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APPLICATION OF GIS IN TRANSPORATION

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Abstract

This report is written to get an idea and information about Geographical Information System (GIS) and its application in Transportation planning. GIS basically it is a computer system for storing, managing, and displaying geospatial data. When so many parameters are to be connected with Transportation network like travel time, speed, road resistance, turning movements, etc. For such a big network GIS (Geographic Information System) proves itself as an efficient tool for solving such a network problems quickly and with a great precision. The GIS Software is determining the optimal routes or Best routes from one origin to many destinations kind of problem, 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. GIS emerged as better tool for getting solution of such complex problems very accurately and rapidly.

Keywords: *GIS, Transportation*

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1. INTRODUCTION

1.1 General

Geographical Information System (GIS) is a system designed to capture, store, manipulate, analyze, manage, and present spatial or geographical data. In general, the term describes any information system that integrates, stores, edits, analyzes, shares, displays geographic information.

GIS is a computer system that can be used by businesses, organizations, schools, individuals and government entities. Those who use GIS are looking for unique and innovative ways to solve a number of problems. Through the use of GIS, information about the world is stored as a collection of layers that are linked together by a common locational component, such as zip code, longitude and latitude, road name or census tract name.

Using this information, it is possible to analyze patterns and trends, GIS is the go-to technology when it comes to making better decisions about a location. For example, GIS is extremely useful in things like route selection, snow event analysis, natural resource extraction, fleet activity, personnel safety, accountability and efficiency and evacuation planning.

Another interesting trend has been the convergence between geospatial technologies comprising GIS, GPS (global positioning system), and remote sensing technologies such as satellite images, LIDAR (Light Detection and Ranging), and products that orthorectify remote sensed data. This convergence is occurring in part because of IT compatibility and the overlap and complementarities between the technologies. Many users prefer the term "geo-spatial" to "geographic" information systems for these reasons (Sutton*etal.*2004).

1.2 Indian Scenario in Transportation

The road network in India is huge with more than 3.01 million kilometres of road length with 34608 km of National Highway, 128622 km of State Highway and informal network of 2737080 km, operated in vastly different social, economic and climatic environments. The planning and management of such a huge network in the country has been primarily done at two levels i.e. national and local level. The national level planning in the country is broad based and is done using some macro

level data like area, gross domestic product etc., whereas local level planning is problem specific and confined to a vicinity of a few metropolitan cities. The road network planning based on the travel demand requirements in the country could not be adopted merely due to lack of relevant data needed for it (MOST, 1984).

Highway networks face deterioration problem due to the lack of funds for infrastructure. The adoption of newly emerging technologies such as Geographic Information System (GIS) can help to improve the decision making process in this area for better use of the available limited funds. Geographical Information System (GIS) are becoming more widely used in transportation planning agencies, especially among metropolitan transportation organizations. In many developed countries, highway maintenance management is becoming a critical issue. Many more authorities are now able to use GIS for Highways and transport management, due to falling costs and GIS increasing overfriendliness. GIS offer transport planners a medium for storing and analyzing data on population densities, land uses, travel behaviour, etc. The most important objectives for using GIS are map/display and data integration. Agencies must identify potential issues that can be addressed through a GIS application more efficiently and effectively, and more economically than with prevailing methods. Federal, state and local agencies are using GIS information to develop transportation policy and planning.

2. LITERATURE SURVEY

2.1 Geographic Information System (GIS)

Geographical Information System (GIS) - System of computer hardware, software, and procedures designed to support the capture, management, manipulation, analysis, modeling, and display of spatially referenced data for solving complex planning and management problems. GIS is a computer-based system used to capture, store, edit, analyze, display, and plot geographically referenced data. GIS was pioneered in the 1960s by the Canadian forestry mapping initiative and continued to develop as Canadian, U.S., and other government and university researchers sought to represent the earth's geography using a computer database, display it on a computer terminal, and plot it on paper. They also developed computer programs to quickly search and analyze this data. The typical GIS is founded on several basic concepts. First, the real-world features on the earth's surface are related to a map grid coordinate system and recorded in the computer. The computer stores the grid coordinates of these features to show where they are, and the attributes of these map features to show what they are. Second, map features can be displayed or plotted in any combination and at virtually any map scale, making computerized mapping data far more flexible to use than traditional paper maps. Third, the GIS can analyze the "spatial" (locational) relationships among map features.

2.2 GIS in Transportation Planning

Information System (GIS) are becoming more widely used in transportation planning agencies, especially among metropolitan transportation organizations. In many developed countries, highway maintenance management is becoming a critical issue. Many more authorities are now able to use GIS for Highways and transport management, due to falling costs and GIS increasing overfriendliness. GIS offer transport planners a medium for storing and analyzing data on population densities, land uses, travel behavior, etc. The most important objectives for using GIS are map/display and data integration. Agencies must identify potential issues that can be addressed through a GIS application more efficiently and effectively, and more economically than with prevailing methods. Federal, state and local agencies are using GIS information to develop transportation policy and planning (Gupta *et al.* 2003).

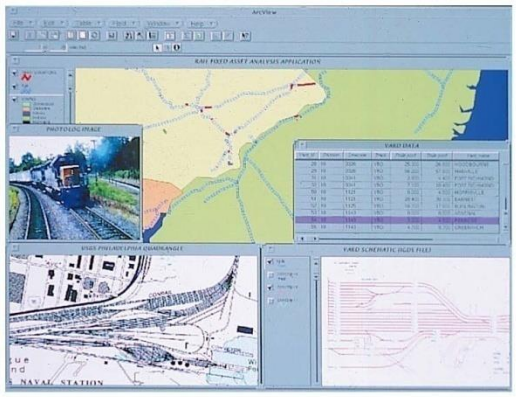

Plate 49
A screen shot from ArcView GIS 3.0 showing dynamic segmentation of railroads (reproduced by permission of ESRI).

Fig 1: A screen shot from Arcview GIS 3.0 showing dynamic segments of railroads.

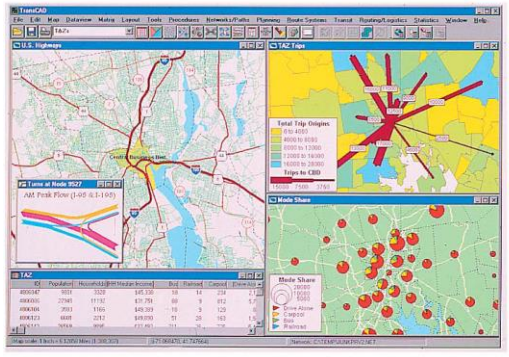

Plate 50
A screen shot from Caliper Corporation's TransCAD package showing the rich functionality of a fully-fledged GIS-T program (reproduced by permission of Caliper Corporation).

Fig 2: A screen shot from Caliper Corporation's TransCAD package showing the GIS-T program

2.3 Role of GIS in Transportation Engineering

The main advantage of using GIS is its ability to access and analyze spatially distributed data with respect to its actual spatial location overlaid on a base map of the area of coverage that allows analysis not possible with the other database management systems. The main benefit of using the GIS is not merely the user-friendly visual access and display, but also the spatial analysis capability and the applicability to apply standard GIS functionalities such as thematic mapping, charting, network-level analysis, simultaneous access to several layers of data and the overlayment of same, as well as the ability to interface with external programs and software for decision support, data management, and user-specific functions (Vonderohe, 1993).

The geographic information system (GIS) could be used as a tool for highway infrastructure management in a way similar to its current application in land-based information. GIS procedures provide a coordinated methodology for drawing together a wide variety of information sources under a single, visually oriented umbrella to make them available to a diverse user audience. GIS tools can be applied to aid technical and administrative specialists both in managing costly and intensively used resources and in supplying information to decision-makers.

Potential applications for GIS in transportation planning include the following:

1. Executive information system.
2. Pavement management system.
3. Bridge management.
4. Maintenance management.
5. Safety management.
6. Transportation system management (TSM)
7. Travel demand forecasting
8. Corridor preservation and right-of-way
9. Construction management
10. Hazardous cargo routing
11. Overweight/oversize vehicles permit routing.
12. Accident analysis
13. Environment impact
14. Land side economic impact and value-capture analysis and others.

GIS applications can be expected in pavement management, traffic engineering, planning and research, bridge maintenance and field office support, Other planning applications include evacuation planning, planning for hazardous material release incidents, development of new traffic analysis zones from census tracts, and development of new urban highway networks. GIS is a powerful tool in the analysis and design of transport routing networks. Its graphical display capabilities allow not only visualization of the different routes but also the sequence in which they are built, which allows the understanding of the logic behind the routing network design. The interaction between the transportation system and its surrounding environment makes the GIS technology ideally suited for hazardous material, routing design, risk analysis, and decision making. GIS can also be integrated with sophisticated mathematical models and search procedures to analyze different management options and policies (Gupta *et al*. 2003).

2.4 GIS Applications in Transportation System Engineering

Pavement Management

Pavement Management System (PMS) contains three primary components: data collection, analysis and updating. The components under data collection include:

Inventory: Physical pavement feature including the numbers of lanes, length, width, surface type, functional classification and shoulder information.

History: Project data and type of construction, reconstruction, rehabilitation and preventive maintenance.

Condition Survey: roughness on ride, pavement surface friction, rutting and distress

Traffic: volume, vehicle type and load data; and

The components under analysis include:

Condition Analysis: ride, distress, rutting and surface friction

Performance Analysis: pavement performance analysis and an estimate of remaining service life

Investment Analysis: an estimate of network and project level investment strategies. These include single and multiyear period analysis and should consider life cycle cost evaluation.

Engineering Analysis: evaluation of design construction, rehabilitation, material, mix design and maintenance.

Traffic Engineering

Congestion management programs can be most suitably developed in a GIS environment. GIS based congestion management systems can start with the highway base maps and attribute databases used for long range transportation planning in urban areas. These regional base maps will provide the framework for identifying and monitoring congestion from a regional perspective. Additional more detailed base maps and databases can be developed to manage congestion in real time in critical corridors.

Safety Management

The analysis of accident data coupled with roadway features and characteristics, traffic volumes, bridge inventory and other data and the geographical presentation of this information in GIS environments will be very useful to develop safety management system. Inventory files such as traffic signals, narrow

bridges and railroad crossings could be analyzed more efficiently using GIS.

Bridge Maintenance

A major benefits derived from GIS use will be in obtaining bridge information through general query capability. Example includes bridge condition surveys, sufficiency ratings, functionally deficient bridges, posted capacity distribution, clearness etc. Through relational database, bridge maintenance engineers could access important information like average daily traffic, as well as system and functional classification from planning and research maps.

New and Emerging Applications

GIS is an ideal environment for routing analysis of hazardous materials because this requires overly of many highway network attributes as well as other databases (e.g. demographic, topographic, weather etc.) on individual road segments in order to properly characterize accidents and consequence to population and environment. Other important application of GIS based system is in managing unexpected emergency evacuation even though it was not initially planned as distant management system. The road network at GIS platform will provide a framework for the development of disaster management system of any kind. The coordination among various management systems in a state can be easily planned and developed through the applications of geographic information system. These subsystems will automatically be valuable resource for many other state level systems.

3. CONCLUSION

The above report concludes that the Geographical Information system(GIS) is widely used in transportation planning. GIS provide the uniform environment in which the data for numerous planning purposes can be integrated. GIS technology provides the core framework for an integrated highway information system. The developed database can be further supplemented with new information as and when it is available. So, the database keeps on evolving, which is otherwise not possible to compile at one time. The topological information available in GIS database opens the new ways for analyzing the transportation related data for different purposes. Various GIS functionality, spatially the spatial analysis functions and querying capability, are very useful tools for the day-to-day management of the road network by the concerned organizations.

The impact of GIS technology in development of transportation information system and Highway infrastructure management is profound. If GIS technology is exploited to it's fullest extent it will completely revolutionize the decision making process in transportation engineering. GIS is being recognized world over as the most efficient tool for integration of all types of data necessary for transport sector. The huge amount of information related to transport infrastructure in the country could be put together for its most efficient utilization in planning, design, construction, maintenance and management of the transport system. There is an urgent need to organize the existing database compatible to GIS environment and suggest various other new data items, which are considered useful for better planning and management.

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