

A Review of GIS Technology Applications in Transportation Planning and Management

Shujie Wang¹, Lin Zhang²

¹North China University of Science and Technology, Tangshan, China

²Tangshan Key Laboratory of Air - Ground Intelligent Transportation, North China University of Science and Technology, Tangshan 063000, China

Abstract

With the rapid development of the economy, the scale of urban construction is expanding, the corresponding transportation infrastructure is also improving, and the traffic congestion problem is becoming more and more serious. The application of GIS technology to transportation management can effectively alleviate the problem of urban traffic congestion at this stage, thus improving the operation of road traffic. This paper describes the advantages of GIS technology in transportation planning and management from the aspects of accuracy, measurement convenience, visualization, scientific, dynamic, data management, and introduces its application initiatives in road design, traffic prediction, vehicle guidance, traffic system design, traffic analysis. The application of GIS technology in transportation planning is becoming more and more extensive and profound, the technology can provide ideas and technical support for modern transportation planning, but also can combine the construction of road transportation system with information technology, effectively improve the rationality and scientificity of the transportation planning program, and play a positive and significant role in reducing traffic congestion and improving the efficiency of traffic operation.

Keywords

Transportation Planning; GIS Technology; Traffic Congestion.

1. Introduction

One of the characteristics of transportation information is its spatiality, i.e., the spatial distribution of traffic flow, the spatial distribution of land use features, the spatial distribution of transportation facilities, etc., and the description of spatial geographic features is the specialty of GIS. In the field of transportation planning, with the advantage of GIS technology, it can effectively alleviate the problem of traffic congestion and produce positive effects.

GIS technology is a geographic information system, which uses a specialized data platform to achieve the spatial data input, storage, retrieval, arithmetic, analysis, modeling, display, output operations, and then the spatial geographic information three-dimensional presentation of an emerging technology [1]. Early GIS functions are mainly to realize the transformation from manual to machine-assisted mapping, geographic analysis functions and other relatively simple functions. With the development of computer graphics and database theory of maturity GIS shows increasingly powerful data management organization and spatial analysis capabilities, in the functional complexity of the distinction between other systems. Geographic visualization capabilities make GIS no longer just a database management tool for extracting useful links between entities, analytical capabilities make it more than just an automated mapping application, and database management features enable it to capture spatial and topological relationships between geographically related entities that are not predefined. Positioning GIS

itself as an ultimate information integration technology, providing data management and modeling platforms to integrate spatial and attribute data from various sources.

GIS technology fully combines the advantages of computer science, data analysis, remote sensing and mapping, geography and other disciplines, and under certain conditions, it can complete the collection, acquisition, and reanalysis of surface information and related data according to the objectives of transportation planning. Combining traditional transportation planning issues with GIS geographic information technology can improve the analysis and management of planning data and application evaluation level, effectively improve the efficiency of urban transportation planning, and provide scientific support for decision-making departments.

2. Advantages of GIS Technology in Transportation Planning and Management

2.1. Accuracy

Compared with traditional data acquisition methods, GIS technology has significant advantages in data collection and processing, especially in data accuracy. GIS technology will analyze and process the data, i.e. quantitative analysis. In the process of collecting information and data, transportation planning under the traditional method will be interfered by many factors, such as environment, personnel, instruments, etc., which will lead to part of the data errors or inaccuracies; in the data analysis of the planning scheme, there is no detailed basic data as a support, which is influenced by the subjective factors, and it is easy to cause the design loopholes. GIS technology will re-process the input data to reduce the rate of error [2]. A large number of pictures and text information will be input when establishing the GIS database, and the integration function of graphic and text information of GIS technology can make the information in the database correspond to each other, avoiding the wrong connection to the extent of affecting the planning program. Through scientific and accurate data acquisition and measurement, it can provide accurate data reference for designers, so as to make better engineering planning and design.

2.2. Measurement Convenience

Traditional engineering in the measurement process, need to surveyors and data recorders to complete the project planning and measurement, GIS technology can play the corresponding function of the relational database, storage and management of traffic survey data, and all the basic data for statistical analysis. With the help of its organization and management of information, to establish a link between different information to achieve visual management. The use of GIS technology can reduce labor costs, surveyors can use the technology to achieve the measurement, acquisition and storage of data, thus improving work efficiency. In addition, the speed of information transfer by GIS is also very fast, and it can transfer and collect all the information related to the transportation situation in a short time, fully demonstrating the rapidity of GIS in the process of transportation management.

2.3. Visualization

Visualization is a combination of computer graphics and image processing technology, the data will be converted into graphics or images displayed on the screen. GIS technology combines two-dimensional technology and three-dimensional technology, the design drawings in three-dimensional three-dimensional mode. With the help of spatial and graphical language expression, the results of transportation planning can be visualized, compared with a single attribute table and text description, it can be more intuitive, vivid and comprehensive expression of the results of planning.

2.4. Scientific

The use of GIS technology to carry out transportation planning, technicians can optimize the management of the system from multiple perspectives, such as: road transport, regional economy, natural conditions and other perspectives, all-round, scientific prediction and assessment of potential natural disasters in the region, security factors, etc., for which a variety of problems arise in a timely manner to solve and make early warning programs.

2.5. Dynamization

The use of GIS technology can realize real-time monitoring of traffic and transportation, and establish dynamic models to improve the scientific nature of planning. According to the real-time traffic conditions of different time periods and road sections, from the perspective of real-time road conditions of transportation, the scientific selection of public infrastructure addresses, to ease the traffic flow during peak traffic periods, to prevent the expansion of the problem of congestion.

2.6. Data Management

Due to the nature of transportation planning, it is necessary to establish and develop a database suitable for transportation planning, which should be able to satisfy the data requirements of transportation planning to the maximum extent possible, for example, there should be detailed data on traffic forecasting, planning, distribution of traffic flow and pedestrian flow, etc., some of which can be generated directly by GIS tools. GIS is also capable of accepting data on transportation planning from other data sources [3]. GIS can also accept transportation planning data from other data sources [3].

A large number of thematic maps of traffic characteristics are generated in urban transportation planning. Under the current level of technology and demand, a number of thematic maps need to be used in transportation planning, such as urban land distribution maps, urban population distribution maps, distribution maps of urban roads and transportation facilities, traffic generation and attraction distribution maps, and distribution maps of traffic flow. These thematic maps can describe the current situation of urban transportation, can also be used to analyze the traffic characteristics. Many of the thematic maps produced by transportation planning are schematic and do not require high accuracy. Transportation planners use GIS's powerful ability to process spatial data and analytical tools to make the implementation of some of the analytical methods of transportation planning very simple.

3. Specific Applications of GIS Technology in Transportation Planning and Management

3.1. Application of GIS Technology in Road Design

The goal of transportation planning is to scientifically design transportation roads in accordance with the trend of social development, reasonably allocate, realize the organic combination of transportation resources and transportation resources, improve the efficiency of transportation, meet the needs of social development, and also improve the efficiency of land development and utilization. Traditional road design workload is extremely large, involving many types of data, and low efficiency. With the advantage of geographic information systems, can effectively improve the design efficiency, thus bringing greater economic benefits. For example: in the urban GIS traffic information system can use virtual reality technology and GIS dynamic simulation technology for simulation, simulation and evaluation of the planning program, so that the program is more in line with the actual needs, and can predict the future development space. At the same time, the network analysis, overlay analysis and buffer analysis

functions of GIS technology can be used to set the length, width and optimal path of the road reasonably. In addition, the three-dimensional topology generation of GIS technology can be used to realize the three-dimensionality of the road and determine the siting plan of three-dimensional intersections, bus stops, etc. according to the road section planning [4]. From the point of view of its positive effect, this can enhance the rationality of the design program to a certain extent, and make advance predictions for its future development space and related planning.

3.2. Application of GIS Technology in Traffic Forecasting

GIS technology has a strong information collection and processing function, the relevant staff can be based on the collected information on the road within a certain period of time in the future for the prediction and calculation of vehicles, so as to anticipate traffic congestion and other problems, and to formulate diversion measures in advance. Through the modeling function of GIS technology, the relevant personnel can grasp the overall operation of the traffic routes, and formulate perfect solution strategies for the existing and upcoming problems to ensure the safety of transportation.

3.3. Application of GIS Technology in Vehicle Guidance

In the road transportation planning system, traffic law enforcement plays an important role in guiding. When traffic congestion occurs, the need for law enforcement officers according to the actual conditions of road operation, its timely instructions and guidance, so as to provide adequate protection for normal road transportation. GIS technology because of its unique navigation performance, in traffic law enforcement work, can provide law enforcement officers with more accurate, scientific traffic law enforcement program. Based on the road information of the traffic command center, scientific and reasonable traffic guidance is carried out. The use of GIS technology for transportation planning and management, can reduce the probability of road congestion, and further enhance the operational efficiency of the transportation system.

In addition, in the process of maturing technology development, GIS technology can also be used in the car navigation terminal system, GIS technology has the function of intelligent route planning, the application of the user can be based on the system prompts combined with their own actual needs, personalized adjustments to the passage of the program to reduce the impact of road congestion on them. Based on the operation data of the traffic navigation system, GIS technology can provide accurate traffic data for transportation planning technicians, assisting road transportation planners to grasp the transportation situation in more detail. In the application process, transportation personnel need to transfer all kinds of traffic data to the electronic map in a timely manner, to provide data support for route planning. In this process, it is also necessary to adjust the relevant information in the electronic map according to the real-time road conditions. In the event of traffic congestion, it is necessary to record it in the file, and its countermeasures need to be uploaded in a timely manner, in order to provide experience for the later relevant work to learn from.

3.4. Application of GIS Technology in Transportation System Design

GIS technology has a more convenient intelligent collection, query, analysis of data technology, to build a scientific, reasonable, stable transportation system, the effective use of GIS technology to urban transportation design work, to a certain extent, effectively enhance the efficiency of transportation planning and management, but also effectively avoid the occurrence of a variety of unnecessary safety accidents, and then realize the optimization of the transportation system goals, enhance the operation of the transportation system Stability [5].

The use of geographic information system software to build the city's total traffic network structure, the network structure should cover all the statistical concept of traffic flow distribution within the road network, with a large number of historical data and real-time

traffic data as the basis for structuring the road network. For the local urban traffic conditions, people's travel behavior, etc. to conduct a full investigation, collect information, combined with relevant data, to make a data model. On this basis, complete the analysis of the data model and reprocessing work, combined with the information collected to formulate a targeted data model, and then the model for systematic analysis, to find the problems in the operation of the transportation system, and the use of GIS systems to develop targeted solutions. Based on the road network structure covered by the traffic flow, different traffic control methods are realized, and traffic signal control objects are constructed by applying layers on the road intersections of the road network, and the relevant data are stored in the database.

Satellite remote sensing technology, as an important element in GIS technology, has also had a positive effect in transportation planning and management, especially in the scientific and rational nature of traffic route selection.

In the design of urban transportation system, the designers must fully realize the positive effect of the technology on the design work and make use of it in order to improve the work efficiency. The urban transportation system involves a large amount of data, and if only a single data processing method is adopted, it will not only lead to a large amount of data loss and relatively low information processing efficiency, but also invest a large amount of manpower cost, time cost, and reduce the economic benefits.

The construction of transportation infrastructure is an important step in the planning and management of transportation system. Using GIS technology to build a static database of transportation facilities, it can query and count the information of various static transportation facilities in the road network, such as road signs, traffic light facilities, indicators, detection coils, etc., and link the road network attribute data and entity data by road sections and geographic coordinates, so as to realize the management and maintenance of all transportation facilities.

3.5. Application of GIS Technology in Transportation Analysis

Spatial auxiliary decision support is an important development direction of GIS, GIS auxiliary transportation and land use is mainly manifested in the planning of transportation facilities and optimization of transportation network. The main content of the planning of transportation facilities is to determine the geographic scope and content of the planning area, the layout of major transportation facilities, the application of models to evaluate the spatial interconnection of passenger and cargo flows, and to further optimize the transportation network according to the spatial characteristics of passenger and cargo flows; according to the evaluation of the impact of transportation facilities on a particular land-use area and determine the impact area; according to the spatial interactions between the land type of the region to make an evaluation, measure the entire planning area of the level of accessibility. The level of accessibility of the entire planning area is evaluated according to the land type, etc.

4. Conclusion

Road transport planning and management information reform has become an inevitable development trend of road transport planning and management, the application of GIS technology in road transport planning and management can not only greatly improve the efficiency of planning and management, but also ensure that transportation planning and management to achieve the goal of information reform. Effective application of this technology to the actual management of transportation planning and management work for the development of transportation planning and management work is of great significance: to ensure that the dynamic planning of transportation management work, GIS technology can be transmitted to the management department through the real-time information of the road traffic via artificial satellites to provide up-to-date data support for the management

department's planning decision-making; greatly enhance the applicability of the planning and management methodology, the use of GIS technology to analyze the data. GIS technology to analyze the data, the data analysis results have a strong accuracy, and then in determining the planning and management methods, in accordance with these accurate data can enhance the feasibility of planning and management methods; promote the overall development of urban road traffic, in the traditional management mode, the implementation of measures have certain limitations, which leads to a number of necessary development measures are difficult to implement into the actual work, while the GIS technology can provide real-time information of road traffic through artificial satellites, providing the latest data support for the management of planning decisions. The application of GIS technology can greatly enhance the operational stability of the management system and ensure the long-term effectiveness of the planning and management work.

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