METHODOLOGY

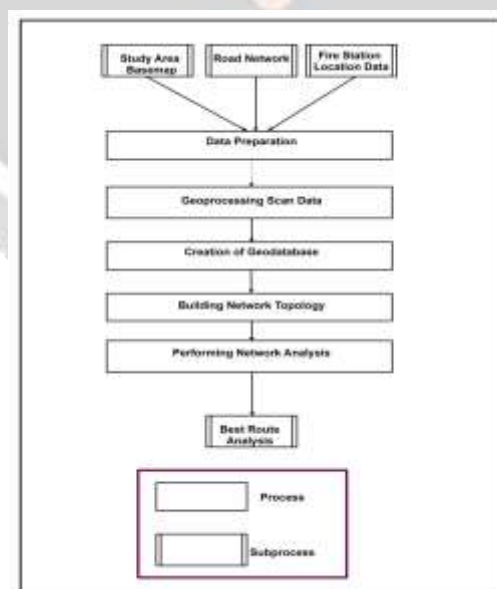


Fig.1 Methodology

In this research, the flowchart of the proposed enhanced roads network analysis methodology using GIS software is shown in Figure . Six stages of the process have been applied, beginning with collecting and preparing the data that

will be used in the analysis (the study area base map of Kolhapur road city, road network data.), then Georeferencing the base map of the study area. Following this is the creation of a Geo-database that will store the prepared data. Then building both the network topology and the network dataset. Finally, the network analysis process has been applied to the road network of the Kolhapur road city.

2. GEO-PROCESSING

The collection of data from Kolhapur Municipal Corporation and private departments as a Surve consultancy, Kolhapur. Surve consultancy is one such consultancy which has taken a contract from Kolhapur Municipal Corporation (KMC) to making the map. We took a Kolhapur city map from the **Surve** private consultancy to make our own map of Kolhapur. They took his fee. This map will be used for road digitization and Georeferencing. From this map, we create geodatabase of Kolhapur city for road map and for important location.

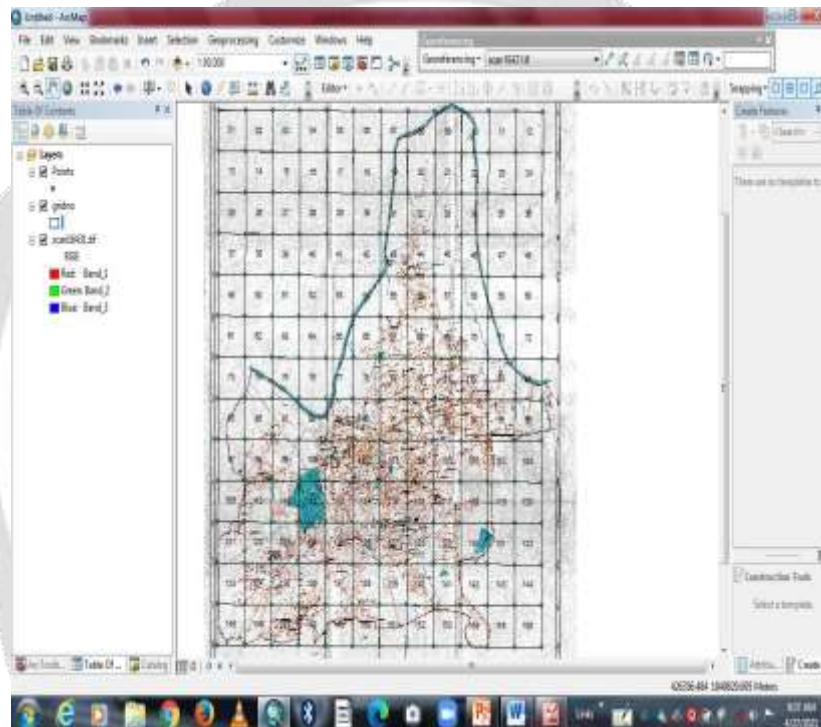


Fig.2 Tiff Image of kolhapur Road City

First we distribute the block wise work. There are 156 block in Kolhapur map that we collected that data. Each got 26 blocks to work out such as Georeferencing, digitization etc. With the help of latitude and longitude we create these blocks. For example consider 1st block, The latitude and longitude of this block is 16 45' 0" North to 16045' 30" North latitude and 74014 0" East to 74014'30" East longitude. Just right click on ARC GIS desktop and select the name of absolute X and Y. and put the values of latitude and longitude clockwise then create point on desk. Similarly the remaining point or blocks are made by this way.

2.1 GEOREFERENCING

Georeferencing means that the internal coordinate system of a map or aerial photo image can be related to a geographic coordinate system. In other words Georeferencing means to associate a digital image file with locations in physical space. Different maps may use different projection system. Georeferencing tools contain methods to combine and overlay these maps with minimum distortion. Shortly Georeferencing means JPG image or file converting into TIFF file. Georeferencing is very important to digitize the road and mark the important locations. Without Georeferencing we cannot work on GIS. In this phase, a Geo-referencing process for the existing map of kolhapur road city is being performed. The Georeferencing process allows the registration of the digitized the kolhapur road map. It is considered a very critical stage as it affects the accuracy of the road network data.

2.2 CREATE SHAPEFILE OF LOCATIONS AND ROAD

A Shape file is an Esri vector data storage format for storing the location, shape, and attributes of geographic features. It is stored as a set of related files and contains one feature class. Create the Shapefile of location name (**Point feature**) and new Palace lake (Polygon feature) and editing with TIFF image grid no 67. Next adding filled attribute table with proper locations help of existing Kolhapur map. Following are the steps of creating new Shapefile of important locations (point features).

1. Open Arc GIS Map. There is three tool below the left side arc tool box, table of content & catalog.
2. Create new folder as location in Catalog. Right click on this folder and select new.
3. Select Shapefile & give the name as PT67.
4. Click on feature type & select the Point Then next click on edit & select geographic coordinate systems as WGS 1984 UTM Zone 43N. and press Ok button.
5. Then shapefile of PT67 will be created. & next work on its with TIFF file of Kolhapur city map. TIFF file of grid no 67 is below
6. Next from editor tool bar, select start editing with PT67. Go the create feature tool below the right side and select the PT67. & mark the Important locations.
7. Important locations marked.

In this way Shapefile of all Roads and locations in 156 Grids were completed.

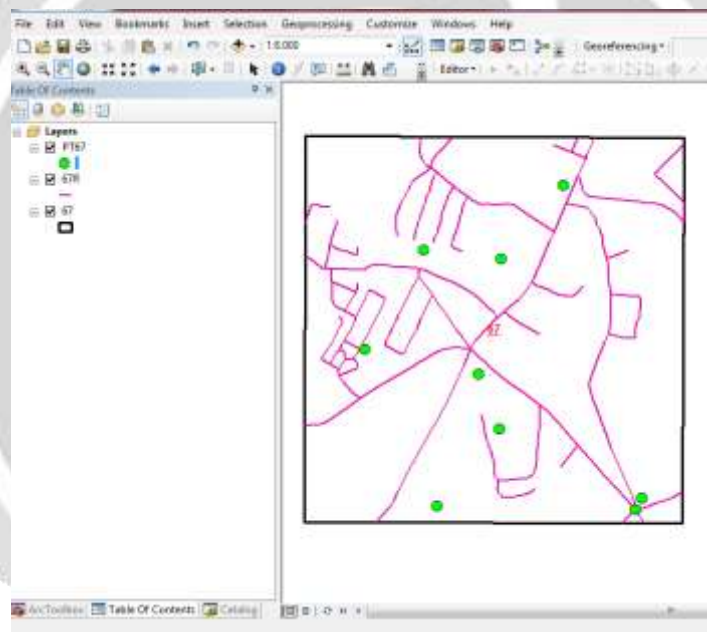


Fig.3. Shapefile of Road and Location

2.3 FILLING ATTRIBUTES OF ROADS

After complete the Shapefile of all road and important locations in total grid then next is filling of attribute table. For example, we consider here Grid 67 sample

1. Open the Shapefile of 67R. In table of content, right click on the 67R Shapefile. Go to the table option then table option window display then click Add Field.
2. Add field table, open Give the name as Road Name then select Text Type and select Ok. Start editing from toolbar window, then select a line of road in 67R Shapefile. Blue line is a selected line
3. After selecting line of road, go to the bottom of right side window then select the attributes and give the name of that road i.e. kasba Bawada Rd Then save edit and stop edit from editor toolbar.
4. The attributes of roads in 67R is completed. In this way attributes of all Roads in 156 Grids were completed.
5. After filling of all attributes then go to the table of content (TOC) and select 67R then right click on this. One window will open then click on the Label Features, After click on the label features then label features will be on.

6. Then Road names will be display after label features on.
7. Next go the Properties and change the style, size & font of of text. Completed Filling of attributes work.

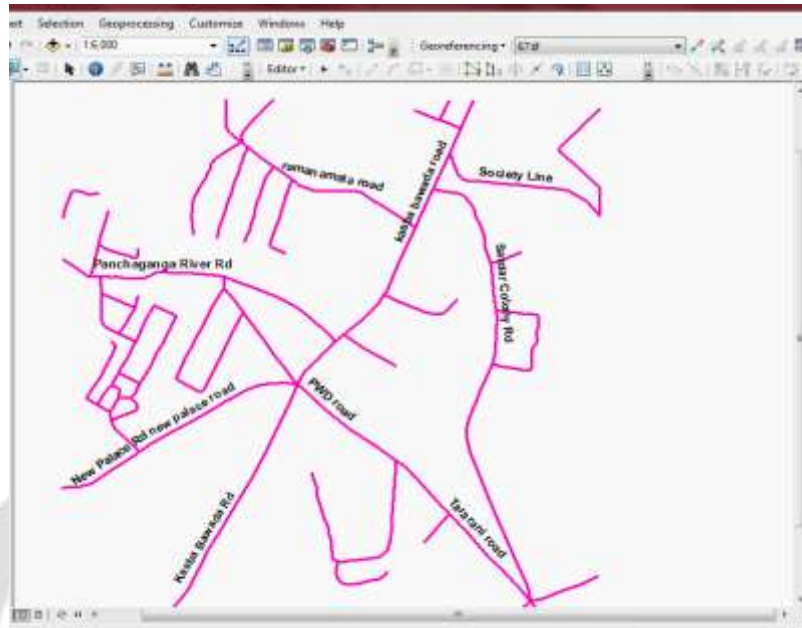


Fig.4 Attributes of Roads

2.4 TO ADD LOCATION OF FIRE STATION BY USING GOOGLE EARTH:

We took the location of the fire station from Google earth to Arc GIS. In Kolhapur city there are total six fire stations. Following are the procedure of how to take location of fire station from Google earth.

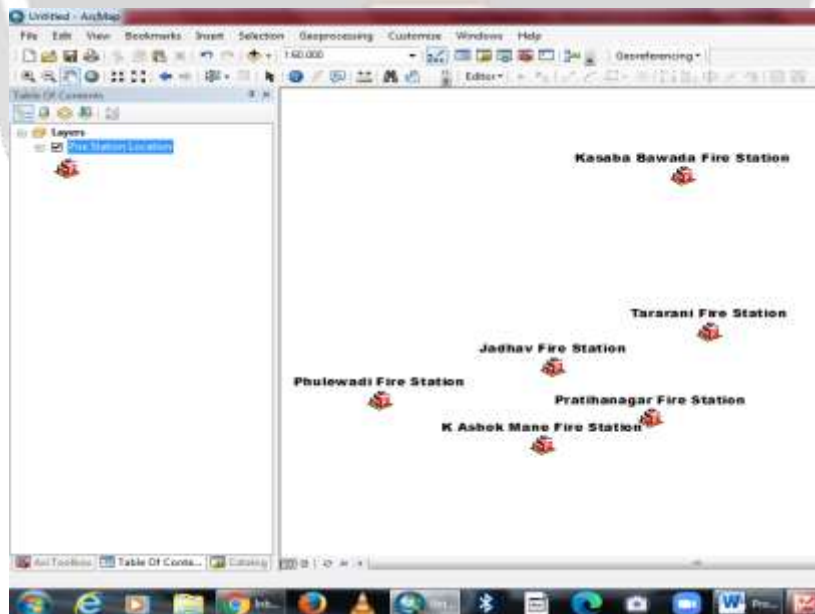


Fig.5 shapefile of Fire station taken by Google earth

2.5 CREATION OF GEODATABASE AND DATA MERGING

The Geo-database is the native data structure used in ArcGIS and is the fundamental data format used for both editing and management of the data. A Geodatabase can be personal, file, or enterprise. In this proposed method, a

personal Geo-database has been created using ARCGIS. A personal Geo-database is a database that can store, query, and manage both spatial and non-spatial data. It will contain the data of healthcare service providers, road network, and traffic tables. The road network data and the healthcare service providers' data were discussed earlier in the methodology.

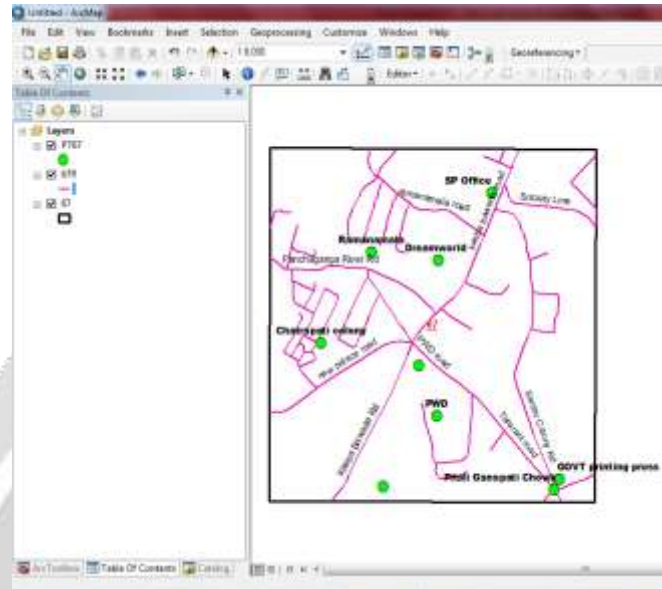


Fig.6 Geodatabase

Data merging is **the process of combining two or more data sets into a single data set**. Most often, this process is necessary when you have raw data stored in multiple files, worksheets, or data tables, that you want to analyze all in one go. In this, team work of group members (Distributed work)i.e. roads takes together. six different Shapefile of roads created by group members is merged into one shapefile.

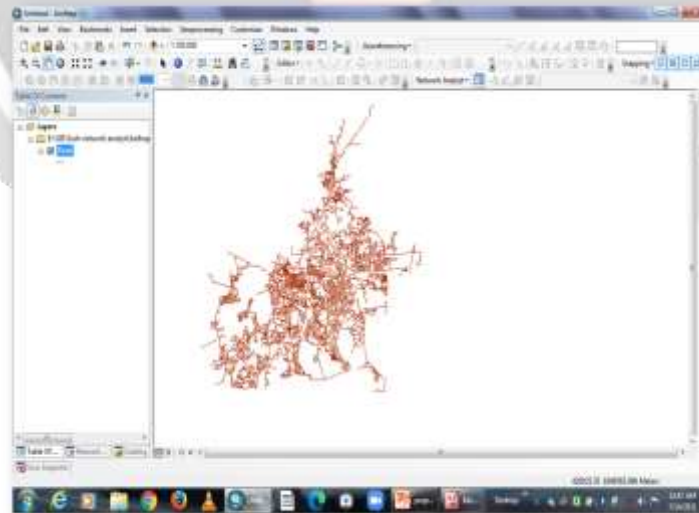


Fig.7 Data Merge

3. BUILDING NETWORK TOPOLOGY

To get good analysis and results, it is necessary to build a topology of the road network to discover whatever errors in the data and correcting them. This was performed by applying some topology rules such as ensuring that there are no dangles in the road network and the roads do not intersect or overlap with themselves.

3.1 NETWORK DATASET

After correcting the road network errors, it is ready for being used in building the network dataset that will be used in the network analysis. The line feature class will represent the road network and must be stored in a feature dataset. It consists of a set of edges that represent the links over which agents will travel, and a set of junctions that connect edges and facilitate navigation from one edge to another. The Network analyst extension was used in ArcGIS for Desktop to create the network dataset shown in Figure. Following are the steps to create the network dataset.

1. In this, First create the **new personal geodatabase as Kolhapur City Road**. Right click on this Kolhapur city Road geodatabase and click new and **select Feature dataset**. Give name As **Road**.
2. Shapefile of Kolhapur city road is **export to Feature dataset (Road)**.
3. Then right click on feature dataset as Road & click New and **Select Network Dataset**.
4. Continue click on Next. Then network dataset will create.

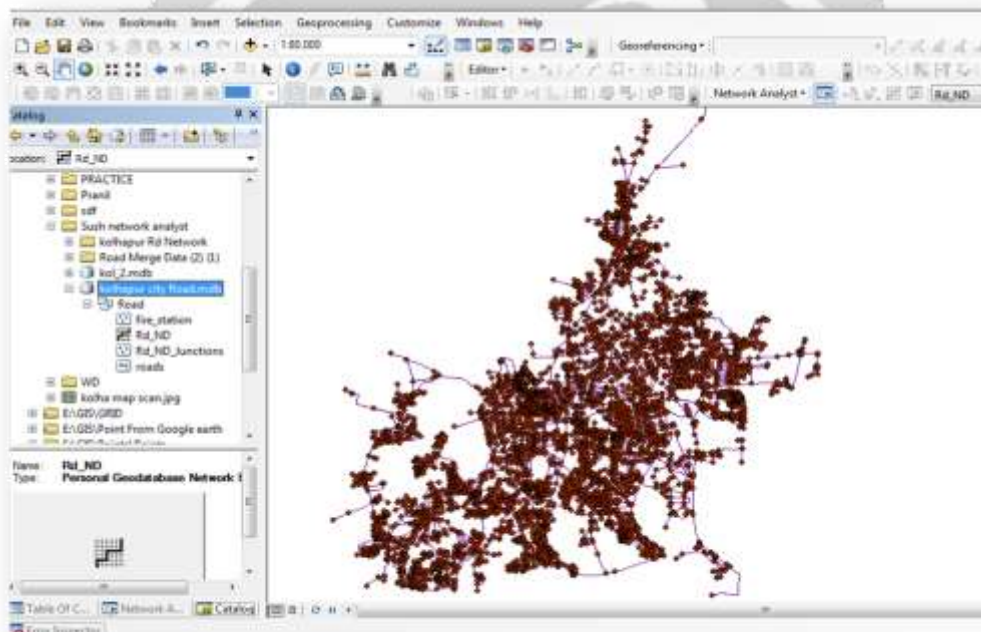


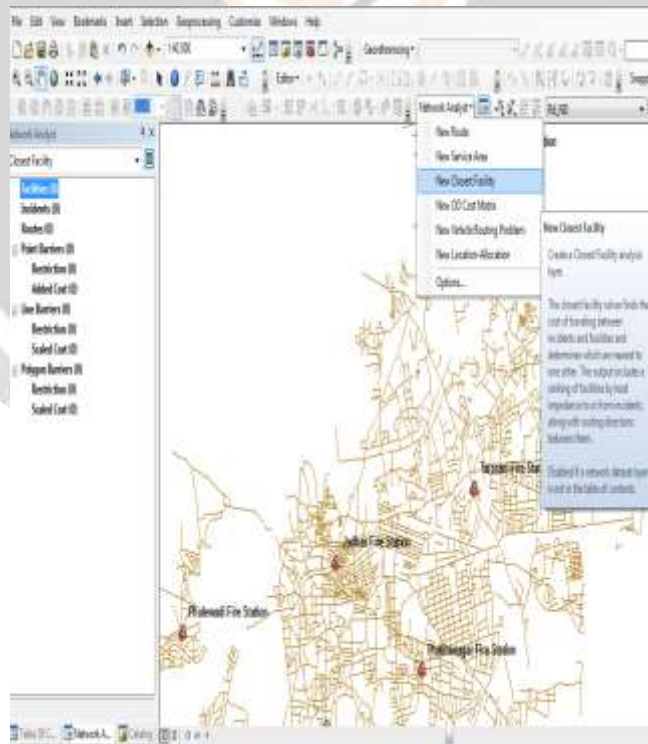
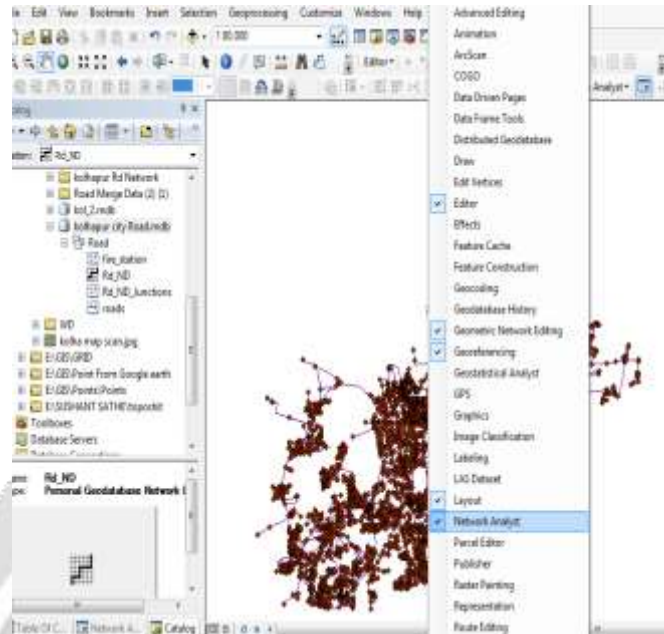
Fig.8 Network Dataset

4. SHORT ROUTE ANALYSIS

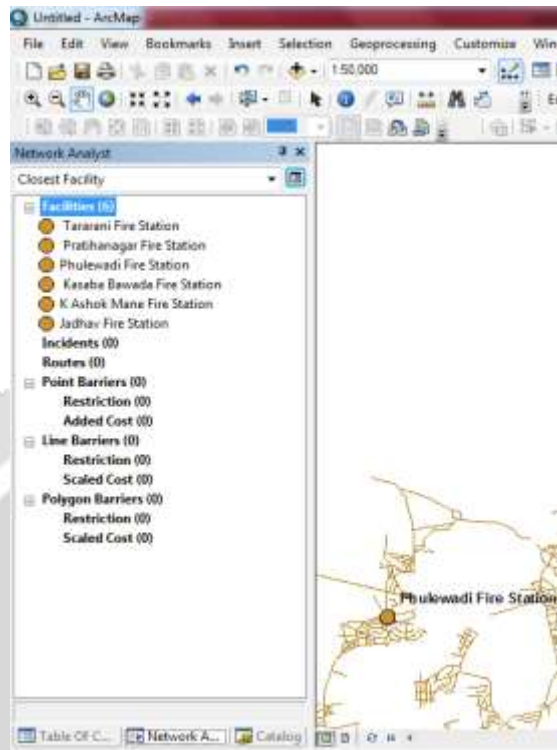
The road network analysis has been implemented using ArcGIS Network Analyst Extension. It is a powerful extension of ArcGIS that provides network based spatial analysis, including route analysis, travel directions, closest facility analysis, and service area analysis. Two types of network analyses were applied; the best route analysis, and the closet facilities analysis.

Following are the steps how to develop/find short route analysis :

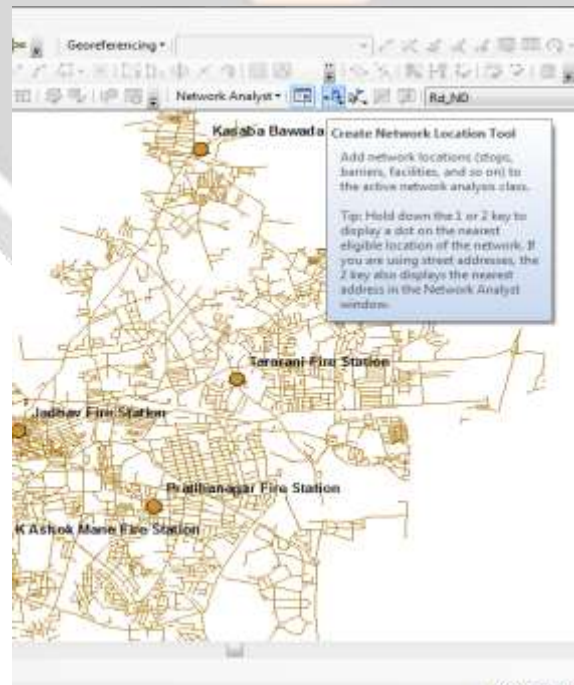
1. Select Network Analyst window from toolbar to perform project model. The Shapefile of fire station is import to Feature dataset of Road then Drag the Shapefile of fire station locations. Then Network dataset junctions turned off. Click on network Analyst window and select new closest facility (Means nearest fire station).
2. Just Right Click on Facilities then Load the locations of Fire stations. Window of Load locations will open then select the fire stations and its Attributes names then click on ok button.



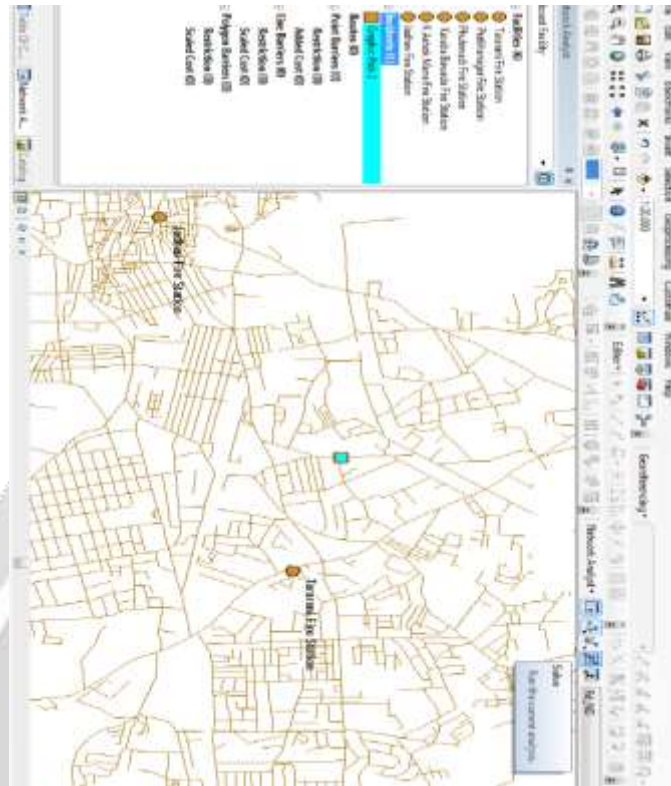
3. Total all fire stations in Kolhapur city is loaded in facilities for closest facilities. In Figure, brown colour circle is indicated the Fire stations in Kolhapur city.



4. Go to the network Analyst and click on create network location tool .After this, click on the incident from Closest facilities in network Analyst.

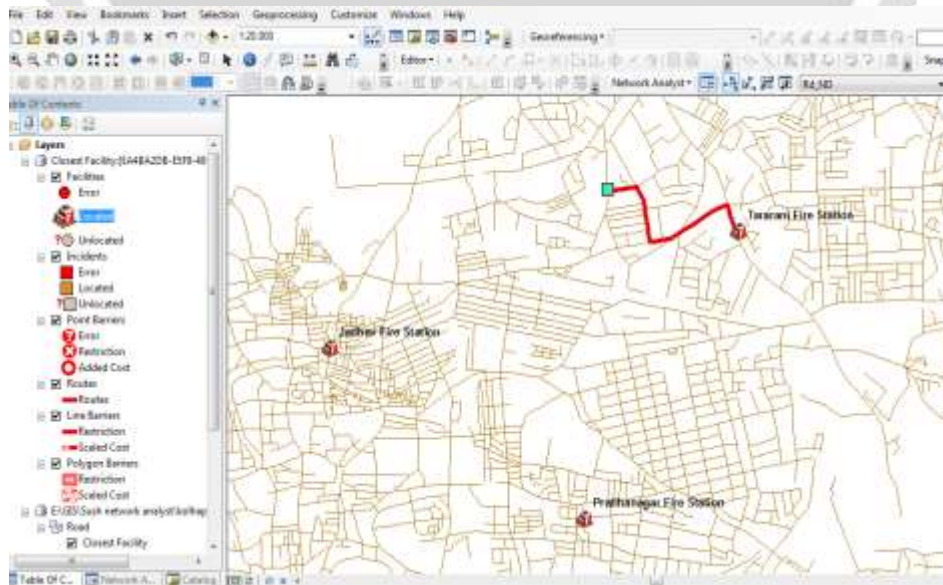


5. Then click the incident anywhere in Kolhapur city map. After selecting Incident point anywhere in map, then just click on Solve button in network Analyst window.

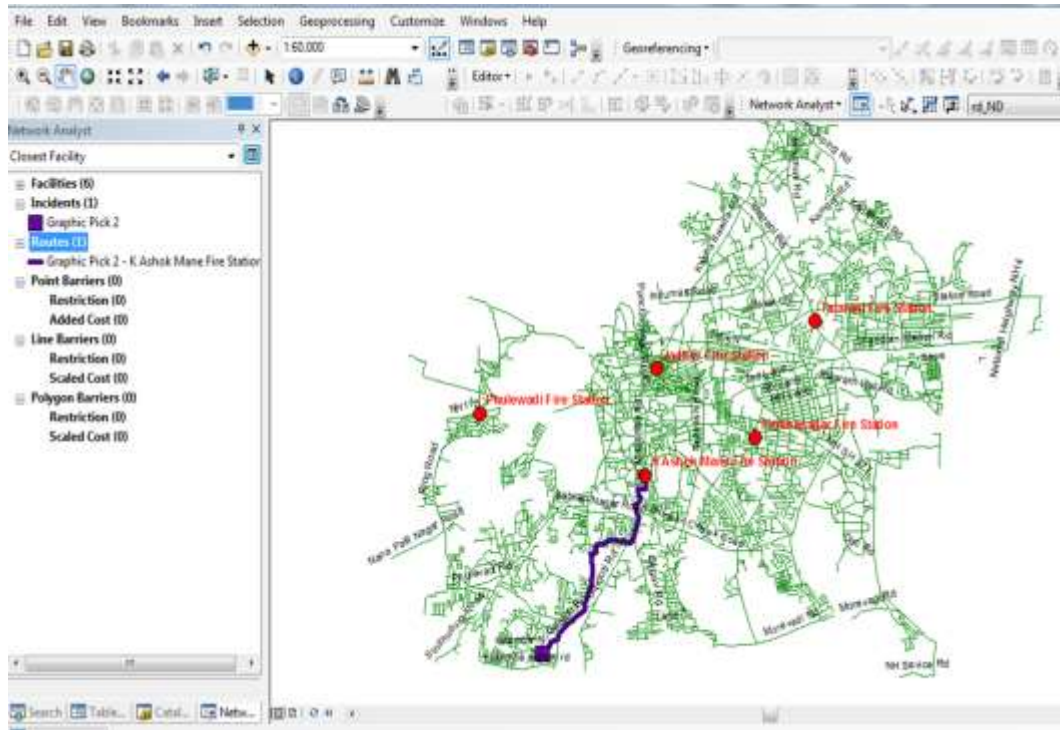


6. After click on solve button, system Searched the nearest closest facility from the incident point. Red colour line is indicated the shortest route from incident point to fire station.

Example no : 1



Example no: 2

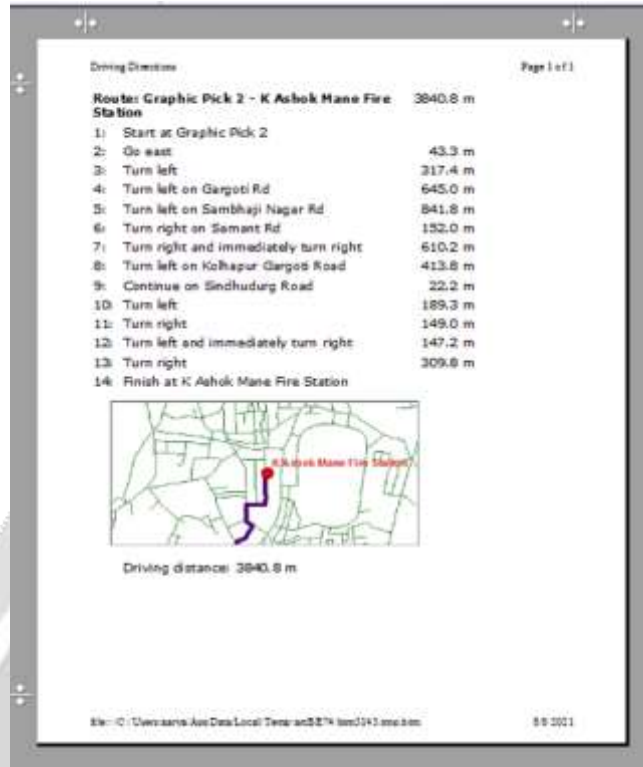


7. To knowing the details of this route, right click on the Routes in network analyst windows then click the Directions.

Example no : 1



Example no : 2



The distance of the route obtained from the shortest route analysis represents the accumulated lengths of the road segments over which agents will travel.

5. CONCLUSIONS

We chose this project but we didn't know this project is so vast. Because no one knows much about its technology in civil industry. Very few people know what GIS can be used for in civil engineering. It was very difficult to know the requirements for these projects. Using GIS we can get the exact idea on the topography of the earth surface. It's also essential to study geological settings of the area by digitizing maps. If fire stations use Google data, but they cannot use it directly because Google never gives their shapefiles; they offer their direct paid services. So that's why you need to create your own map of district/town/city.

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