An evaluation of highway crash-prone areas: A case study on Pan Borneo Highway in the state of Sarawak

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Abstract. Road traffic crashes is one of the major causes of death that needs to be addressed globally. Many studies have been conducted to identify the contributing factors to traffic crashes and to determine the required preventive measures. This study evaluates the causes of 164 traffic crashes along a 10 kilometres section of Pan Borneo Highway Sarawak. The study investigated the main causes of traffic crashes within this section of road through multiple sources: based on expert on site evaluation, analysis of site incident report and police accident record. The finding reveals that most of the accidents (93%) occurs during the daytime, weather contributes a combined 69% and private car owners (80%) cause most of the traffic crashes. The study also indicates that the road condition is a significant factor to the occurrence of traffic crashes in that area contributing 64% of the total crashes.

1. Introduction
Road transportation system plays a major part on the development of socio-economic status in a country. The mobilisation of people or goods from their origin to destination depend on its accessibility. However, frequent travelling on road causes increasing of traffic crash. The World Health Organization reported in 2016 that road accident is eighth leading cause of death and it is expected to be the fifth cause of death in year 2030 worldwide [1-3]. In Malaysia, road traffic crash was ranked at fourth (4.6%), after Ischemic heart diseases (13.9%), Pneumonia (12.7%) and Cerebrovascular diseases (7.1%) for the causes of death according to government’s statistic report in year 2017 [4]. An average of 6,150 deaths were reported yearly due to road traffic crashes from 2007 to 2018 in Malaysia [5], this has made it imperative to investigate the causes and to determine the required preventives measures [6-7]. The probable causes of traffic crash can be identified based on the crash patterns [8], according to Malaysia Institute of Road Safety Research (MIROS), the possible causes of road traffic crashes are but not limited to human careless (80.6%), unsafe road conditions (13.2%) and vehicle condition (6.2%) [5].

Jesna and Anjaneeyulu [1] reported the uncertainty in the behaviour of drivers to the same situation, and the geometry of road is a significant factor in the cause of accident [1]. Dudziak et al [6] identify driver behaviour as a major factor in road accident [8]. The reliability of different drivers or vehicles when reaching an unsafe road condition will be different, and the failure in controlling the vehicle may cause the traffic crash. While human errors appear to be the major cause of traffic crash, poor road conditions could lead to traffic crashes. This article presents a case study finding based on an evaluation conducted at crash-prone areas along Km 421 to Km 431 (Jalan Betong / Sariki / Meradong) of Pan Borneo Highway in the state of Sarawak. Pan Borneo Highway is a major route connecting major towns.
in the state of Sarawak from the southern part in Teluk Melano to the northern part to Sabah through Brunei.

2. Methodology

This study was divided into three parts. The first part was the evaluation of the road traffic incident’s reports recorded by the Works Package Contractor’s Site Safety Officer. The evaluation to the road traffic incident’s reports including determination of the actual crash-prone areas based on each kilometre. The evaluation was done according to four (4) major factors: time of incidents (daytime from 07:00am to 07:00pm or night-time from 07:00pm to 07:00am), weather conditions (fine, raining or after rain), type of vehicles (private cars, small lorries and vans, large lorries, or motorcycles) and cause of traffic crashes (human errors, unsafe road conditions or due to vehicle).

The second part was on site evaluation of the accident areas. Site evaluation was conducted to determine the hazard areas (improper geometry design and unsafe pavement surface condition) with driving on the studied area during daytime, night-time and raining time with normal speed (80 km/hr) and slow speed (40 km/hr). And the third part is the examination of traffic crashes report from Sarikei’s Police Station. The police’s reports evaluated based on the accident description as stated in the reports. Each individual traffic crash was evaluated to determine the cause whether it is human careless, unsafe road conditions or mechanical conditions of vehicles.

3. Data analysis and discussion

3.1. Evaluation to the road traffic incident’s reports

Figure 1 illustrates the actual crash-prone areas based on kilometre. From the analysis, it can be seen that crash-prone areas were in Km 430 to Km 431 (34 cases or 21%), Km 423 to Km 424 (33 cases or 20%), and Km 426 to Km 427 (27 cases or 16%) which accounted for merely half of the total numbers of incidents reported.

The analysis of the incident time indicates that most of the accidents (93%) occurs during the daytime, as shown in figure 2, it could be concluded that poor night vision may not have been the cause of accident along the study area. This is quite different from what most studies has established that the
number of night-time crashes generally declines when days are longer, or when there is enough lighting on the road [9-12].

![Figure 2. Total Traffic Crashes Based on Time](image)

It has been established weather is one of the major causes of accident along the study area. As shown in the figures 3, raining time or immediately after rain fall (which might be due to flooding of the roadway) with a combined 69% of incident occurrence. Rain or flooding on the roadway could easily affect the visual reaction of the driver and the visual reaction times will consequently be affected [13]. When the visual reaction time, which is the estimate of the time of vehicular collision with an object under a specific condition is affected, then the critical stopping distance (which is a key factor of safety) [14] will be jeopardized, thus, leading to accident.

![Figure 3. Total Traffic Crashes Based on Weather](image)
Figure 4 shows that private car owners (80%) cause most of the traffic crashes. The high dependence on private cars has really resulted in the high density of cars. There exists less effective public transport in most rural areas, which has led to a greater dependence on private cars. However, it was not measure or there is no data related to the effect of age as one of the factors in this study. However, most accident that occur during the day may have been causes due to age and caused by drivers older than 65 years old. Literature has demonstrated that older drivers have a raised crash risk on a per kilometer driven basis, which is second only to the very youngest age groups [15].

![Figure 4. Total Traffic Crashes Based on Type of Vehicle](image1)

Figure 5 shows total traffic crashes based on cause of incident. From the results, human errors contributed to 29% of the traffic crashes which is significantly lowered than the national recorded
statistics. Interestingly, unsafe road condition was found as the major contributing factor (64%) to traffic crashes at the study area.

### 3.2. Site evaluation

From the site evaluation conducted, Km 421 until Km 431 of Jalan Betong / Sarakei / Meradong constructed at mountainous terrain area as shown in figure 6.

In addition, figures 7 to figures 10 shows the existing site conditions that is unsafe to the road users due to uneven surface and improper geometry design like sharp curve, continuing horizontal and vertical curve, horizontal curve in sag vertical curve, and horizontal curve in crest vertical curve. The reliability of different drivers or vehicles when reaching these unsafe road conditions will be different, and the failure in controlling the vehicles may cause the traffic crash.

This existing R3 single dual carriageway Pan Borneo Highway will be upgraded to R5 two dual carriageway under the Proposed Development and Upgrading of Pan Borneo Highway in the state of Sarawak. From site observation, the sight distance along this studied area is sufficient, as the obstructions along roadside have now been cleared for road construction works. However, it is dark during night-time in most of the areas. Temporary warning signs and longitudinal yellow crossbars have been provided in advance of the crash-prone areas. Moreover, the safety blinker lights are functioning during the night-time in this studied area. The drainage system of the studied area was found to be insufficient. Water ponding observed on the road surface in many places during rain and after rain.

![Figure 6. Mountainous Terrain](image-url)
Figure 7. Uneven Road Surface

Figure 8. Sharp Curve
Figure 9. Continuing Horizontal and Vertical Curves

Figure 10. Horizontal Curve in Sag or Crest Vertical Curve

3.3. Police’s Report Analysis

Figure 11. Total Traffic Crashes Based on Cause of Incident (Analysed from Police’s Reports)
Based on description stated in the police’s reports, the type of crashes has been identified to determine probable causes with respect to drivers, road, and vehicle. The collisions which have involved more than one vehicle, for example head-on collision and rear-end collisions will consider as due to human careless. The individual vehicle crash to the road side furniture or tree will consider as due to unsafe road condition. And the crash due to vehicle breakdown on road will consider as due to vehicle.

The cause of road traffic crashes based on the police reports are 30% due to human careless, 66% due to unsafe road condition and 4% due to vehicle as shown in figure 11. It was significantly similarity between the percentages in each causes of incident compared with the finding recorded by Safety Officer as shown in figure 5.

4. Conclusion and recommendations
Road crashes have significantly increased in the recent years and it has been identified as the eight causes of death. The effect of road crashes cannot be underestimated, it could significantly affect the socio-economic condition of a nation. To address this important factor, attempt has been made by researchers through study to reduce accidents and thus alleviate the negative effect on the environment. The road section in this study has been identified as the most dangerous along the Pan Borneo Highway Sarawak in terms of the number of traffic crashes. The present study examined road crash factors of crash-prone areas of Km 421 to Km 431 Jalan Betong / Sariki / Meradong of Pan Borneo Highway in the state of Sarawak. The results showed that majority of the road crashes occurred during daytime and during inclement weather condition involving primarily private cars. It was also found that unsafe road surface conditions have significantly contributed traffic crashes for the studied road segment.

Thus, it could be recommended that the unsafe surface conditions along this existing road should be rectified with new geometric alignment design in the proposed development and upgrading of Pan Borneo Highway in the state of Sarawak. This is important as the road quality of the existing road, especially along the studied road segment has significantly reduced and unsafe for the road users on this segment of road, a road safety audit should be carried out more frequently to ensure sufficient safety precaution on site. Road traffic crash can be avoided with proper and effective implementation of the required preventives measures, such as proper planning system, high standard of safety, education (proper public awareness) and prevention methods. Further study should be conducted on most of these preventive measures and its application on the area.

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