TRAFFIC ACCIDENT BLACKSPOT IDENTIFICATION AND AMBULANCE FASTEST ROUTE MOBILIZATION PROCESS FOR THE CITY OF SURAKARTA

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Abstract

Quickly and precisely treatment in traffic accident is one way to avoid the risk of death victims. Therefore, it's necessary to determine the fastest route from the traffic accident locations to the nearest hospital. The research objective was to determine the traffic accident blackspot of Surakarta city, the referral hospitals and the ambulance fastest route using GIS program. Determination of traffic accident blackspot used three methods, that are kernel density estimation, cluster and outlier analysis. Method of determining the fastest route mobilization is network analyst tool. Determination of the fastest route mobilization based on travel time. According to an analysis, there are 15 locations of traffic accident blackspots in Surakarta city. A referral hospitals in Surakarta city are Brayat Minulya, Dr. Moewardi, Dr. Oen, Kasih Ibu, Kustati, Panti Waluyo and PKU Muhammadiyah hospital. Mobilization route of the accidents victim has an average of travel time about 4.84 minutes.

Keywords: traffic accident blackspot, hospital, GIS, fastest route

Abstrak

Penanganan yang cepat dan tepat pada kecelakaan lalulintas adalah salah satu cara untuk menghindari risiko kematian korban. Oleh karena itu, diperlukan rute tercepat dari lokasi kecelakaan lalulintas ke rumah sakit terdekat. Tujuan penelitian ini adalah untuk menentukan blackspot kecelakaan lalulintas di kota Surakarta, rumah sakit rujukan, dan rute ambulans tercepat menggunakan program GIS. Penentuan blackspot kecelakaan lalulintas menggunakan tiga metode, yang densitas kernel estimasi, klaster dan analisis outlier. Penentuan mobilisasi rute tercepat adalah alat jaringan analis. Penentuan mobilisasi rute tercepat didasarkan pada waktu tempuh. Menurut analisis, ada 15 lokasi blackspot kecelakaan lalulintas di kota Surakarta. Rumah-rumah sakit rujukan di kota Surakarta adalah Brayat Minulya, Dr Moewardi, Dr Oen, Kasih Ibu, Kustati, Panti Waluyo dan RS PKU Muhammadiyah. Mobilisasi rute korban kecelakaan memiliki waktu tempuh rata-rata sekitar 4,84 menit.

Kata-kata Kunci: kecelakaan lalulintas blackspot, rumah sakit, GIS, rute tercepat

INTRODUCTION

Surakarta city has a plenty high number of traffic accidents. According to Surakarta city, Central Bureau of Statistics, the average number of accidents during the years 2006-2010 reached 630 accidents. The number of traffic accidents that occurred in Surakarta city is increase every year. The possibility of accidents will always be on a transportation

system which will be higher in dense traffic conditions, poor transport infrastructure and lack of awareness about driving safety. Quickly and precisely treatment is a step to avoid. Treatment of traffic accident victims were divided into 2 (two) phases, namely pre-hospital phase and hospital phase. Hospital phase is a phase in which the victim to obtain medical services/emergency rescue. Pre-hospital phase of the aid before the victim reached the hospital. Mobilization/evacuation from the location of a traffic accident to a hospital that is usually used in the ambulance is named by pre-hospital phase. Travel time of mobilization affect the possibility of death victims. Finding the fastest route is the solution to minimalize the travel time to be the shortest. The objective of this study to determine the location of the accident blackspot as a representation of the accidents, determine the referral hospital and then find the fastest route to the mobilization of traffic accidents victims.

Several studies have been carried out to investigate traffic accidents, especially in of Surakarta city. Banawati (2009) carried out an analysis of traffic accidents in the city of Surakarta by considering the fatality of victims. This method is called EAN (Equivalent Accident Number) with a weight of 12 deaths; major and minor injuries, 3; victims who just suffered a loss / damage 1. The results of weighting were analyzed using Shewhart control charts to determine traffic accident blackspot. Along with the development of technology, the traffic accident analysis easier with the help of computer programs. Some program-based Geographic Information System (GIS) is used by institutions to analyze traffic accident data. Edorgan et. al. (2007) used GIS to analyze traffic accidents and determine the traffic accident blackspot in Afyonkarahisar, Turkey. That study used two different methods is Kernel Density analysis and the repeated analysis. Anderson (2008) carried out a study using GIS and Kernel Density estimation to study the spatial patterns of traffic accidents in London, England. Then, the results are used to classify an accident hotspot by using clustering methods. The main advantage using Kernel Density Estimation (KDE) and K-mean lies in determining the spread of the risk of accidents. The spread of risk can be defined as the area around the cluster in which there may be increased due to an accident. In addition, using this density, arbitrary units of spatial analysis that can be defined and homogeneous for all the areas that can be used as a comparison or even further as a taxonomy (classification). Manepalli et. al. (2011) to identify locations prone to several statistical methods, namely Kernel density estimation (K) and the brittle-Ord Gi * coupled with the method of conceptualization of spatial relationships (CSR). This study also uses geographic information systems. The results showed that the results of these methods is almost equal.

Accident blackspot is a representation of the accidents that occurred during a certain period. Referral hospital determined based on the travel time required to evacuate the traffic accident victims to a hospital. Based on traffic accident blackspot location data and the referral hospital, ambulance fastest route is selected from the existing road

network. Rochim (2009) create a database of geographic information systems from Surakarta city's transportation system. The database is a network of roads that are equipped with traffic assignment information. Furthermore the data base used to determine the fastest route from one point to another within the Surakarta city. Muslim (2005) also carried out research on the application to determine the best route. The goal is to design a geographic information system modeling of the transport pathways and analyze the impact parameter to determine the best path in Semarang city. This study use the classification of time: the normal, pick hours and off-pick hours. While the resulting output can be divided into the shortest route (distance), fastest route (time) and effective route (distance, time and cost) to the classification of the three conditions mentioned above. These application also based on geographic information system. Lin et. al. (2005) carried out research on travel time and the factors that influence it. The factors used in this research that signal intersection (traffic light signal), the volume of traffic (traffic volume) and speed (travel speed). The study also states that with the help of computer programs, modeling of transportation system will become much easier and faster.

This study uses ArcGIS program to analyze the hospital service area, identify traffic accident blackspot locations and determine the ambulance fastest route to the mobilization of traffic accident victims to hospital. The road network data used in this study was taken from Rochim (2009). Road network database has information of each road segment travel time (secondary collector roads) and then corrected by adding one-way street information using ArcGIS program. These data were formatted on geodatabase and used for the subsequent analysis. Traffic accidents data in 2011 were taken from the police department of the city of Surakarta. The number of traffic accidents in 2011 reached 610 events.While the hospital location data derived from several sources.

Act No. 44 of 2009 about the hospital mentioned that one of the requirements of building a hospital must have emergency rooms. This means the hospital is a institution that holding on the emergency services. Facilities in the emergency installation include: mechanical ventilation, defibrillators, bed side monitor, pulse oxymeter, blood pressure monitors, electrocardiograph (ECG), resuscitation equipment and other emergency equipment. Surakarta city does not have rules / policies of the hospital where it is used as a referral hospital for victims of traffic accidents. Therefore, the determination of the referral hospitals in this study is only based on hospital location and type of hospital.

Each hospital service area is determined by the accessibility of and or to the hospital within a certain time period. Analysis of hospital service area using netwok Analyst Tool-Service Area. Network datasets required to run the analysis using the "Service Area Tool". Analysis of hospital service area using road network data that have been compiled into a network dataset and hospital location data. Both of these data were analyzed using Anlayst Network Tool - Service Area is in the ArcGIS program. Referral hospital service area is the distance from one place to the location of the hospital that can

still be achieved within a certain time. The time set for the analysis of service area for 5 minutes (300 seconds) with consideration of the referral hospital, the location of the referral hospitals, road network data and extensive areas Surakarta city.

Identification of traffic accident blackspot locations aimed to determine the locations where accidents frequently occur, the number of accident victims or the condition of the victims are many and severity/death. This site is a representation of the scene of an accident that occurred around the area and used as an approach to determine the route the ambulance evacuation/mobilization of the victims to hospital. This means that if traffic accident blackspot in the vicinity of the accident, the evacuation/victim mobilization can use these routes so that victims get immediate medical care at the hospital.

EAN data obtained from the accumulation of multiplying the number of victims by the severity of the coefficient of 12 for deaths, 3 for severe injuries, 3 for minor injuries, and 1 for the only suffered victim. The data were analyzed using three methods to identify traffic accident blackspot locations are: the Kernel Density Estimation (KDE), and Cluster Outliers Analysis (Anselin Local Moran I) and Hot Spot Analysis (Getis-Ord Gi*).

Kernel Density Estimation Methods

Kernel Density Estimation (KDE) is a spatial data analysis capabilities of ArcGIS program. KDE analysis principle is distribute the value of a point in the distribution of events into a smooth curve (smooth) around the point of being simulated by a certain distance. The highest values are at the point under review. Value will be reduced by the farther distance of the point under review until it reaches zero value at a specified distance. In the event of an overlay of the distribution curve of an event with other events in the distribution curve, the value at the point of the overlay is a cumulative value of two or more curves. Analysis using Kernel Density tool produces output in the form of raster data.

1. Cluster and Outlier Analysis Method (Anselin Local Moran I)

Clusters and Outliers Analysis (Anselin Local Moran I) is a statistical method that takes into account equation (value) events/feature similarity. This method aims to identify the clusters with high and low values and points/events that surrounded the incident with different values. Analysis using this method will produce output in the form of Local I index, Z score, P Values and Cluster Type outliers. Analysis using Cluster and Outliers Analysis (Anselin Local Moran I) defines accident traffic accident black spot as a point of having a CO Type "HH" (clusters of high values).

Hot Spot Analysis (Getis-Ord Gi*)

Hot Spot Analysis similar to the Cluster and Outlier Analysis and also included in the methods of spatial statistics. This method calculates Gi* value of each point/event in a particular area, where the values are analyzed and influenced by the number of events

around him. The results of this method of analysis of Z Score and P Value. Point/hotspot is the point of incident/event that has a value of Z-Score is high (positive) and P-value zero.

Ambulance Fastest Route Determination

Ambulance fastest route selection is the result of network analysis that calculates the accumulation of a parameter / cost - travel time by certain conditions or restrictions. The route with the least amount of accumulated travel time chosen as the route for evacuation of victims of traffic accidents. In this study, the result of traffic accident blackspot identification and service area of referral hospitals will indicate which hospital is selected as a referral hospital if a traffic accident occurred around blackspot if both data are overlied. Analysis to determine the ambulance fastest route use the Network Analyst that appear in ArcGIS - Utility Network Analyst toolbar. The data required for ambulance fastest route determination is road network that has been compiled into a geometric network.

ANALYSIS

The result of hospital service area analysis using netwok Analyst Tool - Service Area was shown in Figure 1 and presented in Table 1. Traffic accidents that occurred in Surakarta city during the year 2011 is shown in Figure 2. Victims of traffic accidents in Surakarta city (2011), including 29 deaths, 32 severe injuries, 633 injuries and 704 minor casualties material losses. Location of traffic accidents tend to disperes or random. Many value EAN of each traffic accident locations are equal. Information chronology of incidents of secondary data and the data above show a traffic accident that occurred in the Surakarta city caused more by human error/driving behavior.

Table 1 Referral Hospital Victims of Traffic Accidents in Surakarta

No	Hospital	Address	Coordinate	
			X	Y
1	RS. Brayat Minulya	Jl. Dr. Setia Budi No. 106	479510	9165115
2	RS. Dr. Moewardi	Jl. Kol. Sutarto No. 123	482517	9164379
3	RS. Dr. Oen	Jl. Brigjend Katamso No. 55	482202	9164796
4	RS. Kasih Ibu	Jl. Brigjend Slamet Riyadi No. 402	478122	9163892
5	RS. Kustati	Jl. Kapten Mulyadi No. 249	481323	9162044
6	RS. Panti Waluyo	Jl. Jend Ahmad Yani No. 1 - 2	476845	9164284
7	RS. PKU Muhammadiyah	Jl. Ronggowarsito No. 130	479738	9163699

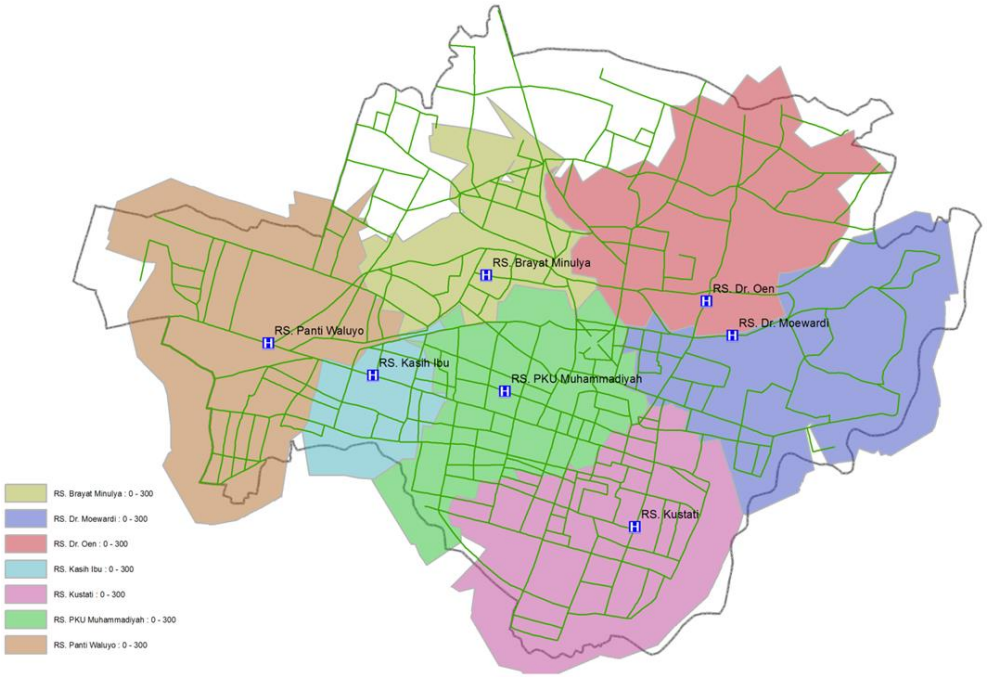

Figure 1 Service Area of Referral Hospitals

Analysis using of Kernel Density method determine 8 locations as traffic accidents blackspots and Cluter-Outliers Analysis (Anselin Local Moran I) method determine 5 locations and Hotspot Analysis (Getis-Ord Gi*) method determine 4 locations. Some locations overlap and indicated the same locations. The result of analysis/identification of traffic accident blackspot using the KDE method is shown in Figure 3. Traffic accident blackspots based on Cluter-Outliers Analysis (Anselin Local Moran I) is shown in Figure 4. Traffic accident blackspots based on Hotspot Analysis (Getis-Ord Gi*) is shown in Figure 5.

Incidence of traffic accidents in Surakarta city during the year 2011 tended to spread on some streets that are within the road network of Surakarta city. The results of the analysis of these three methods showed some common point, so that raffic accident blackspot in this study is a combination/overlay the results of three methods of analysis such as shown in Table 2 and Figure 6.

Identification of traffic accident blackspot locations depend on the data obtained from secondary data and survey. The data collection process traffic accident got some obstacles that number change of houses/buildings, irregular numbering of buildings, change of function and or name of the building/land. This appears the difference between traffic accident location information from secondary data to field conditions. GIS is a system that facilitates the collection, storage, processing and analysis of data, especially spatial data. Traffic accident reporting systems need to be integrated with GIS to obtain

accurate data (eg using GPS to obtain coordinate data), so analysis will not need a survey to the location again. Traffic accident report should be made more detailed and formatted properly for the requirement of statistical analysis and spatial.

Figure 2 Traffic Accident in Surakarta City (2011)

Figure 3 Traffic Accident Blackspot (Using KDE Method)

Figure 4 Traffic Accident Blackspot (Using Cluster and Outlier Analysis Method)

Figure 5 Traffic Accident Blackspot (Using Hot Spot Analysis Method)

Table 2 Traffic Accident Blackspot Locations in Surakarta City (2011)

No	Blackspot Location
1	Jl. A. Yani, simpang. 4 patung Wisna Manahan Banjarsari
2	Jl. A. Yani, simpang Ngemplak Gilingan Banjarsari
3	Jl. A. Yani, Timur Terowongan KA Gilingan Banjarsari
4	Jl. Adi Sucipto, depan HAILAI CLUB Jajar Laweyan
5	Jl. Adi Sucipto, depan Mapolresta Manahan Banjarsari
6	Jl. Adi Sucipto, depan PDAM Karang Asem Laweyan
7	Jl. Adi Sucipto, depan Universitas Sahid Laweyan
8	Jl. Adi Sucipto, simpang 4 Fajar Indah Jajar Laweyan
9	Jl. Adi Sucipto, simpang 3 DPRD Karangasem Laweyan
10	Jl. Dr. Radjiman, atas jembatan Jongke Laweyan
11	Jl. Ir. Sutami, depan pintu masuk kampus UNS Jebres
12	Jl. Jend. Sudirman, Simpang 4 Bank Indonesia Gladak
13	Jl. Ki Hajar Dewantoro, depan kampus STSI Jebres
14	Jl. Ki Hajar Dewantoro, depan Techno Park Jebres
15	Jl. Slamet Riyadi, depan Kantor Pengadilan Laweyan

Figure 6 Traffic Accident Blackspot in Surakarta City (2011)

Overlay of the result of traffic accident blackspots identification and referral hospital service area indicate where the selected as a referral hospital if a traffic accident occurred around blackspot as shown in Figure 7.

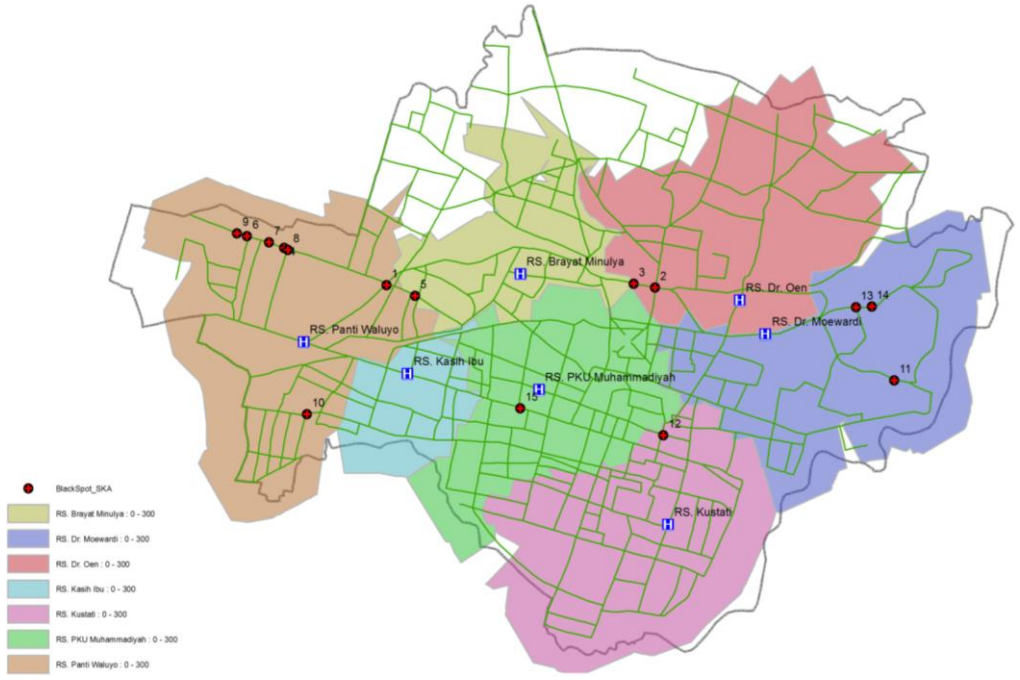

Figure 7 Overlay of Traffic Accident Blackspot and Service Area of Referral Hospital

There are differences in the determination of referral hospital for traffic accident victims between reality and the results of the analysis as shown in Figure 8. This is caused the analysis only considers the travel time in order to get the victim to a hospital immediately, whereas in fact the individual factors and quality of hospitals service are also taken into consideration. Therefore, hospitals must have a standard of emergency care, especially for the victims of the accident so that all aspects can be considered fulfilled.

This study used data of the road network research in 2009 to determine the fastest route to evacuate traffic accident victims. Economic growth, increasing population, technological developments and increasing number of vehicles will affect the transportation system that includes roads.

Changes in the characteristics of the road network will also affect travel time. In the future, the road network data up to date, traffic accident data accurate and the standard of emergency care the victims of traffic accidents may soon get health care so that the risk of death due to traffic accidents will decrease.

The finding of this research is to identify traffic accident blackspots and service area of referral hospital for determination ambulance fastest route in mobilization process of traffic accident victims. A referral hospitals in Surakarta city are Brayat Minulya, Dr. Moewardi, Dr. Oen, Kasih Ibu, Kustati, Panti Waluyo and PKU Muhammadiyah hospital. This research identification/analysis showed 15 traffic accident blackspots and the average time required to evacuate the victims of traffic accidents for 4.84 minutes.

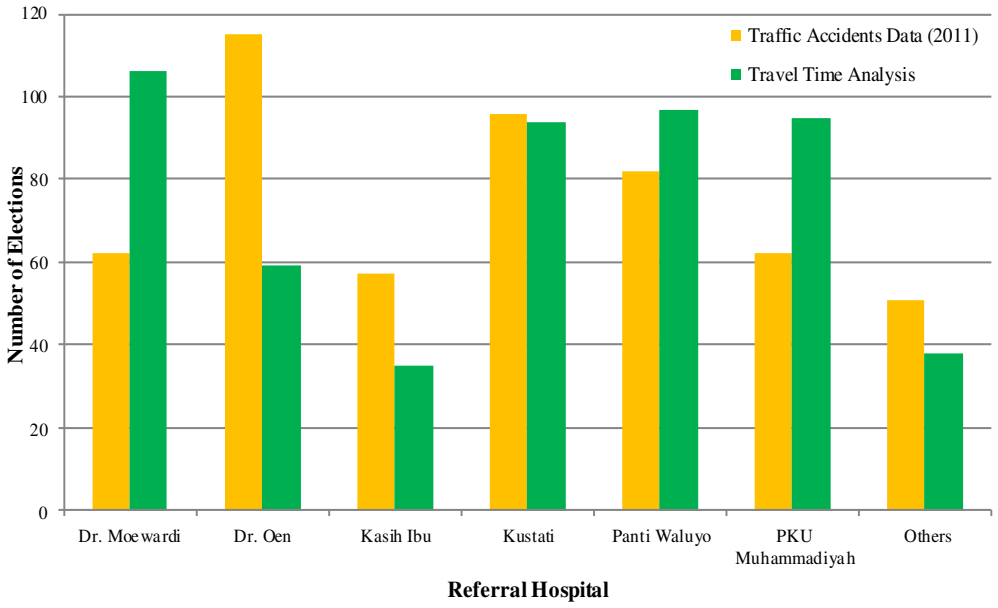

Figure 8 Comparison of Elections Number of Referral Hospital

CONCLUSION

The police department, the department of transportation, hospitals, local governments and other agencies competent in road safety should work together to reduce the number of traffic accidents and the number of deaths from traffic accidents. One way to reduce the risk of death from a traffic accident are treated accident victims as good as and as quickly as possible. Finding ambulances route to evacuate the victims of traffic accidents is very important especially for severe injuries. Evacuation traffic accident victims to the hospital faster will make the victim more quickly get medical care so that the risk of death will be decrease.

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