GIS Analysis on Road Accident and Road Safety: A Case Study of Road Geometry in Kajang, Selangor

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Abstract

Malaysia has recorded the 8th highest number of fatal road accident. This is due to a few factors such as inexperience, incapacity and risk behaviours of driving. Other than that, road conditions also play a role. Road Accidents need to be seriously taken into action by the government and agencies involving in road safety. Geographical Information System (GIS) technology had been used in this study to store, retrieve and view data for number of accidents that occurred and to compare with road geometry characteristics. This study focused on the relationship between road geometry and road accident cases in chosen study area which is Kajang, Selangor. GIS offers various advantages thanks to its integrated statistical analytical capabilities. GIS technology has widely been used to process the map of accident-prone locations. Moran's I technique is a tool used that measures the overall spatial autocorrelation for this study. The relationship between road geometries and road accidents was determined with the use of Getis Ord Gi* tools that is provided in GIS technology. By identifying the hotspot locations. At the end of this study, map of hotspot accident location and the connection between road geometries had been successfully analysed where it was found that accidents occur most frequently in T-intersection where is was recorded the highest number of accident cases for the intersection type.

1. Introduction

According to the data from Royal Malaysian Police, number of accidents has increased year by year. Selangor has recorded the highest number of accidents as compared to other states (Khairul Amri Kamarudin et al., 2021 and Shahid et al., 2015). There is an increasing trend of accident cases in Malaysia (MOT, 2022). Important policies on road safety include public protection, road safety marketing, policy formulation and crash prevention funding. Road safety is a cooperative requirement that needs the participation of local governments, civil society, as well as public and private sector corporations (D. O. S. Malaysia, 2022). In addition, rapid motorization, inadequate maintenance of highways, lack of law action, rapid population growth and bad roads are a few examples of variables that could contribute accidents in developed countries (Amedorme and Nsoh, 2016). Infrastructure is an essential component of a country's growth, protection and happiness. Bad road quality may also add to future crashes and carelessness (Wong et al., 2006). According to the World Health Organization, road deaths are among

the top ten causes of death globally, killing 40,999 people in the U.S. alone in 2019.

In a previous study (Kunji et al., 2018), it was indicated that the lights and signposts mounted near driving lane have triggered a high impact crash in the degree to which cars were broken up and motorist killed. In the study, it was found that a new road drainage facilities are built from concrete and those with debris lined walls are dangerous. When they are put inside a roadside safety recovery area or corridor for skidding errant vehicles, they destroy and injure motorist and require recovery to return to the roadway. This leads us to the awareness of the importance of road features in roads.

Kajang is a town in south-eastern Selangor, Malaysia. It is located 20 km southeast of downtown Kuala Lumpur, in the coterminous mukim (commune) of Kajang in the Hulu Langat District. The Selangor population stood at approximately 6.57 million in the first quarter of 2020. Selangor is the most populous state in Malaysia and, in terms of gross domestic products, the state with the highest economy. This study aims to evaluate the impact of road safety in road geometry category toward road accident by using GIS in Kajang, Selangor. Technique in GIS can be used to analyze safety level toward accident locations, determine spatial correlation between road safety level towards accident location to visualize the impact of road safety occurred and to create map showing accidents-prone areas to help people become aware of road safety and reduce the number of accidents and make people realize how important road safety in order to reduce road accident (Radzuan et al., 2021).

2. Methodology

The data and the location of road accidents have been obtained from the local authority department which is the Royal Malaysia Police. The data was gathered and managed separately between road accident location and type of road geometry. The number of accidents recorded for year 2019 was 18,094 accidents in total, comprising of accidents record that include fatal cases, serious injuries, minor collisions, and vehicle damages from 83 roads in Kajang. Vector data contain different type in attribute table of vector such as line, point and polygon. The attribute contains the name of Road Accident Location, Date and Time of road accident, Factor Led to Road Accident, Type of Road Damage, Number of Road Accident Cases. Table 1 shows the corresponding number of road geometry according to its types in the study area.

Type of Geometry	Number of Road Geometry
T – Intersection	42
Y – Intersection	4
Cross – Intersection (4 legs)	14
5 or More Legs and Not	2
Circular	
Roundabout	2
Straight Line	9
Roundabout	6

Table 1: Road geometry data

Moran's I is worked to measure the overall spatial autocorrelation of the data set. From the occurrence of negative value retrieved from the processing, it indicates that a certain feature has neighboring features with dissimilar values, when it doesn't correlate with other neighboring characteristics, indicating the function is an outlier that implies that they are not clustered. Moran's I generated report that depicts the value of p-score and z-score as well (Borhan et al., 2019).

Hotspot analysis using Getis-ord Gi* is to identify the hotspot location of road accident for this study area. Correspondingly, several issues related to road safety have been recognized and addressed in the location. The positive and larger Z scored is an indication that they are more intense clustering of high values whereas smaller Z score signified the more intense the clustering of low value. This can be seen in Figures 2 and 3. Kajang area has many developing housings and dense settlement areas. There are many connections of roads needed and roads constantly cross each other. The number of road intersections play a role and contribute to the number of accidents. A planning type for road geometry for future development can be taken into consideration when expanding roads.

3. Findings and Discussion

Accidents could have happened for a cause. As previously noted, road geometry can be one of the variables contributing to traffic accidents. As a result, the following analysis will investigate the association between road deficiencies and traffic accidents. From the data collection done, the result shows that T-intersection has recorded the highest number of accident cases in road geometry. Tintersection area is the popular road that will be used by the public user all the time. This would be worrying if the authorities do not do any alternative measure in order to curb the problem. Cross intersection (4 Legs) is the second highest number of cases in road geometry. The Cross - intersection (4 Legs) is always focusing in township area such as the city of Kajang since there are in crowded area. It would be very dangerous if people do not alert with the warning signboard. Y-intersection is recorded the third highest number of cases in road geometry. The least number of cases in road geometry is roundabout and 5 or more legs and not circular

which only few cases reported. It can be concluded that T-intersection and Y-intersection are the two major types of road geometry that possibly lead to road accident in Kajang area.

Figure 1 below shows the map of study area and its corresponding accident and road geometry. The hotspot accidents area in Kajang area for the year 2019 is shown in Figure 2. The Getis Ord Gi Generated from Collected Event approach was used to produce the hotspot area. The number of hotspot accident cases on the road can be used to identify the frequent spot for accident area based on the investigation and analysis. T-intersection road is a daily type of road geometry use by community in Kajang area.



Figure 1: Road geometry at accident locations in Kajang, Selangor

Based on data collection, each roundabout has accident location but due to least number of roundabouts in Kajang area, the number is not affected as highest the number of T-intersection. As a result, it is possible to conclude that a road flaw was one of the key elements contributing to the road accident in. Following the identification of road segments with a high rate of vehicle accidents, preventative actions should be taken to improve the safety of these segments. Based on site visits, the results had been verified along the way to check the hot and cold spots as indicated in Figure 2. the condition of road is not fully satisfying the criteria of the road safety especially to the group of motorcyclist and car drivers. It was found that there were many road geometries without any sign and any warning that can be seen along the road and has been followed by the road construction that give effect for the condition of road on that area. Figure 3 shows the map of the relationship of Road Geometry with the accident hotspot in Kajang Area.



Hotspot Map of Road Accident Locations in Kajang, Selangor

Figure 2: Road accident hotspot map in kajang, selangor

4. Conclusion

The impact of road safety in road geometry category toward road accident by using GIS in Kajang, Selangor can be said to affect the number of accidents in Kajang. This is because accidents occur in different number of times for different road geometry. Result from analysis shows that Jalan Balakong is found to have a few dangerous segments since it has recorded the highest number of accident number. GIS application was also used to identify the significance of hazardous locations on the road as a result in graphical map format. Furthermore, most of the hazardous spots were discovered near T-intersections, Y-intersections, roundabouts, Cross intersections (4 legs), five or more legs and not circular, straight-line roads, and road bends. it was critical to improve the data collection method as well as the methodology of these data processing and geographical analysis for enhancing traffic safety analysis. This study proposed a method for evaluating clusters of traffic incidents and identifying these places based on their

severity. Moran's I was a spatial analytic technique utilized in clustering hotspots, which were also confirmed and ranked based on their clustering locations. The most hazardous places in these cities of Kajang were incredibly significant and useful for the appropriate road transport organizations, considering safety improvements on these highways, whether policies or practices. Therefore, the spatial autocorrelation between road safety level towards accident location has been achieved from second objective.

Accidents occur regularly as a result of a lack of information recorded about the causes of the event. The Getis-Ord Gi* statistic was utilized to identify hotspot locations and investigate the level of road safety in such dangerous places on Kajang. According to the result of the data, dangerous accident locations are occurred on the red area. Since value of z-score is -0.436118, Moran's I index value indicates tendency toward dispersion.



Figure 3: Relationship of road geometry with the hot spot in Kajang area

Hot spot and cold spot that shown on the map would alarm people of all the residents and also government agencies in order to improve the level of road safety. The map showing accidents-prone areas has successfully been produced. The road geometry is one of hidden factor that will lead to road accident. Therefore it is important to take action on how to inform road infrastructure design to address road safety problem by investigating the long term effect from the hot spot and cold spot mapping. This would help people to understand and clearly understand the input on the map. Lastly, the hotspot mapping not only can analyze road geometry but it can be used for further research such like disaster mapping, crime mapping and other type of road safety.

It can be said that it is important for government or agencies that involve providing road users with appropriate knowledge, skills and attitudes so that they choose to use the roads safely. Road policing is a fundamental and irreplaceable activity, a key factor in saving lives and minimizing road injuries. To do this efficiently, the government and the police must give policing its appropriate priority and be adequately equipped to do so. By adding some extra road features near the T-junction and road accident location such as speed bumps, road lane, zebra lane, and related signboard to make people aware and beware with the hotspot accident location area.

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