

Geographic Information System (GIS-T) database design for transportation safety system (case study: spatial database for road transportation system in Indonesia)

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Abstract. This study aimed to develop a spatial database design on transportation safety system. Spatial databases is a fundamental factor that is very important in the utilization of GIS for transportation, so it is important that a good preparation of spatial databases. Preparation of spatial database will be effective if tailored to the needs. Factors affecting transportation safety is different from one region to another. Factors that affect transportation safety system in an area can be influenced by the transportation system infrastructure in the area. Database design for transportation safety in this study is expected to be a model of the spatial database according to the highway transportation system in a small town in Indonesia. Characteristics of the transport system in Indonesia was largely dominated by private vehicles and less of public transport. Spatial analysis has the advantage to combine data and analyze various factors based on spatial location. Spatial data that can be used to support the analysis include the basic data, thematic data path, data that can be supporting the highway transportation system. Spatial data and GIS - T can be used as an analysis tool and alternative approach to improve road transport safety.

Keywords: Spatial Database, GIS-T, Road Safety System

1. Introduction

Trends in the development of roads in Indonesia is often said to be directly proportional to the development of road users. The length of the road is said to be biased in accordance with the increase in motor vehicles continue to rise rapidly. Ease of purchase of motor vehicles facilitate people acquire the vehicle, the road will consequently diminishing the effectiveness of the use of the road.

Reduction in the effectiveness of the use of the road is shown by the way it was no longer able to accommodate vehicles that perform mobility. The number of vehicles using the road is getting more and more roads are not wide or increased, the result would be congestion on the roads. These factors make the management of road traffic becomes very important to do. Traffic management is not expected to inhibit the mobilization that use the road, but did not make the level of congestion is getting worse.

Road traffic management has been carried out using field data analysis utilizing the tabular analysis. Spatial approach with the use of maps and geographic information systems, have not been widely used. The use of spatial data actually allows because the road is a factor related to the phenomenon of spatial form of human movement. Everyday human movement is certainly a movement that originated from one location to the destination location, this is a phenomenon of the movement or the movement of



people is a spatial phenomenon. Spatial or spatial approach will certainly help in the implementation of road traffic management.

An application of GIS technology is used for policy making occurred in the State of Miami, Kansas [8]. 12 fatal accidents in 11 months on a two-lane road along the 20 miles of U.S. Highway 169. Head of the police are very concerned that fatal incident in the street and ask for land information management office (LIMO) to create GIS maps that show the location of the accident and the attributes associated with the accident that can be accessed by the Governor and authorized personnel to quickly analyze the situation and take decisions where the accident occurred due to significant errors when the driver left the vehicle after leaving the road. After looking at the map, the Governor ordered to widen along the way. The police chief then focus area to reduce future accidents using crash data analysis based on other roads GIS [2].

Bob Thomson wrote the words of the head of the traffic safety bureau said that "GIS is a strategic revolution that could potentially improve the effectiveness of employment for police and policy makers in all parts of the State". The only potential strategies need to be explored. Utilize of GIS with dynamic map. The future of GIS to improve efficiency in every job with safety advantages of human life which is a potential asset [8].

Some explanation on how to use GIS technology showed in developed countries have started to be considered ranging from about 1 decades ago . It makes use of GIS technology and the advancement of information systems used in the State of Indonesia, which until now most of the movement of the future highway use.

This system is also suitable to be applied in Indonesia, GIS is a map-based analysis tool, as long as there are coordinates and digital maps can be implemented anywhere. The analysis is carried out with map layers that have data and information according to the theme. The results of the analysis are also in the form of a map that describes the purpose of the paper. For the appearance of the earth that is informative and can help transportation planners, consultants in carrying out urban and regional transportation planning.

1.1. GIS-Transportation

GIS is a computer-based system that has the ability to handle the data has geography references as data entry, data management, manipulation and analysis of data, and output as the final result [1]. While Burrough in 1986, defines GIS (geographic information system) as a computer-based system that is used to enter, store, manage, analyze and re-enable data have spatial reference for a variety of purposes related to mapping and planning. In the next phase, the GIS form and store it in rational tables at once connecting these elements and their attributes. As such attributes can be accessed through the site map elements, and vice versa map elements can be accessed based on the attributes [4].

Transportation safety systems, including services such as highway traffic safety systems and automatic location detection on the traffic system, is part of the purpose of integration between geographic information systems (GIS) and communications technology to develop this type of transportation services [9]. GIS-T is a holistic approach to the complex land use and transportation issues. GIS-T can also be used to reduce the lack linked between analysis and communication, makes a great public input into policy analysis, such as data selection, assumed models, and formulation of scenarios [6].

Geographic information system for transportation is the relationship between hardware, software, data, operators, organizations and institutions to collect, describe, analyze, and communicate various kinds of information about the earth. Information type is the transportation system, and the region is affected by the system [5]. Deploying GIS in transportation (GIS-T) at an enterprise level presents an opportunity to eliminate the traditional application- specific development pattern of information systems by providing a common data structure centered on transportation features [2].

2. Method

2.1. Data Inventory

Inventory data is needed in the preparation of GIS-T database design. Inventory Data is useful to know the different kinds of data to be entered into the database. Sorts the incoming data in the database is the data used in the implementation of the use of GIS for transportation. Inventory data contains the type of data, information from the data, and how the data acquisition of the data.

Table 1. GIS Data Inventory.

Data	Description	Data Acquisition
Traffic Infrastructure	Road segment, detail road information, object, etc.	Survey/GIS
Public Facilities	School, market, restaurant, fuel station, etc.	Survey/GIS
Thematic Data	River, land use, geology, boundary, etc.	External
Crash Data	Up to date data, prediction	Survey, study
Traffic Flow Arrangements	Traffic scenario	External
Hazardous Data	Flood, soil movements, etc.	External

Table 2. Tabular Data Inventory.

Data	Description	Data Acquisition
Road Metadata	History	Internal
Road Specification	Detail Information	Internal
Road Plan	Planning	Internal/external
Traffic Information	Traffic situation, scenario	Survey
General Information	Population, etc.	External
Other Data	Thematic information	Internal/Study

Table 3. Other Data Inventory

Data	Description	Data Acquisition
Real time Traffic Video	Road Monitoring	Telemetry
Real time Traffic Instrument	Road Monitoring	Telemetry

Inventory Data includes all the data that will be used in GIS-T database. Database design is critical to determining the foundation for the data entered in the database. Inventory data in this design were divided into three groups based on the type of data. The group of data is spatial data, tabular data, and other kinds of data, in this design is the data sourced directly from the telemetry tool in the field.

2.2. Relationship Design

The relationships between data with other data that is essential in the preparation of the data base. This study is concerned with how the GIS data and tabular data can be connected to the data that are complementary to the analysis.

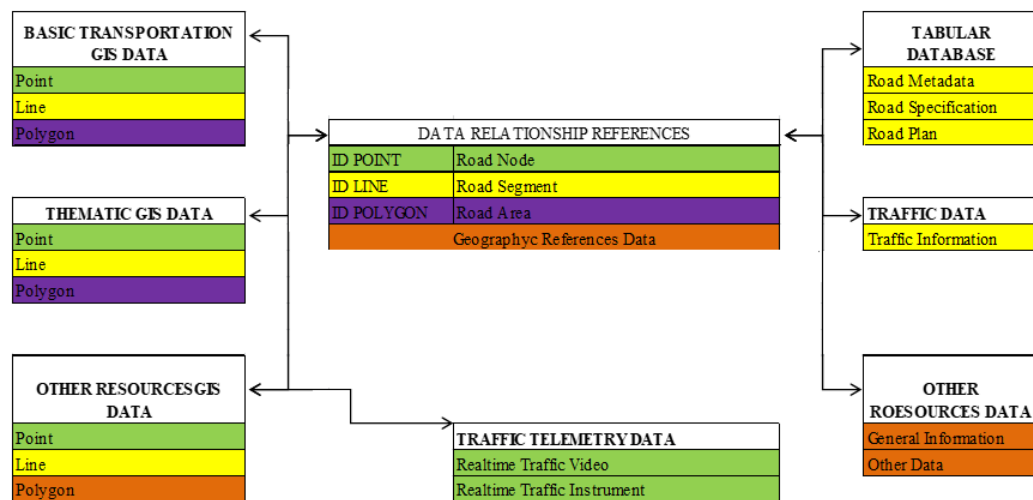


Figure 1. Database Relationship Design

Design relationships between databases using reference data relationships. Reference data is divided into four sections relations, namely the reference point, the reference line, the reference polygon, and geographical references. Reference points spatial location of an object contains data, reference data are used to connect the tabular data which is an attribute of the site and may be updated periodically. Data reference line connecting the data segments of roads and road attributes tabular data that can be updated regularly. Data detailed image reference polygon connecting paths can be combined with tabular data as attributes that can be updated regularly as well. Relationships that last reference data is based on the geographic location where they can relate to administrative boundaries, or polygons that are not raw like inundation polygon area, soil type, and others.

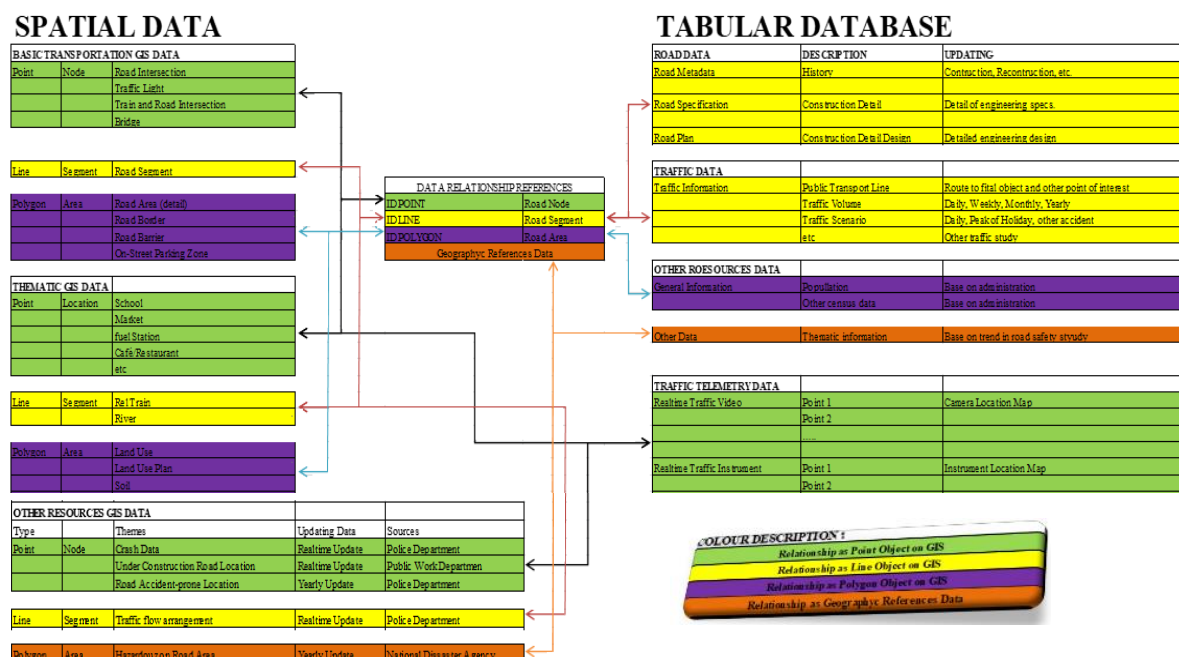


Figure 2. Detailed GIS-Transportation Database Relationship Design

2.3. GIS-T Database Design

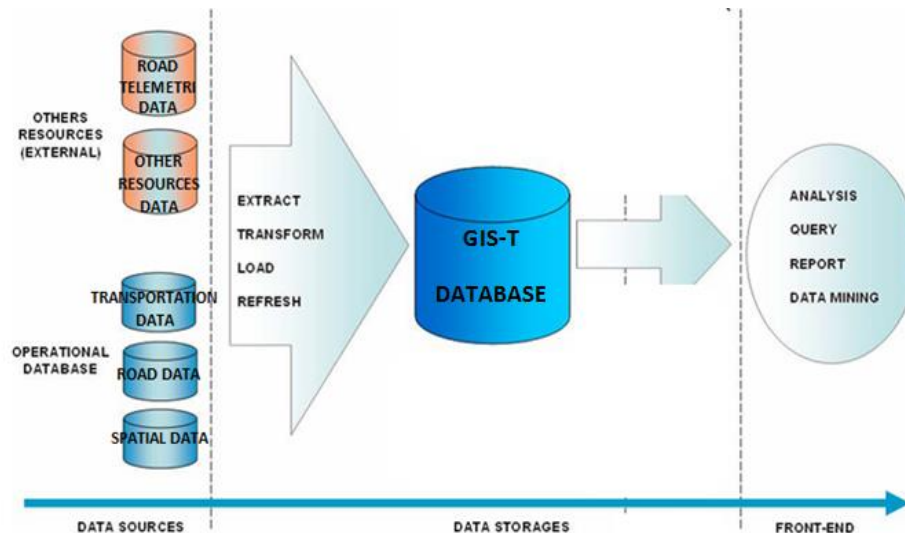


Figure 3. GIS-T Database Structure Design

The preparation of the database is expected to be used as a data center in decision making. Examples that can be explained from this database is the spatial data where every street has a street name and detailed description of the road tends to be static. The road segment data can be combined with traffic information data volumes on the roads which are updated every day. Daily data stored in the database will be analyzed to determine how the ability to pack a road, so it can be determined how the management or regulation of traffic on these roads.

The use of data sourced from other agencies, for examples geological data and the type of soil. This data can be used as input in the analysis of road maintenance prioritization. Prioritization of road maintenance can be performed by using the data of geology and soils are the foundation of the construction of the road, traffic volume, and type of vehicles that used the road. This analysis will also be used to determine how the scenario so that the road traffic arrangements can last longer.

The preparation of this database is also used to accommodate the specific phenomenon that has not been mentioned in the image database design details. Specific case in Indonesia is how the parking arrangements in the area of highway had not been set properly. Rules also not been properly enforced so that it may be necessary to monitor how the analysis of on-street parking areas. Other case is the number of spilled market in Indonesia. The spilled market can happen on certain days or every day. In the event of a long holiday as traffic peak season, spilled market data can be used as a reference for the selection or the nearest alternative route that does not result in a long traffic jam.

3. Result

Database design consists of an inventory of data, collate relationships among the data, and draw up into a series of databases for policy-making. Combination database compiled in this study is as shown in the figure below. Consists of two main types of data are sourced outside the operational and data sourced from daily operations. Data sourced from outside consists of telemetry data path, and other data such as population data, soil type, etc. Data into daily operations are divided into three databases namely road transport data, road data, and spatial data path. Overall the database and entered into the main database can be used for analysis of all the data that is designed using interconnected by reference.

The design shown in detail in the present study does not include all the data. This design is only used to illustrate how to use the tabular data that is already widely used and combined with spatial data.

Spatial data is best used for analyze road use which is a network that has a spatial reference. The use of tabular data with spatial data and connect it, will make monitoring the highway will be better and will hopefully facilitate decision makers in their policy. A good policy is expected to improve the safety of road transport.

4. Conclusion

This research is to design a database for transport safety, in this particular case road transportation in Indonesia, just designing how to accommodate between GIS and data transport. Connecting two data into a GIS database in transportation or that many called GIS-T database. The design is not include the all required data that used. This study focused on how to build a GIS-T database that could integrate data in consideration of transport policy-making, especially in Indonesia. The future research is needed to design more detail how the composition of each type of data and data types that are connected. All detail of data with better references and more systematics. It is expected that both the data structures in the database and make the data detail relationship between data in one integrated database can improve the effectiveness of the analysis.

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