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Analysis of Severity Level Types and Trends in Road Accident Cases at Johor Inter State Road Using Analytical Hierarchy Process (AHP) And Geographical Information System

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Abstract: Road traffic accidents are usually happened and keep increasing year by year in Malaysia. It will give a adverse impact at the road also to the road user. There are several causes that contribute to the accident such as faulty vehicle, uneven roads, driver behavior and many more. So, with all these causes, it might be the reason why the road accidents keep on increasing. The purpose of this case study is to determine the highest road accident ranking based on the types of injuries at the state road, Johor. Another purpose is to identify the current traffic accident trends. Secondary data collected from Balai Polis Trafik, Batu Pahat are used to get an accident data and the Analythical Hierarchy Process (AHP) will be proceeded to find the road accident ranking based on the types of injuries. The case study used the five years' road accident data as from 2016 until October 2020. Geoda as GIS application is used to insert the data about the road accident trends. The highest road accident ranking based on the types of injuries and the road accident trends were obtained and achieved all the objective of this case study. The hierarchy structure has founded highest ranking by types of injuries, which is the highest is Wreckage injuries that has the consistency ratio 2.92 which is the highest then the other value. The fatal injury has the second highest value which is 1.31, the minor is 0.88 and the lowest value is in the serious injuries which is 0.70 in consistency Ratio. In conclusion, by using the AHP it is more easy to find the ranking at any of problem issues and by using this method it can use primarily used to weigh the parameters and pick and rate the alternatives that have been chosen.Besides that, it will be useful as a reference to any party in the future for the road traffic management.

Keywords: AHP, GIS, Geoda, road accident trends

1. Introduction

Road traffic accident is the inescapable incident that can happens anytime anywhere, and it is the one common thing in the world. World Health Organization (WHO) said that the road accident injuries are about 1.25 million people with another 20-50 million individuals that being physically disabled as a result of road accidents. According to WHO, in the year 2020, accident fatalities will become the fifth leading cause of the death worldwide based on the current trends. Besides that, the traffic accidents also will cause of high economic losses due to the traffic congestion such as traffic delay, travel time unreliability, supply chain interruptions, increase in noise pollution and deterioration of air quality. Moreover, the main reason among the traffic accident is occur according to the netizen's dangerous road condition and unsafe vehicles. In the year 2020, the rate should be reduced because Malaysia struggles to be a developed country in this year. Therefore, to avoid the road traffic accident being increases every year, the case study is conducted. The locations of the study were selected at the Johor state road. From this case study the highest road accident ranking by types of injuries and the current traffic accident trends can be found.

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2. Road Accident Cases Information

There has a several issues that will be discussed and need to conduct which is to analyses the increasing of the road traffic accidents. In this study, the analysis focused on the Johor state road, which is the analysis of highest accident ranking and traffic accidents trends.

2.1 Road Accident

In WHO, the major cause of death is the road traffic accidents which is indict a million lives every year in the world [1]. Over the past five year, Malaysia have experienced the road accident and fatalities which is the global problem in the road traffic accident [2]. The massive contributors to the road traffic accidents are the human factor, while 60% is the speeding behavior. It can be predicted that the number of fatalities will increase from 5.1 million in 1990 to 8.4 million in 2020 based on the WHO [3].

2.2 Traffic Information

The serious concern to the community and authority is the traffic accidents which considered as an unplanned and unfortunate event. The cause of the accident infrequently happens in the situation which is only one thing or in one person only. The Average Annual Daily Traffic (AADT) and speed of vehicles were used in the research for the traffic information [5]. In year of 2010, 2011, 2012 and 2013, the AADT was provide by the ministry of works Malaysia Highway planning unit road traffic volume Malaysia [6]. In this organization, it conducts a bi-monthly study at each year in a specific station in April for the first half data and in October for the other half year data [4]. Next, for every type of vehicles, data were collected hourly from 0600 until 2200 hours.

2.3 Analythical Hierarchy Process (AHP)

Many fields have been used the AHP, such as health issues, banking, management and business, sciences and engineering sources. Process of Analytical Hierarchy is a mathematical device in multi-criteria result making which designing the result factors in hierarchy problem structure [5]. Other than that, structuring the criterion hierarchy of Multi-Criteria Decision Making (MCDM) were using to resolve and help decision makers in making resolution for the complex problem which is the main target of the AHP [3]. AHP is known as a very powerful tools for decision making. The procedure of AHP is the determination of focus or aim of the problem that must be recognize and it will consider as the first level for the AHP hierarchy, next it will be multiple criterion that explain the alternatives and the last level is the provide alternatives for the focus [5]. For the measurement, the standard scale with absolute numbers will be use in order to control the weight of each alternative. The weight can be used as contrast and ranking the alternatives of the problem and direct the decision maker in making option [5].

2.4 Open-Source GIS

Geoda-web is made as a cloud-to-cloud solution that applies the latest web technologies to combine any cloud-based software services and Application Programming Interfaces (API) [7]. Spatial Data analysis where the latter is taken to contain of visualization, exploration, and explanation of attractive patterns in geographic data which is the introduction to GeoDa [6]. In many aspects, it is a reinvention of the original space stat package, which by now has become really dated, with single a rudimentary user interface, an outdated architecture and show constraints for medium and large data sets [7]. On all sides of the central idea of dynamically linked graphics was redesign and rewritten from scratch by Geoda. This shows that it gives different views of the data that represented graphs, maps, or table with selected monitoring in one highlighted in all [7].

3. Methodology

A flow chart (Fig. 1) has been created in this chapter for the subtopic below to indicate how the project is progressing. Following that, data was gathered through personnel authorisation in order to meet the case study's goal. In addition, AHP and Geoda are used in this research. AHP will also be utilised to establish the top accident ranking by injury type, and Geoda will be used to analyse road accident trends.

3.1 Method of Trace

The movement of this study began to determine the ability of GIS systems to produce results to list the rangking position and types of accident levels more efficiently. Fig. 1 shows the directions for all aspects in the study using traffic reports and records received from PDRM.

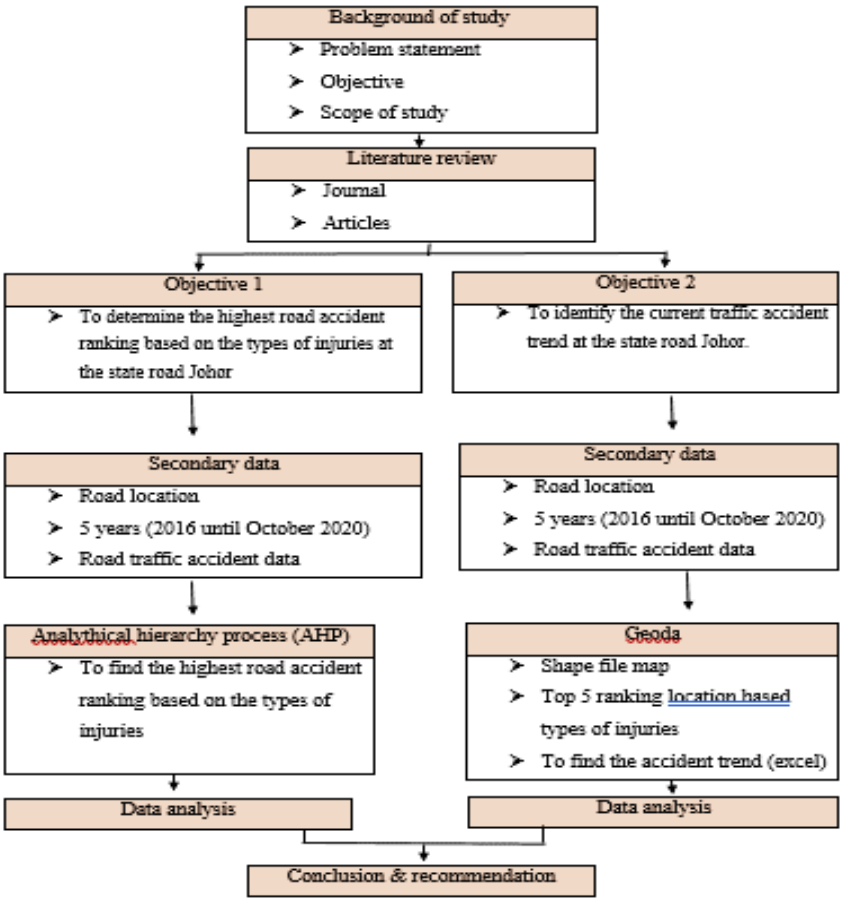

Fig. 1 - Research process flowchart

3.2 Highest Road Accident Identification

Based on the data accident by the local authorizations, the data analysis can be carried out by using the AHP. Next, the AHP will be used to identify the highest road accident rangking by types of injuries for the 5 years, which is from the year 2016 until October 2020.

3.2.1 Secondary Data Analysis

The data for the data collection, which will include data for road accidents that occur from time to time, will be acquired via secondary data. The secondary data was obtained using employee authorisation at the Batu Pahat Police Traffic Department in Johor to ask about the road accident data's specification and accident history. This element may be utilised in this case study based on data from the Batu Pahat Police Traffic Department in Johor. The year of the event, the location of the accident, and the sorts of injuries involved are all examples of elements.

3.2.2 Analythical Hierarchy Process (AHP)

The top road accident ranking by types of injuries from 2016 to October 2020 may be acquired from the AHP. This technique applied a mathematical device to multi-criteria decision-making, displaying the outcome components in a hierarchical issue structure. The AHP technique must be followed in order to find the outcome. First, the hierarchy structure will focus on the problem that has to be identified, and it will be considered the AHP hierarchy's first level. Then, determine which criteria or categories should be included in the hierarchy structure.

3.3 Accident Trend

In this subtopic, data from road accidents that have been ranked in the AHP will be inserted into an excel spreadsheet and geoda software. The location's shape file map will be included into the geoda. Accident trends will also be examined based on injury categories and five years of road accident data from 2016 to October 2020. The numerous perspectives of data, such as graphs, maps, and tables, are displayed in this road accident trends. This approach will make use of secondary data from the authorisation department.

3.4 Geoda

Based on the Geoda software and by using the excel, the road accident trends by types of injuries in the year 2016 until October 2020 can be obtained. This method used cloud to cloud solution that applies the latest web technologies to combine any cloud-based software services and application programming interfaces. The phase in geoda must be followed to insert the shapefile map in other to find the result. Next, after inserting the maps, the table from the excel that has the top 5 highest location will be add into the geoda. Next, the trends of the road accident will be analysed in the excel software to show the current of the road accident trends.

4. Ranking and Categorise Analysis

In order to achieve the objective, the data collection have been done by collecting the road accident data at the personnel authorization which is at the Balai Trafik Batu Pahat. The data analysis was carried out by using the method analythical hierarchy process to get the highest accident ranking by types of injuries. Next, the geoda will be used to analyse the accident trend at the state road, Johor. The road accident data in 5 years' period, 2016 to October 2020.

4.1 Total of Road Accident

Based on the analysis, the total accident trends based on the types of injuries which is fatal, serious, minor and wreckage injuries in each location at the state road johor in the year 2016- October 2020 have been analyzed. It can be seen that the fatal road accident trends show that the highest accident location is in the year 2018 which is at the Jalan Bukit Pasir – Tongkang Pecah and Jalan Parit Jalil (Fig. 2). The lowest accident trends are in the year 2019 which is at the Jalan Sg Nibong Semerah and Jalan Rejosari. Next, the accident trends of serious injuries show that the highest accident is in the year 2020, which is at Jalan Parit Jalil. The lowest accident trends are in the year 2016 which is at Jalan Simpang Lima – Parit Sulong. For the minor injuries, the highest accident is in the year 2018 at the Jalan Bukit Pasir – Tongkang Pecah and the lowest is at the year 2020, which is at Jalan Haji Ariff Sri Medan. Lastly, at the wreckage injuries, the highest value for road accident is in the year 2019, which is at the Jalan Bukit Pasir-Tongkang Pecah and the lowest value is in the year 2020, which is the total road accident value is zero.

Table 1 - Total of road accident based on the types of injuries in 5 years 2016 until October 2020

Year/ Types	2016	2017	2018	2019	2020[a]
Fatal	38	36	37	29	17
Serious	1	3	2	3	5
Minor	15	17	23	10	1
Wreckage	1226	1199	1292	1375	777

[a]as of October 2020

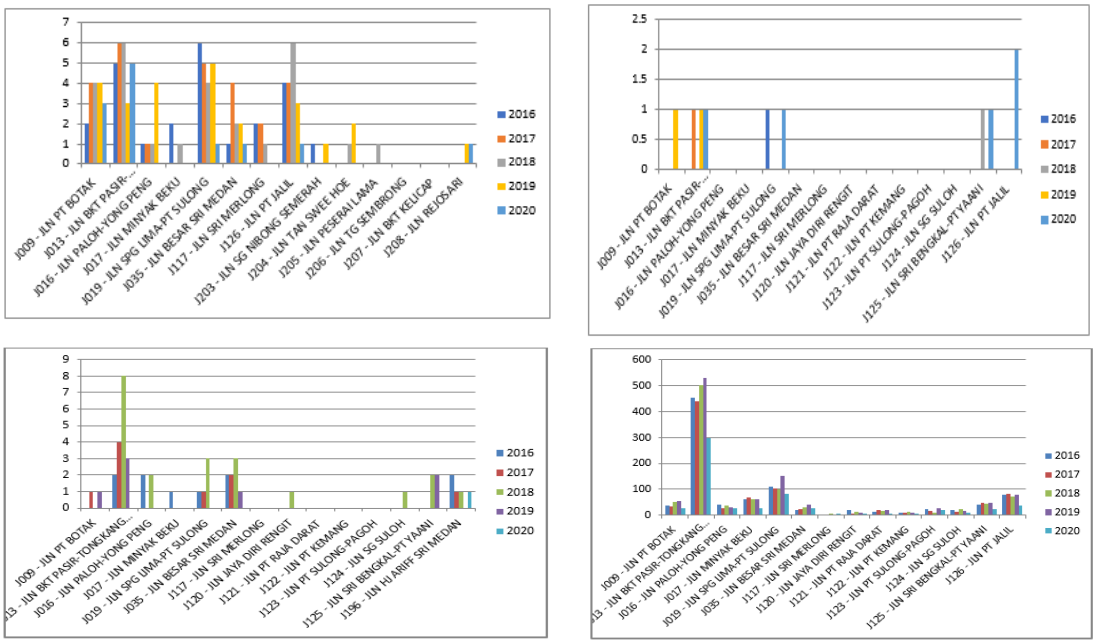

Fig. 2 - Road accident trend based on types of injuries from 2016 - October 2020 at the road Johor State

4.2 Consumption of Analythical Hierarchy Process (AHP)

Once the data has been collected at the Balai Trafik, Batu Pahat. The analythical Hierarchy Process will be used. The first step is total up the accident by the year and the types of injuries and the data will be insert by following the step at the analythical Hierarchy Process, which is the first step is to make the hierarchy structure, then the next step is using the pairwise. By using this method, the highest road accident by types of injuries can be found.

4.2.1 Hierarchy Structure Selection

Hierarchy structure is the structure that built through the top with the goal of decision and from a wide perspective through the objective and intermediate level to the lowest level. Normally, the main objective is defined through a bottom-up process through the top down process by access a correlated problem that seeking a solution through it.

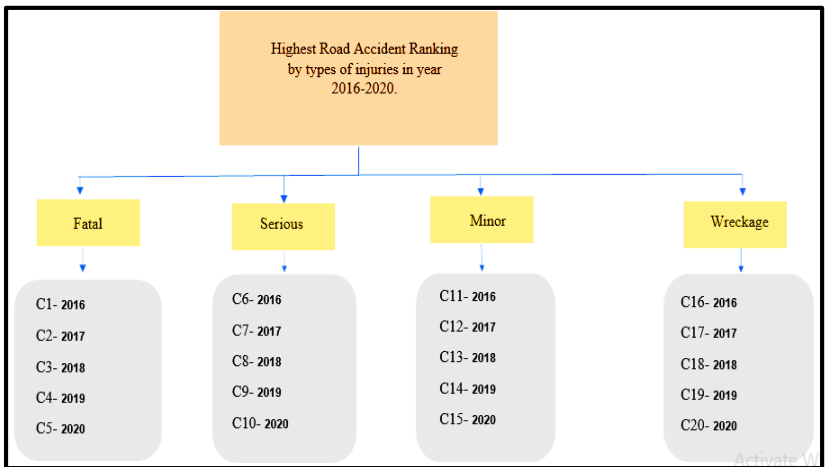

Fig. 3 - Hierarchy structure by the types of injuries in the year 2016-2020

4.2.2 Pairwise Comparison Scale of Analytical Hierarchy Process (AHP)

The element in the upper level is used to compare the element in the level immediately under some respect to it, which is the one matrix must be built for each criterion in the upper level. The differentiation is made by a scale to show how much time more essential or dominant one element is over other element with the respect of criterion with respect to which they are compared. The scale number 9 is more important to the scale number 1 which is equal range. It is use as a verbal scale for measurement quantitative and the criteria of qualitative. Table 2 shows the Pairwise comparison scale for AHP preference.

Table 2 - Pairwise comparison scale for AHP preference

Preference on pair wise comparison	Preference number
Equally important	1
Moderately more important	3
Strongly more important	5
Very strong more important	7
Extremely more important	9
Intermediate value	2,4,6,8

Step 1: Calculate the weighting value for each criterion. Scale that being used are based on Table 1 and Table 2.

Fatality					
	C1	**C2**	**C3**	**C4**	**C5**
C1	1	O.14	O.14	O.14	O.14
C2	7	1	7	5	5
C3	7	O.14	1	5	5
C4	7	0.2	0.2	1	5
C5	7	0.2	0.2	0.2	1

Step 2: Multiply the scale of each criterion by the value of each weight to get the total 1.

				Fatality		
C1	1	O.14	O.14	O.14	O.14	**0.30738**
C2	7	1	7	5	5	**4.14598**
C3	7	O.14	1	5	5	**1.895978**
C4	7	0.2	0.2	1	5	**1.475773**
C5	7	0.2	0.2	0.2	1	**0.561872**
				Total 1		**8.38698**

Step 3: Divide the amount by the weight to get the total 2.

	Fatality
C1	8.3698 /0.307381 = 27.29
C2	2.02
C3	4.42
C4	5.68
C5	14.93
Total	**54.34**

Step 4: Calculation of Consistency Index (CI) and Consistency Ratio (CR). N value is the number of criteria that has been use.

Table 3 - Random Inconsistency Index (RI) value refers to the number of criteria

n	1-2	3	4	5	6	7	8	9
Random Inconsistency	0.0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

$$\lambda = \frac{\text{Total 2}}{n} = \frac{54.34}{5} = 10.87 \tag{1}$$

$$\text{Consistency test, CI} = \frac{\lambda - n}{n-1} = \frac{10.87-5}{5-1} = 1.47 \tag{2}$$

\

$$\text{Consistency ratio, CR} = \frac{\text{CI}}{\text{RI}} = \frac{1.47}{1.12} = 1.31 \tag{3}$$

By using this AHP the road accident data by types of injuries has been rank by using this formula. Which are the wreckage injuries having the highest location accident then follow by the fatal, minor and serious in the year 2016-2020.

4.3 Top 5 Ranking for Road Accident Location

To shortlist it into an easy information, the simplest way that being used is by using the ranking sites which are the recommended use in Malaysia. From the analysis, the data has been listed from each location about the total of road accident for each location at the state road Johor. Table 4 shows the data listed, the 5 highest value will be selected as the top 5 rangking road accident location based on the types of injuries from the year 2016 until october 2020.

4.4 Data Result Using Geoda

Geoda is a set of software tools for implementing methodologies for exploratory geographical data analysis that give a user-friendly and graphical interface to descriptive spatial data analysis approaches. Auto correlation statistics and indications of spatial outliers are two examples. It also contains dynamically connected windows technology,

which creates an interactive environment that mixes maps and statistics visuals. The results of the analytic hierarchy approach were used in Geoda in this chapter (Fig. 4)

Table 4 - Top 5 rangking locations by types of injuries in 2016 until October 2020

Fatal	Serious	Minor	Wreckage
J009 – Jalan Parit Botak	J013 – Jalan Bukit Pasir – Tongkang Pechah	J013 – Jalan Bukit Pasir – Tongkang Pechah	J013 – Jalan Bukit Pasir – Tongkang Pechah
J013 – Jalan Bukit Pasir – Tongkang Pechah	J019 – Jalan Simpang Lima – parit Sulong	J016 Jalan Paloh – Yong Peng	J017 – Jalan Minyak Beku
J019 – Jalan Simpang Lima – parit Sulong	J125 – Jalan Sri bengkal – Pt Yaani	J019 – Jalan Simpang Lima – parit Sulong	J019 – Jalan Simpang Lima – parit Sulong
J126 – Jalan Parit Jalil	J126 – Jalan Parit Jalil	J035 – Jalan Besar Sri Medan	J126 – Jalan Parit Jalil
J209 – Jalan Parit Karjo	J209 – Jalan Parit Karjo	J125 – Jalan Sri bengkal – Pt Yaani	J204 – Jalan Tan Swee Hoe

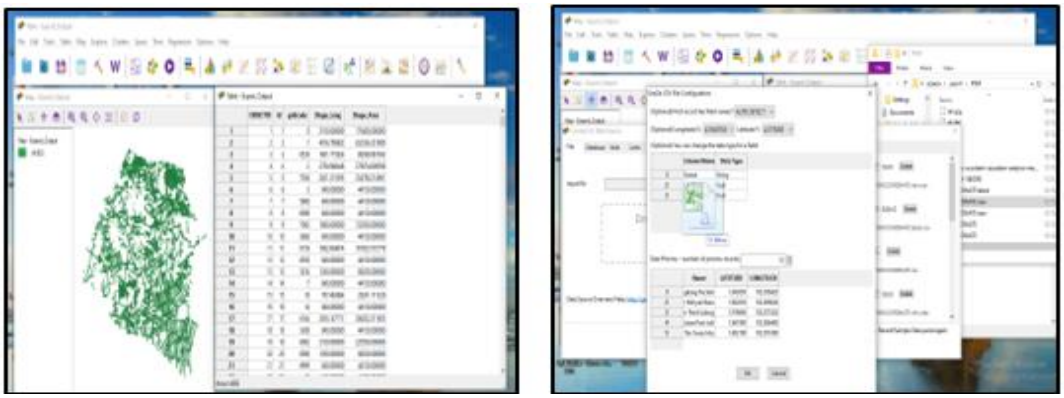

Fig. 4 - Shows the attribute table based on the state road maps Johor and additional table that has top 5 highest location in wreckage injuries

4.5 Data of Road Accident Trends

Fig. 5 shows the road accident trends based on the types of injuries that have been rank in the Analythical Hierarchy Process in the year 2016 until October 2020. The data shows that the location at wreckage injuries has more accident occur compared to the other locations.

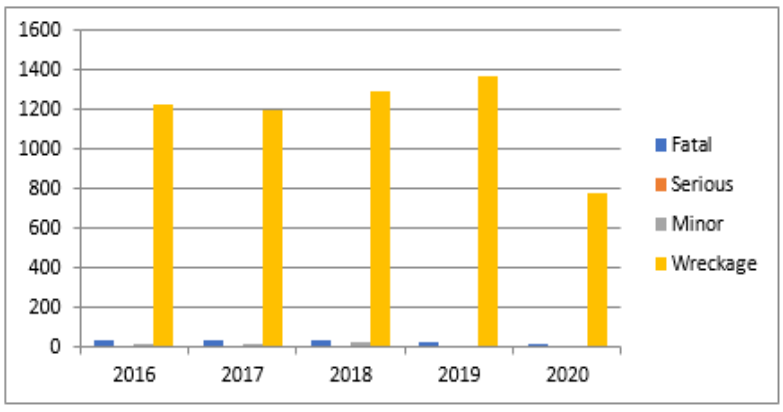

Fig. 5 - Road accident trends based on the types of injuries in 2016 until October 2020

4.6 Analysis of Selected Section

After the analysis have been done by using Analythical Hierarchy Process and the geoda, this figure below shows

the top 5 location that has been stated in the top 5 rangking for the highest road accident in the state road Johor for the year 2016 until October 2020. The location is different based on the types of injuries that have been state at the Table 4.

5. Conclusion

The first goal is accomplished by the secondary data from Balai Traffic Batu Pahat Johor based on the accident data that have been obtained in the year 2016 until October 2020. In order to find the highest ranking based on the types of injuries, the road injury data has been analyzed and summarized so that the data can be included in the first form, which is by using the AHP. The method of AHP can be help to assess the weight and rank of the road accident by using this mathematical equation. In this method it has 7 step to follow, which is the first step is to conduct a hierarchy structure. The hierarchy structure has state the factor which is the highest ranking by types of injuries has been found, which is the highest is Wreckage injuries that has the consistency ratio 2.92 which is the highest then the other value. Next, the fatal injury has the second highest value which is 1.31, the minor is 0.88 and the lowest value is in the serious injuries, which is 0.70 in consistency Ratio. In conclusion, by using the AHP it is easier to find the ranking at any of the problem issues and by using this method it can use primarily be used to weigh the parameters and pick and rate the alternatives that have been chosen. Moreover, these findings concerning the outcome of the AHP application depended solely on the adequacy of the model and the technology. It will help the recommendation for future research on the complexities of implementing AHP in order to determine the best parameters, achieve consensus on the need for the results or modify the framework.

Through objective one, which result in the highest road accident ranking based on the types of injuries, the data from there were analyzed and the top 5 ranking locations based on the top 5 highest locations by types of injuries were found. From here, the data will be used in Geoda after inserting the maps of Johor state road. From the data, the current road accident trends based on the data location, including the 5 years of accidents were made to achieve this objective. The accident trends show that the wreckage injuries have the highest accident record in 2019 then followed by the years 2018, 2016,2017 and the lowest in the year 2020. In 2020, the data on the accident decreased, it is because the data is not fully recorded, it is just from January until October 2020. The other reason is that the Johor state road has some improvements in road geometry, and road environment and the maintenance of the road defect is regularly done.

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