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Investigation of Road Crash Rate at FT050, Jalan Batu Pahat – Kluang: Pre and Post Road Median Divider

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ABSTRACT

The number of fatal crashes along the Federal Road FT050 (Jalan Batu Pahat – Kluang – Ayer Hitam) involving students of Universiti Tun Hussein Onn Malaysia (UTHM) are still accelerating. Road quality upgrading such as lanes expansion, upgrading road surface and construction of road divider are carried out to improve road and traffic safety, since 2010. Unfortunately, the total number of crashes did not reduce but even showed a tendency to increase. Therefore, the objectives of this study are to analyses the crash trends, determine the rank of hazardous road section and identifying the impact of the road divider in an attempt to reduce road fatalities. This study is focused on the road along FT050, which start from the Kolej Vokasional Batu Pahat to the Kolej Jururawat Parit Raja (KM7 - KM21 or 14 km lengths) where the road divider was constructed. Crash data have been collected from Polis Diraja Malaysia such as crashes data before the road divider are constructed (2010 – 2012) and after the construction (2013 – 2014) and road geometry design data are collected from Jabatan Kerja Raya for road design assessments. The determination of Accident Point Weightage (APW) was performed by applying the APW method and Microsoft Excel, which was used for hazardous road ranking. The Accident Prediction Model developed based on multiple linear regression are used to relate the crashes rates and the road design parameters. The results show sufficient proof to support the road safety relate to the relationship between the vehicles crash numbers and road design and the number of crashes namely accident point weighting is described as the dependent variable. The following results found the existing number of major access points, at the following signalized and unsignalized intersections, number of traffic volumes/Annual Average Daily Traffic (AADT) and road geometry are the main potential contributors of increment crash rates on multiple lane rural roadways.

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1. Introduction

Road infrastructure is the predominant transport facility in developing world such as Malaysia. Roads with good maintenance and infrastructure play a significant role in the traffic safety of road users (Fulep & Oberling, 2012; Masuri et al., 2011). Federal Route FT050 or Jalan Batu Pahat-Kluang, is one of the main federal roads in Johor, Malaysia (Figure 1). The road link Batu Pahat district in the west to the area of Jemaluang in the east. The road was partially upgraded on 2002 with four-lane carriageway from Batu Pahat to Kluang and the rest of the road remains with two lanes. It is known that vehicle crashes became a major concern to road users along the route FT050 because the high percentage of fatalities and serious injury was increased within years (Free Malaysia Today, 2016; Dugat, 2016). Furthermore, the crash is estimated to be the third most common cause of death by 2020 (Ismail, 2014; Eilmy, 2012).

Batu Pahat city is a capital of Batu Pahat District, Johor, Malaysia that is located 239 km from Kuala Lumpur (Majid, 1980). Batu Pahat town was announced as the 20th largest urban area in Malaysia in terms of population in 2009. These results in the increasing number of road traffic and capacity along the federal road FT050 with the risk of the higher number crashes among road users (Solhi et al., 2014; Samsuddin, 2013; Masirin et al., 2013). The upgrading project of federal road FT050, which is including the scope to build a U-turn, median (divider) and associated works, were implemented in several phases (Malaysian Public Works Department, 2013). Divider/road median separates the two directions of traffic on the same road that might improve road quality and safety (Gaca & Tracz, 2012). The usage of divider is important especially if there are high traffic volumes and a crash on one side of the road (going one direction) and this construction suits that nothing crosses the road into oncoming traffic (Prasetijo et al., 2016a).

The previous phase 1 project which was upgrading of FT050, the total cost of the project worth RM331 million and it was completed in August 2011. Meanwhile, phase 2 which is to build a U-turn and the median route Batu Pahat-Parit Raja as long as 14 km costing of RM52.5 million with projects involves two separate contracts were completed in October 2012 (Malaysian Public Works Department, 2013). This federal road is also in the planning to be upgraded in the future for phase 2A which is building a U-turn and the median at route Parit Raja –Ayer Hitam as long as 12 km and phase 3 which is building a U-turn and the median at route Ayer Hitam – Kluang as long as 26 km. It has been applied to the consideration of the Central Agency in the *Rancangan Malaysia yang ke*-11 (RMK11). The estimated cumulative costs involved in Phase 2A and Phase 3 is up to RM80 million. However, implementation of this project is subject to approval by the provisions of the Central Agency.

This study was conducted based on objectives that are to analyze the crash trend, crash critical area and crash parameters along the federal road FT050 pre and post the road divider constructed; to determine the black spot and the hazardous road section; to identify the impact of the road divider in attempt to reduce road fatalities. This study investigated the federal road FT050 and mainly along the federal FT050 which is start from the Kolej Vokasional Batu Pahat to the Kolej Jururawat Parit Raja with a distance of 14 km lengths. This following research is expected to be a practical reference for the readers in analyzing the existing crash data and identifying the impact of the road divider in an attempt to improve the safety to road users.

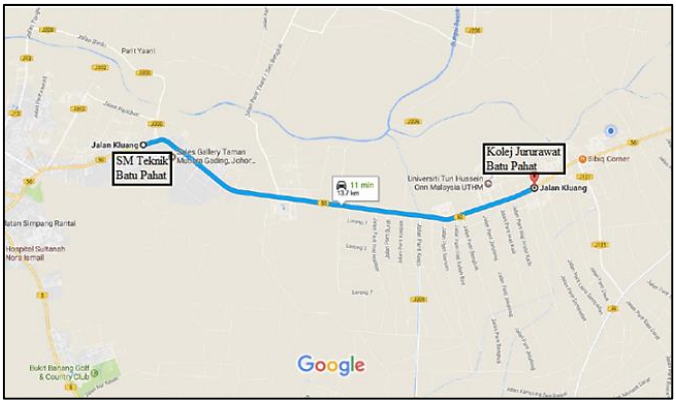

Figure 1: Road Divider Constructed along FT50, Jalan Batu Pahat - Kluang (*Source:* Google Maps)

2. Method

2.1. Data Collection

The existing data such as vehicle crash data were collected from Polis Diraja Malaysia (PDRM) and data of road geometry details were collected from Jabatan Kerja Raya (JKR). Vehicle crash data before road divider constructed is required between the year of 2010 to 2012 and from 2013 to 2014 after the road divider was constructed. The road geometry detail is necessary to identify the potential crash variables and their parameters.

2.2. Blackspot Identification FT050

Identification of accident blackspot location along the Federal road FT050 sections (Batu Pahat – Ayer Hitam – Kluang) were carried out based on the crash trend and the categorized by accident point weightage within years of 2010 to 2014.

2.3. Data Analysis

The following stage data were analyzed to determine the extensive variety of road crash problems. It was analyzed based on the Accident Point Weightage (APW) approaches. APW is considered a suitable tool to determine the level of crash risk based on several potential traffic and road geometric parameters; traffic volumes/capacity, shoulder width, lane width, median width and access point.

2.4. Model Development

The APW measurement is carried out with the APW method and Microsoft Excel. This method follows the value that is contributed by the Transport Research Laboratory (TRL) based on Interim Guide on Identifying, Prioritizing and Treating Hazardous Locations on Roads in Malaysia which the point is given based on type of the crash; fatal (6), serious injury (3), slight injury (0.8) and damage only (0.2). The general weightage formula follows:

$$APW = X_1(6.0) + X_2(3.0) + X_3(0.8) + X_4(0.2) \quad (1)$$

where,
X_1 = Number of fatal, X_2 = Number of serious injuries, X_3 = Number of slight injuries, and X_4 = Number of damages only.

Multiple regression analysis is conducted in this case study. The Accident Prediction Model (APM) is developed after the best-fitted model and transformation of level-level linear regression to log-level linear regression were considered. Therefore, the APM follows;

$$ln(APW) = C_1(SW) + C_2(LW) + C_3(MD) + C_4(AP) \quad (2)$$

where,
APW = Accident point weightage, *SW* = Shoulder width, *LW* = Lane width, *MD* = Median width, and *AP* = Access point. C_1, C_2, C_3 and C_4 refer to the coefficients determined from the regression analysis that changed years due to the conditions of the roadways (Seal, 1967; Rencher & Christensen, 2012; Freedman, 2009).

The model shows that coefficient, C_i is determined, which can represent a change in road geometric design (*SW*, *LW*, *MD*, *AP*). Further APW measurements allow to use 2010 to 2014 traffic and crash data. Therefore, APM is defined by section along the road of FT050 which is shown in Table 1.

3. Results

3.1. Total Accident per Year

The study found that the number of crashes in 2010 to 2014 along FT050 was uneven based on the data analysis (Figure 2). Acceptable fluctuations in crash rates on graphs may be related to several factors. Total crashes increase to 555 in 2011 compared to the previous year which is only 199, more than double the increase rate which is considered due to the upgrading of roads and during the progress of construction of road dividers. Therefore, the total number of crashes seem to decline to 400 in 2012, in the year the road divider start operating in November. However, the number of crashes were again increased up to 682 in 2013 and was going down to 549 in 2014.

The total number of fatal crashes throughout the study area, it began to rise to 3, 12 and 14 during the years of 2010, 2011 and 2012 and it fell slightly to 8 and rebounded to 16 respectively in years of 2013 and 2014. Unlike serious crashes, it was only recorded in a small number of crashes in the starting year with only one crash in 2010 and its rise to 4, 5 and 9 in subsequent years. However, the numbers dropped back to 2 cases in 2014. Eventually, the minor crash trend has also been recorded in non-linear stated at 13 cases in 2010 and slightly increase in 2011 amounted 38 cases reported in study sections. The number of minor crash decreasing to 30 cases in 2012 and it rises again as 34 cases in 2013. However, the minor crashes reduce again to only 19 cases in 2014 (Polis Diraja Malaysia, 2011; MIROS, 2017).

The following crash figures (Figure 2) results on the decreasing number of fatalities after competition of the constructions (2012), significantly. However, the total number of crash does not decrease in any years after the construction. The previous studies found several

potential parameters that have to be considered in developing crash model; AP/conflicts, SW, LW, traffic volumes (Prasetijo et al., 2016b, 2018a). This may be assumed that the constructions/MD should not be the only solution to decrease the crashes.

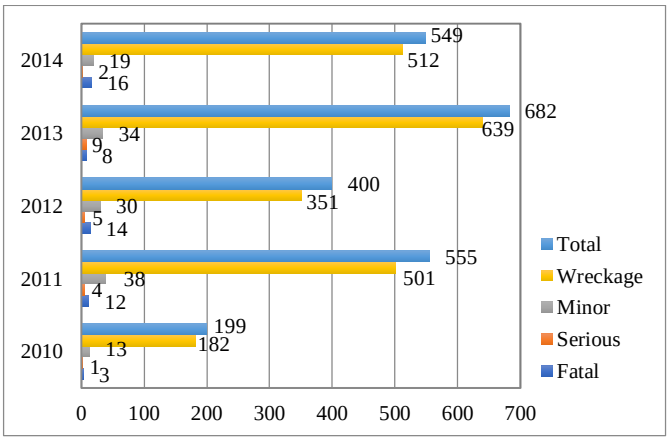

Figure 2: Total crash diagram from 2010-2014 along FT50 (KM7 – KM21)

3.2. Total Accident per Month

The following Figure 3 illustrates the total crash per month in 2014. The highest number of crash recorded are in August which is 56. The lowest crash rate was noticed in June 2014 with 25 number of total crashes. It is shown based on the graph that the number of crash start to increase obviously from June to August. This may occur due to several factors such as school holiday and Muslim Hari Raya on July since road FT050 is the only proper alternative road that links Batu Pahat and Kluang district.

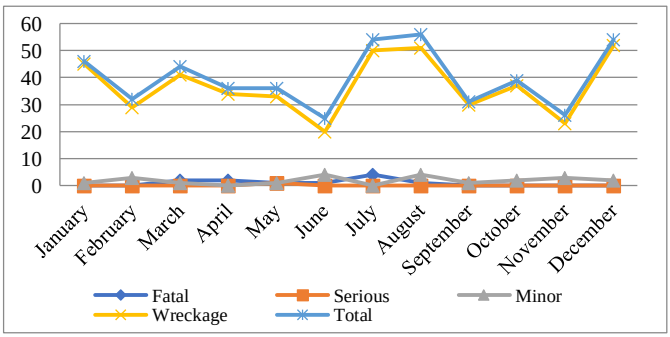

Figure 3: Total crash per month in 2014

3.3. Total Vehicle Crash Hour per Day

The total number of crashes per hour within the study area is shown in Figure 4. The data studied is in reference to the crash data in August since the crash reported was the highest in 2014. The figure is considered a typical and would represent the performance of the number of vehicles crashes and traffic volumes/day (vehicles number).

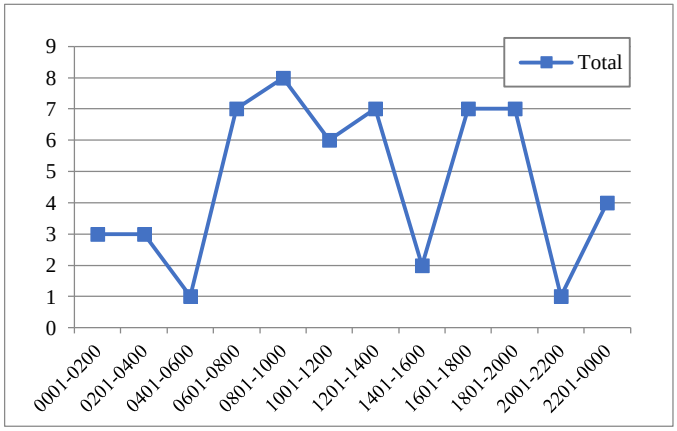

Figure 4: Total number of crashes per hour in August 2014

Figure 4 shows that most crashes occurred around peak hour (06.01 – 10.00 am and 16.01 – 20.00 pm) and during lunch breaks (12.01 – 14.00 pm), as it was recorded as a total of 36 crashes. This finding may give clear indications of other potential parameters that should take into account such as traffic volumes (vehicles/hours).

3.4. The Rank of Road Section FT050

The study has mentioned of KM7 to KM21 length of FT050 road with several differences in road geometric designs (*SW, LW, MD, AP*), traffic volumes and number of vehicles crashes. Therefore, an investigation was considered to be conducted in sections (per kilometre road). Segmented road analysis may help to prioritize countermeasures based on conditions. The rank system could simplify in getting the priority. The easiest way of ranking road segments as it is recommended to use in Malaysia (Ismail, 2014) is to shortlist it into simple form or information. The ranking shows that the highest APW from KM7 to KM21 analyses from the traffic crash recorded by PDRM based on the analysis. As shown in Table 1, the least data compiled from January 2010 until December 2014.

Table 1: The rank of hazardous roads in FT50 after road divider constructed by Accident Point Weightage

Rank	Section	Location	Fatal	Serious	Minor	Wreckage	APW	Ln (APW)
**1	9	Taman Ria Jaya	6	7	5	335	128	4.85
**2	8	Maktab/Pej Kaji Cuaca	5	1	4	371	110.4	4.70
*3	21	Kolej Jururawat Batu Pahat	3	1	5	60	37	3.61
**4	10	SHARP/ROXY	3	0	8	53	35	3.56
**5	7	Kolej Vokasional Batu Pahat	2	0	9	77	34.6	3.54

** for the single hazardous section*
*** for the continuous hazardous section*

4. Discussions

The federal road of FT050 has been improved frequently since 2010 including the construction of road divider that has been done in 2012 for 14 kilometre lengths. However, the vehicles crash numbers are still slightly to increase in the coming years. The data shows from the year 2010 to 2014, a total of 2393 crashes, 2185 non-fatal crashes (wreckage), 134 minors and 21 serious crashes were recorded. It is known that the highest fatal crashes recorded as many as 53 per 5 years. The lane separations or road median (*MD*) would contribute a significant on reducing the crash fatalities rather than the number of crashes. Other potential parameters to reduce the crash should involve; road designs and traffic performances (volumes/AADT). Number of vehicles conflict and number of vehicles/traffic volumes are considered as two of main factors (Prasetijo et al., 2019).

The following crash prediction model would become a reference as one of the solutions. This study established the accident point weightage that ranks the road sections along the FT050 at KM7-KM21 that determine the hazardous road sections based on blackspots. Further initiatives to reduce the crash might necessary to carry based

on the ranking weightage by improving information, safety awareness and proposal action for public or authorities (Prasetijo et al., 2018a, 2018b, 2019). Furthermore, the type of crash data is an important factor in developing a crash model with categories involving the level of injury of the crashes.

This study is a promising approach in developing a practical methodology to relate the type of vehicles crashes and road geometric design parameters. The following regression model could be used to predict the crash rates that is found as;

$$ln\ (APW) = -0.09194408(SW) - 0.0264875(LW) - 0.76348192(MD) - 0.111567842(AP) \quad (3)$$

The following *ln(APW)* shows a linear correlation with negative constants of each independent variables. This implies for lower quality of safety and road ranking as higher values of independent variables and it is fit for coefficient determination or coefficient correlation (R^2) while the range of the values that apply for the model as in Table 2.

Table 2: Independent variables for Accident Prediction Method

Independent variables	Range of values
Shoulder Width (SW)	0.5 m - 2.8 m
Lane Width (LW)	2.5 m - 3.75 m
Median Width (MD)	0.5 m - 2 m
Access Point (AP)	9 - 14

5. Conclusion and Recommendations

The result of the analysis provides sufficient proof to support the case study of the relationship between the number of crash/type of vehicles crashes; fatal, serious injury, minor injury and wreckage and the road design parameters; *SW, LW, MD, AP*. Results show that there is a significant reduction in fatalities while it is not a significant crash reduction due to the construction of dividers. Increasing traffic volumes or capacity and speed of the vehicles along federal road FT050 play a substantial role in contributing factor of traffic crashes and fatalities. The impact of size reduction of the shoulder width and lane width could be less necessary as influential effects on the road crashes. The crash predictive models developed and rank of hazardous road sections can be used as a reference for the rest of divider construction along the federal road FT050.

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