

Minimizing the Traffic Congestion Using GIS

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Abstract

Traffic congestion is a condition on road networks that occurs by slower speeds, longer trip times, and increased vehicular queuing. Traffic congestion varies from time to time. Traffic management is the application of sound management principles and practice to optimise the use of existing road network with a view to improving traffic flow and road safety without impairing environmental quality. To study the effect of the Transportation System Management (TSM) measures one needs to have a clear view of the flow patterns, locations, as well as existing road network. Geographic information system (GIS) can be effectively used analyse the problems associated with transportation. In Coimbatore the number of vehicles in the city is increasing day by day and almost 2000 vehicles are being registered every day. An attempt has been made to reduce the traffic congestion using SPSS16 and to identify and rectifying the problems using a GIS based model.

Keywords: *Transportation System Management, Geographical Information System, GPS, Regression Analysis, SPSS – Statistical Package for Social Science*

1. Introduction

GIS provides a powerful, logical, and intuitive means to store, manipulate, and retrieve data. In addition to promoting linkage between various types of data and maps GIS is able to manipulate and visually display numerous types of data for easy comprehension. GIS is a technology for managing and processing location and related information. It visually displays the results of analyses thus enabling sophisticated analysis and quick

decision making. Toposheet helps us to know about the boundary of each area, road networks, railway routing, buildings, waste land etc. To identify and map the changes, updating is done using ArcGIS. Although GIS has been used for over thirty years however it has only been recently used in the field of transportation. Development of a system that uses GIS to analyze traffic congestion has been pursued towards improving the efficiency and effectiveness of traffic congestion counter measures.

2. Literature Review

Ogunbodede E. F. explained that GIS is a tool that can be used to sustain an enduring flow of traffic in urban environment, provided it is built on a properly designed database, which must also be amenable to constant updating.

Ammar Alazab, Sitalakshmi Venkatraman, Jamal Abawajy, and Mamoun Alazab examined the value of real-time traffic information gathered through Geographic Information System for achieving an optimal vehicle routing within a dynamically stochastic transportation network. These features will help users and vehicle drivers in improving their service levels and productivity as the Web application enables them to interactively find the optimal path to reach the destinations.

Mukti Advani, B. Srirama and S.K. Pathan developed a GIS based model with an objective of minimizing

travel distance and travel time of users. Constrains taken into consideration were impedance for intersections, type of road and speed. It is reported that GIS is an useful tool for getting solution of such complex problems very accurately and rapidly.

3. Study Area

Coimbatore also known as Kovai is the second largest city in the Indian State of Tamil Nadu and the 15th largest urban agglomeration in India with a metropolitan population of over 2 million. It is a major commercial centre in TamilNadu. It is surrounded by the Western Ghats mountain on the Western side and reserve forests and the Nilgiri Biosphere Reserve on the northern side. The Noyyal river runs through Coimbatore and forms the southern boundary of the corporation. Coimbatore is administered by the Coimbatore Municipal Corporation which comprises 100 wards grouped into five zones. It has 9 Taluk and 482 Revenue villages. The study area covers about 246.75 sq km. It lies between latitude 10°55'N to 11°10'N and longitude 77°10' to 76°50'E.

4. Materials and Data Used

4.1 Traffic Data

This is the average daily traffic in pcu and cvpd on the national highways in TamilNadu.

4.2 SOI Toposheet

Scale - 1:25000

4.3 Software Used

Software packages to be used

- Arc GIS
- SPSS 16.0

5. Steps Involved

The steps involved in the analysis are shown in Fig1.

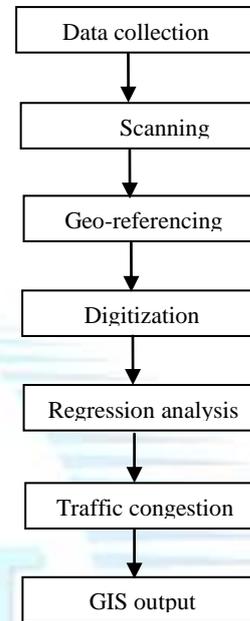


Fig .1 Methodology

5.1 Data Collection

In order to determine the accident prone locations in Coimbatore district, following data were collected and used.

1. Traffic data for the years 2011 and 2012.
2. Survey of India topological map at a scale 1:25000.

GIS Software

The various GIS software available in the market are as follows:

1. ARC VIEW
2. AUTOCAD MAP
3. ARC/INFO
4. MICROSTATION GEOGRAPHICS
5. MAPINFO
6. GEOMATICA
7. SPANS
8. ILWIS

9. GRASS

In the present study, ArcView software was used for creating the congestion map.

5.2.1 Map Scanning

Scanning a map results in raster data that could be further converted into vector data.

The Survey of India topographical map at a scale of 1:25000 was scanned and a raster map was created. Existing maps can be digitized to produce digital data.

5.2.2 GEO Referencing

Geo referencing involves assigning real world coordinates to a number of reference points on the image. In Arc GIS, this is done using geo referencing tool bar. Geo-referencing means defining the object existence in physical space. That is, establishing its location in terms of map projections or coordinate systems. The term is used both when establishing the relation between raster or vector images and coordinates, and when determining the spatial location of other geographical features. To establish the relationship between an image co ordinate system and a map(x, y) coordinate system, the raster data has to be geo-referenced.

5.2.3 Preprocessing Technique

IRS image of 5.8m resolution and toposheet of scale 1:25,000 were scanned. Geo-referencing was done using ArcGIS and geometric rectification was done using ERDAS IMAGINE 8.6.

5.2.4 Digitizing

Digitizing is the process of encoding the geographic features in digital form as x, y co ordinates. It was

carried out to create spatial data from existing hard copy maps and documents. In the present work the geo-referenced raster image of Coimbatore district was digitized using Arc GIS9. The digitized road network of



Coimbatore district is shown in Fig.2

Fig .2 Road Network of Coimbatore District

5.3 ARCVIEW Software

Arcview is one of the best software to analyze spatial data and to produce high quality maps. Spatial Analyst extension is added in Arc view for spatial analysis. Arcview comes with a useful set of ready-to-use data to create hundreds of different maps. Once the map is created it is easy to add tabular data, such as dbase files and data from database servers, so that one can display, query, summarize, and organize data geographically.

5.3.1 Platform

- Microsoft Windows
- Unix

5.3.2 Data Formats

The data format includes spatial and image type.

5.3.3 Spatial formats

Spatial data is at the heart of every Arcview application. Here are the main spatial data formats:

- ArcView shape files
- ARC/INFO coverage's

5.3.4 Image formats

An image is a type of spatial data based on rows and columns, where a single piece of information is stored in each pixel (or grid-cell).

- BSQ, BIL, and BIP
- ERDAS LAN and GIS
- ERDAS IMAGINE
- JPEG
- BMP
- Sun raster files
- TIFF, TIFF/LZW compressed, and geotiff

5.3.5 View

A view is a collection of geographical features, which when overlaid creates a composite map. A view defines the geographical data that will be used and how it will be displayed. A typical view of the window of the Arcview GIS is shown in Fig 3.

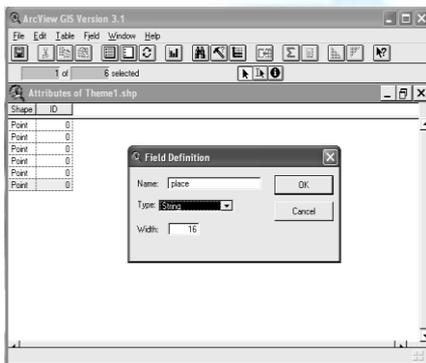


Fig .3 View Window of ArcView GIS

5.3.6 Theme

The geographical features in this world can be represented in Arcview as point, line or polygon theme. Points represent discrete locations such as wells, cities, shops and telephone poles. Polygon represents

homogeneous or relatively homogeneous areas such as states, parcels, land use zones, soil types, or forest stands. Line represents roads, streams and pipelines.

5.3.7 Creating a new theme

The following steps are followed while creating a new theme be it a point, line or polygon.

1. The view is opened to add the new theme
2. From the view menu, new theme is chosen. One of the feature types (Point or Polygon or Line) is selected for the theme.
3. The drawing tool palette is used to add the points, lines or polygon features to the theme. And creating a new theme dialog box is shown in Fig 4.

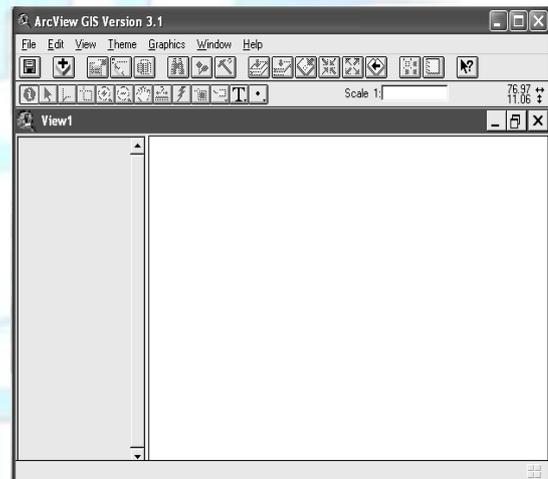


Fig .4 Creating a New Theme

5.3.8 Attribute table

The Attribute table is a data file that contains information organized into rows and columns. Each column represents an attribute and each row a record. Tables are typically linked or joined to themes. A table lets to work with data from a tabular data source in ArcView. Data from almost any tabular data source can be brought into ArcView as tables. Data from these

tables can be added to maps, and symbolize, query and analyze can be done to this data geographically.

6. Regression Analysis

Regression analysis is done by using the software SPSS 16.0 SPSS is good for organizing and analyzing data. One can rearrange data, calculate new data and conduct a variety of statistical analyses. Theoretically, there is no limit to the size of data files, so you can work on large data files in SPSS when you cannot do so in Excel. The most common example is the physical use of roads by vehicles. The equation is formed and the range value 'R' is interpreted.

6.1. Procedure and Output Using Regression Analysis

One of the most powerful uses of regression analysis is to predict the values of the dependent variable, sometimes for a future time period, but more generally, for any given set of values of the explanatory variables.

Types of Regression

- Linear regression
- Binary logistic regression
- Multinomial logistic regression
- Ordinal regression

SPSS 16.0

SPSS 16.0 is a modular analytical product for all stages of the analytical process, from planning, data collection, data access, data management and preparation, to reporting and deployment. SPSS 16.0 is a modular solution that allows user to plug in add-on modules and integrate stand-alone software which enhances the core SPSS 16.0 system with specialized capabilities.

6.2 Regression Model

In order to determine a mathematical model using regression model, in present study we have considered parameters like hourly traffic volume, average traffic flow speed (kmph), PCU, total vehicles parked, distance

A common form mathematical model for traffic congestion is as follows

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + \dots + a_nX_n$$

Where, Y is traffic parameter.

a_0 is constant.

$X_1, X_2, X_3, \dots, X_n$ are the variables affecting the road traffic.

a_2, a_3, \dots, a_n are the coefficients to be determined adopting multiple linear regression method.

6.3 Linear Regression Using SPSS

Linear regression is used to specify the nature of the relation between two variables. Another way of looking at it is, given the value of one variable (called the independent variable in SPSS), how can we predict the value of some other variable.

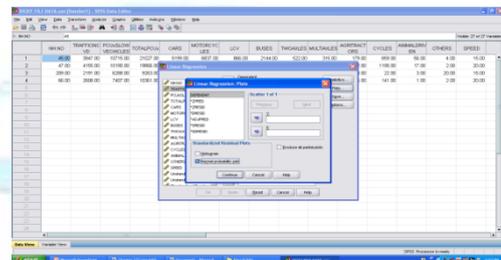


Fig.5 Linear Regression dialog box

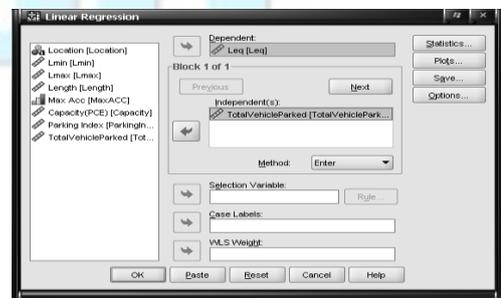


Fig.6 Variables Selection Window

1. The Method drop-down box allows you to select the method of regression you want to run. The methods listed are Enter, Stepwise,

Forward and Backward. By default, Enter method is selected.

2. Click on the Statistics... button to select the regression coefficients, residuals and other options listed. Click on the Continue button.

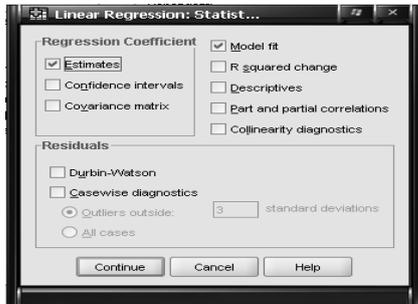


Fig.7 Linear Regression Statistics Window

3. Click on the Plots.... button to select the plots variables. Click on the Continue button.

The output obtained by using ARC GIS and the map showing the traffic congestion is obtained.

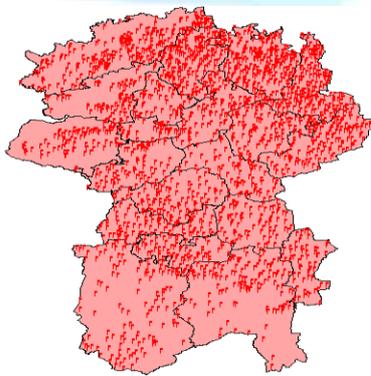


Fig.8 Map showing the congestion in road

7. Conclusion

The significant result obtained from the study, is during working days the average speed of traffic flowing towards city is found to be 20km/hr. It clearly shows that during working days more people migrate towards city for official and business practice for the aforesaid case during holidays the situation takes place in reverse

manner i.e., average speed of traffic flow towards city is 40km which is more than compare to that slow away from the city. This may be because more people travel away from city for recreational purpose. In the study GPS and GIS for used in data preparation and data definition for model development .it is used as disseminate congestion ,result and for model speed comparison the transferable ability for of the model develop is not fully tested .In the study because the data collection technologies have different for different cities.

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