

Accident Severity Analysis in Johor

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Abstract

Road accident has been a common problem in Malaysia. Road accidents occurred due to various factors with different type of accident severities. This study analyzed the relationship between the accident severities and accident factors in Johor. Accident severities were analyzed using R software to develop regression models that capable of predicting the number of accidents as well as the accident severities by road type, time of occurrence, and road geometry. As for the severity, there were three levels of severities that were presented in this study which were death, major injuries and minor injuries. The results showed that the combination of the federal road with straight road which took place around 8 PM to 10 PM were the most critical combination that caused the highest chance of fatalities. It was also shown that there were high chances for a driver to suffer death from road traffic accident anytime in the 24 hours.

Keywords

Road Traffic Accident, Severity, Accident Factors, Regression

Introduction

Road accidents increased yearly in Malaysia with the increase in road activities and also population. Road accidents subjected to any form of accidents between vehicles, accidents between vehicle with infrastructure or even accidents between vehicle and pedestrians and all these accidents eventually led to injuries and death. Approximately 1.35 million deaths were caused by accident all around the world and between 20 to 50 million suffered non-fatal injuries, including disability (WHO, 2018). In the year 2017, 533,875 accident occurred in Malaysia with 6,740 fatalities, 3,310 serious injuries, and 6,539 minor injuries (Kareem, 2003). Three types of severities were analyzed in this study which were death, serious injuries, and minor injuries. Many factors affect the level of severity when road accident occurred. For example, the speed difference between the colliding vehicles affects the severity where the severity were higher when the difference in speed was also high (Tay & Rifaat, 2007). Speeding by driver affects the severity of road accident whereby lower speed led to lower severity level as they have more time to react (Tay & Rifaat, 2007).



This report focused on three factors that cause road accidents which were road types, road geometry, and time of occurrence. Rural road users on less awareness regarding road safety was a factor of high road accident casualties on rural roads. In the year 2014 at China, approximately 78.61% of road traffic accident casualties happened in the rural road, and this was due to the lack of safety devices and traffic signs (Ma, Zheng, Zhang & Cheng, 2012) Road geometry affects the number of accidents as well as the severity. In the year 2009, 66% of fatalities involved by Malaysian motorcyclist occurred on the straight road. Most of the fatalities on the straight road were due to the high speed (RMP, 2009). Time of occurrence was one of the significant factors that led to accidents due to the relationship of time and fatigue and sleep deficit which decreased the drivers' driving performance, bad vision, and alertness (Jamroz & Smolarek, 2013). In Malaysia, most of the accidents that happened were usually during the evening, approximately from 16:01 to 22:00 (Abdelfatah, 2016). This study analyzed the accident frequency and accident severity together with three factors that caused the accidents. R statistical software was deployed to produce regression model and predictive formulation. Countermeasures were proposed to minimize the frequency and severity of accidents.

Methodology

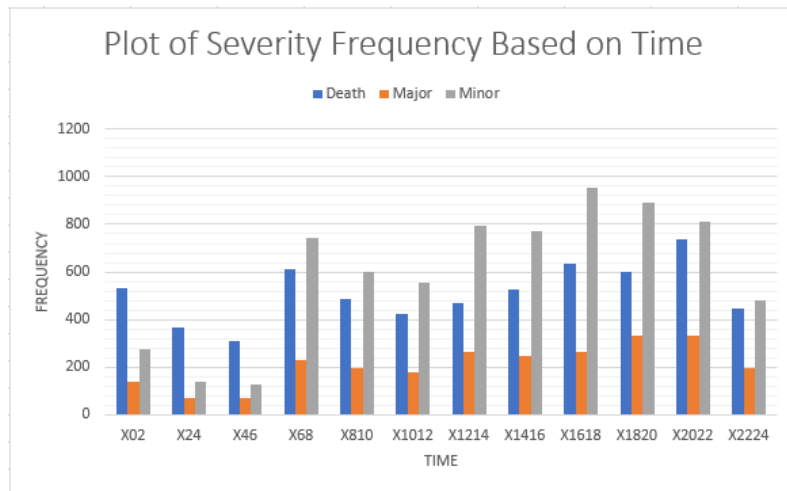
For analysis purpose, the data used in this study were collected from Johor police headquarters. The data collected were the accident severities and the accident factors which contributed to accident. The accident severities were deaths, serious injuries, minor injuries and damages while the accident factors were the time of accident occurrence, road type, and road geometry.

Six years' of accident data were collected from police department from the year 2011 to 2016 encompassed the entire Johor state covering districts of Johor Bahru selatan, Johor Bahru utara, Seri Alam, Kulai Jaya, Nusa Jaya, Muar, Ledang, Batu Pahat, Kluang, Segamat, Kota Tinggi, Pontian and Mersing. In this study, the accident severities taken as the dependent variable, while the three factors were the independent variables.

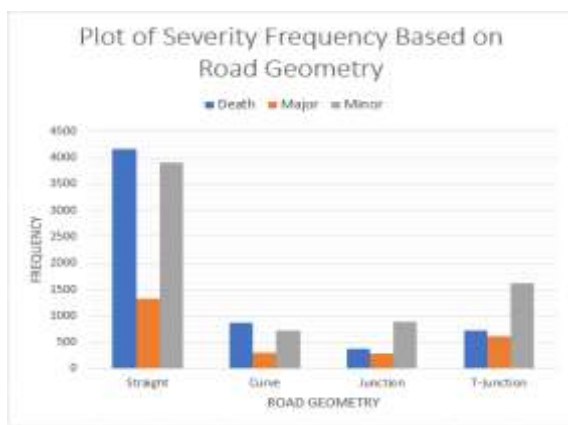
Road accidents by the time occurrence were divided into twelve-time interval starting from 00:01 to 02:00, 02:01 to 04:00, 04:01 to 06:00, 06:01 to 08:00, 08:01 to 10:00, 10:01 to 12:00, 12:01 to 14:00, 14:01 to 16:00, 16:01 to 18:00, 18:01 to 20:00, 20:01 to 22:00, and lastly 22:01 to 24:00. Road type was classified into four types which were the state road, express road, rural road, and federal road. For road geometry type, there were seven types including roundabout, straight, curve/bend, elevated, cross junction, staggered junction, T junction and Y junction. However, not all geometry type was used. Road geometry with higher accident data was used for analysis which were straight road, curve/bend, junction and T/Y Junction. Regression model, as well as comparison and relationship plot, were generated from R software.

Results and Discussion

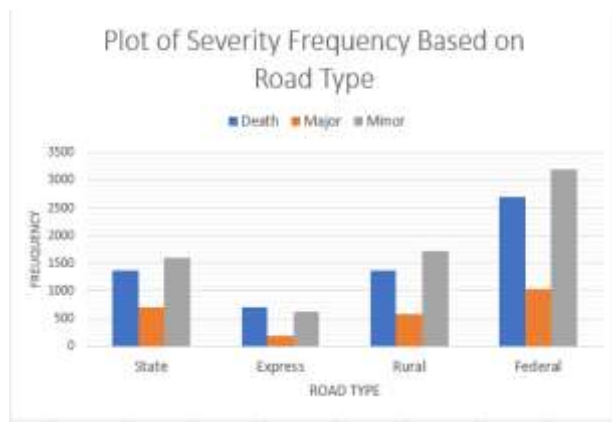
There were three categories for the results, which were Comparison, Relationship, and Regression Model.



(a)



(b)



(c)

Figure 1. Bar Plot of Road Traffic Accident Based on (a) Time of Occurrence, (b) Road Geometry, (c) Road Type

With regards of time of occurrence shown in Figure 1a, in term of the frequency of the accidents, the only time when most of the accidents happened was during 8 PM to 10 PM and the time that the number of accidents reaches the lowest was during 4 AM to 6 AM. In term of severity, the most critical time when most of the deaths happen was from 8 PM to 10 PM, and the time when deaths reach the lowest was 4 AM to 6 AM. However, the number of fatalities were dominant compared to other severity levels which were the major injures and minor injuries at 4 AM to 6 AM. The possible cause due to time might be the speed of the drivers that driving during both periods of sleep deprivation since the lower density of the vehicle during 4 AM to 6 AM shown lower result than 8 PM to 10 PM. A research done on motorcycle fatality in Malaysia resulted that the motorcycle fatalities occur during clear weather accounted about 93.0% and during the day of 55.6%. The percentage of fatalities occurring during the day in clear weather is 52.5%. Fatalities at night also occur mostly in clear weather conditions for about 34%. (Manan, 2012).

With regards to road geometry in Figure 1b, the road geometry that contributes the most accidents was a straight road with very dominant frequency among other road geometry. The straight road was labelled as the most dangerous road geometry because of the big difference of the fatalities and minor injuries with also more major injury victims amongst the other road geometries. Similar to the time of occurrence, straight road considered dangerous among other

road geometries due to the tendency for drivers to speed up their vehicle or even violate the speed limit provided by the government. A research done by Yusria Darma mentioned that the number of road traffic deaths was the highest for straight road segments, followed by bends (Darma, 2017).

With regards of road type shown in Figure 1c, in term of accident frequency, the road type that contributes the most accident was at the federal road, and the one that contributes the least accident was on the express road with total accidents around 6927 and 1524 respectively. Again, the most dangerous road type that led the accidents to death was the federal road with 2692 deaths, and the least dangerous was the express road which contributes 703 deaths. One reason that federal road recorded the highest death was due to the network and length of the federal road compared to the expressway. The federal road network was larger and broader; thus, toll-free gives access to more road users compared to the expressway. Yusria Darma in his research indicated that the number of road traffic deaths is the highest for federal roads (Darma, 2017). Another study mentioned that increased vehicle speed and greater number of access point on federal route were the main cause of accident on federal road (Federal Route 024) (Mohd Masirin, 2016).

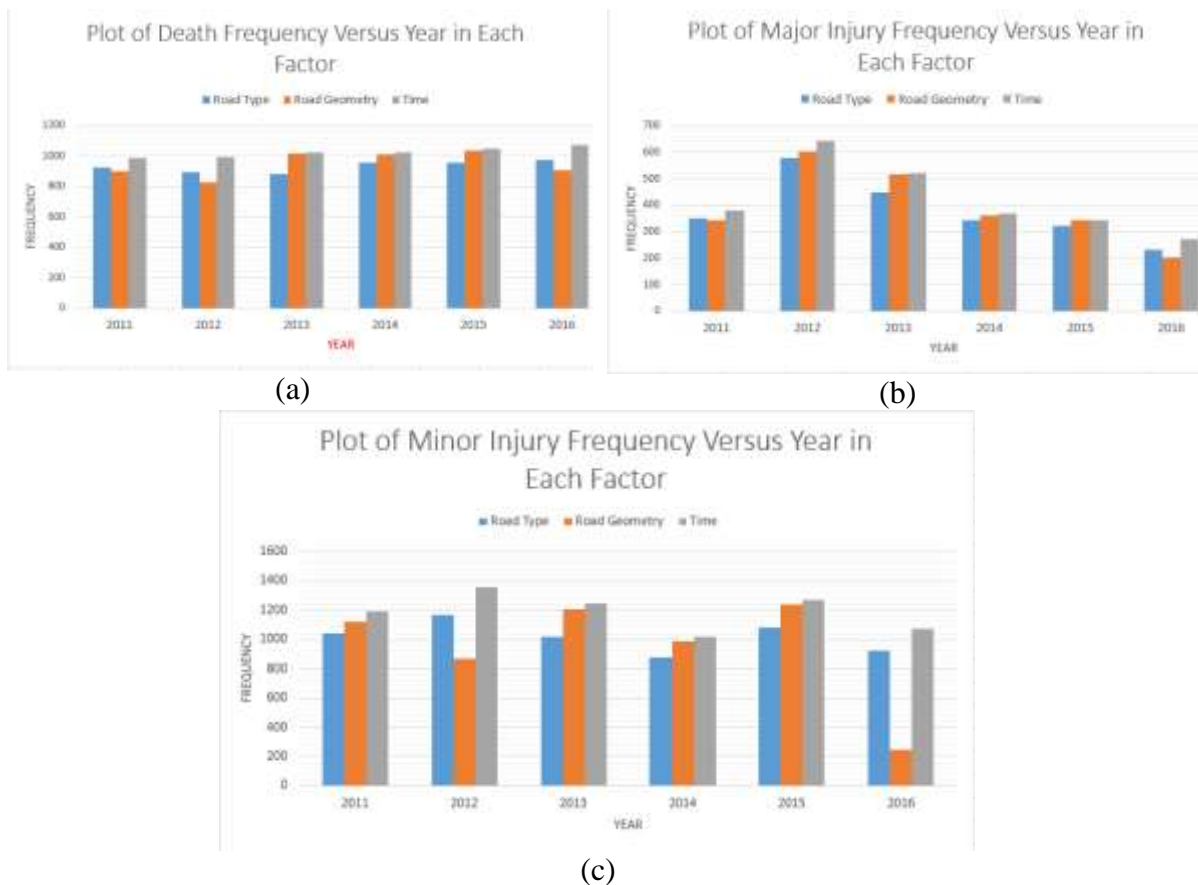


Figure 2. (a) Death, (b) Major Injuries, and (c) Minor Injuries Frequency Based on Factors

From Figure 2a, 2b and 2c, all the trends throughout the six years from 2011 to 2016 for death, major and minor injuries were dominated by the time of occurrence, which means that there was a high chance that accident with any severity occurred during 24-hour period were profoundly affected by the time of occurrence compared to other factors. For deaths in Figure 2a, the trends throughout the years were unsteady but shown a slight increase. This indicated that the death increased and this might be due to the number of registered vehicles

increased yearly with more accidents that led to death. As for serious injuries in Figure 2b, it can be seen that the trend overall was decreasing even though there was one year where the number increase significantly and this might due to the vehicle safety kept improving every year instead led the drivers to a lower severity level which was minor injuries. Finally, for minor injuries in Figure 2c, the trend was fluctuating every year, which shows a slight change. However, it was not the case in 2016 where the number of accidents caused by road geometry had sudden decrease.

Table 1. Summary of the Regression Equation

Severity	Regression Equation	Predicted Case Every 1000 Accidents	R-Squared Value
Death	$y=0.3637x+62$	426	0.8735
Major	$y=0.3673x+30.1960$	397	0.8184
Minor	$y=0.4935x+13.4835$	507	0.9052

Accident severity level was predicted for every 1000 accidents from the regression equation shown in Table 1. Severity models with combinations of 3 sub-factors for every model that cause the average number of each severity level were developed. It was found out that federal road with the straight road during 8 PM to 10 PM were the most critical factors whereby every 1000 cases of the road traffic accident, it was expected to lead to 426 death cases, 197 major injury cases and 507 minor injury cases. The high number of predicted cases for every 1000 accidents were observed for all severities, especially death. This was due to the contribution of at least one of the three factors which led to an increase in predicted cases. For example, an accident related to either time interval, road geometry or road type contributes to 1 case; meanwhile, an accident related to all three factors were counted as 3 cases. The predicted case here might be from a singular factor or from a combination of factors.

Conclusions

Three major conclusions were obtained from the result. From time of occurrence, most of the accident that happened in Johor occur within 8 PM to 10 PM had the highest severity having with highest death cases within 24 hours. The least cases recorded from 4 AM to 6 AM. However, deaths were dominant from 4 AM to 6 AM compared to the other severities. For the geometry of the road, the straight road proved to be the most dangerous road as it also led to most of the deaths, serious injuries and minor injuries. With regards to the type of road, the road type that has the most road traffic accident cases was the federal road with having most deaths while the road type that had the least accident cases was the express road. In terms of comparison between 3 factors, time of occurrence dominated the other two factors with the highest fatalities, major injuries and also the minor injuries. However, road type has the least contribution to the total number of road traffic accidents. Therefore, the reason for accidents that lead to fatalities was unlikely due to the road types but the time of occurrence in this case.

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