

## FACTORS CONTRIBUTING TO ROAD ACCIDENTS: CASE STUDY OF JALAN SEREMBAN-TAMPIN

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### ABSTRACT

Malaysia is ranked 18th in the world for the number of people killed in road accidents. Road safety in rural areas has been less emphasized and overlooked by relevant authorities. Rembau, Negeri Sembilan is a rural area with a high road accident rate. Accidents in rural areas need urgent road safety measures to reduce road accident cases in the future. Hence, this study comprises two objectives, 1) to identify the factors contributing to road accidents at Jalan Seremban-Tampin, 2) to determine the mean rank of an accident during day and night, and to recommend common road safety approaches to reduce road accidents at the prone location. Based on the secondary accident data obtained from IPD, Rembau can find common road safety approaches worldwide to reduce road accidents at prone locations. The analysis method used was descriptive and inferential analysis, that is, Mann Whitney U using SPSS. This study revealed that human factors such as risky driver behaviour are the main factors contributing to road accidents, followed by environment or road factors. Different road safety approaches in other countries worldwide are classified into three themes, namely (i) the traditional approach, (ii) the systematic approach, and the vision-zero approach, which can be used to reduce road accidents. Therefore, this study highlights that the choice and implementation of road safety approaches varies according to each country's principles, priorities, and infrastructure based on the Sustainable Development Goal (SDG), such as targets 11.2 and 3.6.

**Keywords:** Crash Data, Road Safety, Rural Areas, Safety Approaches Weather Effect.

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## 1. Introduction

Road accidents and accompanying deaths have been on the rise around the world. According to the World Health Organization (WHO), 93% of all road fatalities occur in low- and middle-income nations (WHO, 2018). Over 1.3 million individuals die annually from road accidents. This dangerous scenario must be taken action to avoid massive economic losses to save lives. The United Nations General Assembly has set an ambitious goal of halving worldwide road traffic fatalities and injuries by 2030 (A/RES/74/299) (WHO, 2018). According to the World Health Organization (WHO) and the World Bank's Global Status Report on Road Safety 2018, Malaysia is ranked third in Asia, involving fatal road accident cases, trailing Thailand and Vietnam (WHO, 2018).

Unfortunately, most past research only examined the factors of road accidents in urban areas. Cases of accidents in rural areas are rarely studied, whereas road safety in rural areas has been less emphasized and overlooked. According to Bhandari & Nalmpantis (2018), the rural road plays an essential role in the overall development of rural areas because about half the world's population lives in rural areas. It provides accessibility and mobility for the rural dwellers, providing economic, physical, social, and political links and facilitating the exchange of the products of the urban areas and the raw materials of the rural areas. Road accidents also occur in rural areas, not only in urban areas.

Rembau is a town that is located in Rembau District, Negeri Sembilan. Rembau is a rural area located in the south bordering the State of Melaka. Rembau district covers an area of 402.76 square kilometres or 41,512 hectares with a population of 43,011 (2010) people living in 17 sub-districts containing 204 villages. Most of the residents of this district are farmers, government employees, and manufacturing workers in the district's industrial areas in Seremban. According to the Rembau District Police Headquarters, a total of 2605 road accident cases were reported and recorded in Rembau from 1<sup>st</sup> January 2020 to 13<sup>th</sup> September 2021 along roads, including expressway (E), federal road (F), and state road (N). Jalan Seremban-Tampin is a federal road that is the main route for residents to get to work to Seremban, and it was recorded as the second lead higher road accident recorded which was 942. Even though the level of road accident injuries on Jalan Seremban-Tampin did not involve serious injuries, accidents still resulted in death. Therefore, it is essential to study the causes of road accident cases in Jalan Seremban-Tampin.

Therefore, this research was conducted to identify the factors of road accidents in rural areas for the improvement of road safety and to provide safe roads to users in rural areas. The area selected to conduct this study was a federal road in a rural area, namely Jalan Seremban-Tampin, Rembau. In addition, the study could identify the difference in the probability of road accidents occurring during the day and night to facilitate stakeholders such as the Public Works Department (PWD). Therefore, engineers and stakeholders can find ways to reduce road accidents at prone locations.

## 2. Literature Review

Previous studies reviewed factors contributing to road accidents, including human, environmental, and vehicle factors. This research adopted the Theory of Planned Behavior (1985) (Ajzen, 1991) and other factors influencing the driver's relationship between human, environmental, and vehicle factors. The human factor is one of the main factors contributing to road accidents. To better understand the causes of traffic accidents, it is necessary to include the human error in the classification process (Bucsuházy *et al.*, 2020). The human factors contributing to road accidents include drivers' attitudes, fatigue, falling asleep,

speeding, lack of driving experience, deliberate disregard for traffic laws, decreased cognitive function, and panic reactions (Zhou, & Zhang, 2019; Elshamly *et al.*, 2017).

The environmental factor is the second factor that contributes to a road accident. Weather conditions, such as snow and rain, can impact the road's surface (Chen & Chen, 2011; Malim *et al.*, 2019). Most fatalities occur during the day and in warm weather (Manan *et al.*, 2018). Accidents involving rear-end crashes, which are more common at night, might be worsened by darkness in the surrounding environment (Zhu, & Srinivasan, 2011). The driver's eyesight becomes hazy when driving in heavy rain or at night. Drivers are not able to anticipate any potential dangers from the surrounding. In addition, precipitation causes tire grip and weak roads due to slick roadways. Also, on rainy days especially when it is raining heavily, the driver's vision will be limited and blurred, making it difficult for the driver to see the surrounding situation. Therefore, the driver needs to pay more attention to ensure he stays focused and drives at a slow and safe speed. Poor and hazardous road conditions and geographical roads can contribute to road accidents. Straight sections of road account for most motorcycle deaths. Straight road sections had three times as many motorcycle fatalities as curving sections. According to the National Highway Traffic Safety Administration, less than 1% of fatalities in 2009 were at staggered intersections, interchanges, and roundabouts. Signboards, road markings, and traffic lights are essential elements of the road. It aims to provide guidance or information on road conditions and instructions to vehicle drivers. Damage to signage, fading line signs on the road, and malfunctioning traffic lights can cause accidents, especially for vehicle drivers unfamiliar with driving within the area. This situation may happen because vehicle drivers cannot anticipate unexpected hazards on the road.

Vehicle factor has also been recognized that can cause a road accident. The investigation by (Hasrat *et al.*, 2018) found that most vehicles on the road today are built according to standard safety rules. However, a crash will occur if there is a technical vehicle problem, unscheduled vehicle maintenance, worn and damaged tire, leaking fuel, brake and light system malfunction, and overloading. Brake system failure in tires is one of the most common mechanical system failures. Worn and damaged tires are the two most typical causes of this problem. Tire leaks can be caused by various factors, including worn tires, under-inflated or over-inflated, and road debris puncturing the tire. Tire explosions can significantly impact heavy vehicle control, leading to accidents (Zhang *et al.*, 2014). In addition, slippery roads and worn tires can cause various problems as they reduce vehicle traction and inertia (Behnood & Mannering, 2019).

Furthermore, most drivers are less concerned about vehicle maintenance and do not keep track of the schedule by maintaining the vehicle's condition. It is, therefore, essential for drivers to perform regular maintenance on their vehicles. Drivers must ensure the tires are not bald and worn; the brake system should also be in good condition before driving. Overloaded vehicles can also affect the tires to overheat and easily wear and consequently cause road accidents (Klinjun *et al.*, 2021). The conceptual framework used in this research is illustrated in Figure 1.

### **3. Methodology**

This study started with exploring the research background, problem statement, research objective and scope of the study. Then, an intensive literature review focussing on the research topic related to factors contributing to road accidents in rural areas was conducted. Next, the case study location of Jalan Seremban – Tampin was chosen due to the high number of road accidents compared to other rural areas' road networks. The secondary data or raw road accident data gathered in this research was filtered and arranged according to different variables using descriptive and inferential analysis using SPSS software. The variables'

names used in this research were retrieved from raw data of road traffic crashes from the Royal Malaysian Police (PDRM), obtained from the Rembau District Police Headquarters (IPD) traffic unit, Negeri Sembilan, Malaysia. In total, only nine (9) variables related to a road accident at the selected study location used in this research, namely, (i) closely following the vehicle ahead, (ii) exiting or entering junctions, (iii) skidding, (iv) blurred vision, (v) risky overtaking, (vi) u-turn, (vii) fatigue, (viii) violating traffic light, and (ix) crossing street (pedestrian and bicycle) as tabulated in Table 1.

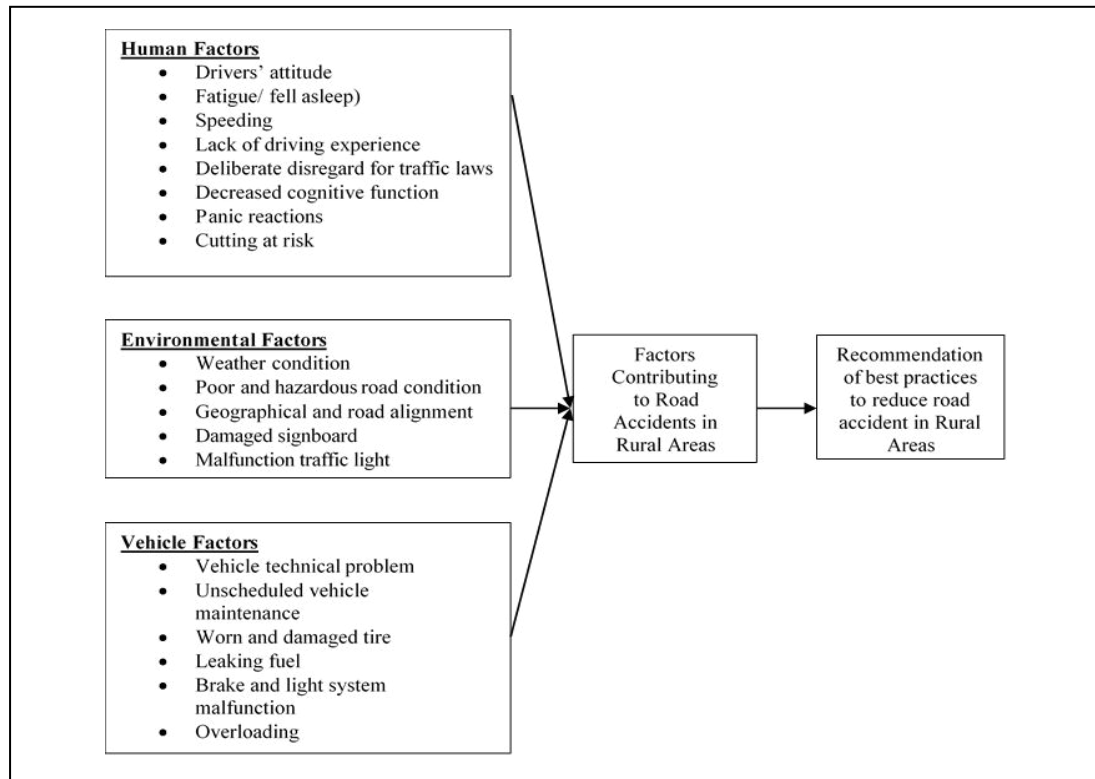


Figure 1. Adapted conceptual Framework from Ajzen, 1991; Bucsuházy et al., 2020; Zhou & Zhang, 2020; Chen & Chen, 2011; Behnood & Mannering, 2019.

Table 1. Factors contributing to road accidents in rural areas.

Factors contributing to road accidents in rural areas	Frequency	Percentage (%)	Ranking
Closely following the vehicle ahead	348	44.2	1
Exiting or entering junctions	144	18.3	2
Skidding	75	9.5	3
Blurred vision	56	7.1	4
Risky Overtaking	56	7.1	5
U-Turns	52	6.6	6
Fatigue	37	4.7	7
Violating traffic light	17	2.2	8
Crossing street (pedestrian and bicycle)	2	0.3	9
<b>Total</b>	<b>787</b>		

Finally, the researcher discussed the findings for each data presented in the conclusion and recommendation section. The flowchart of the research methodology for this research is explained in Figure 2.

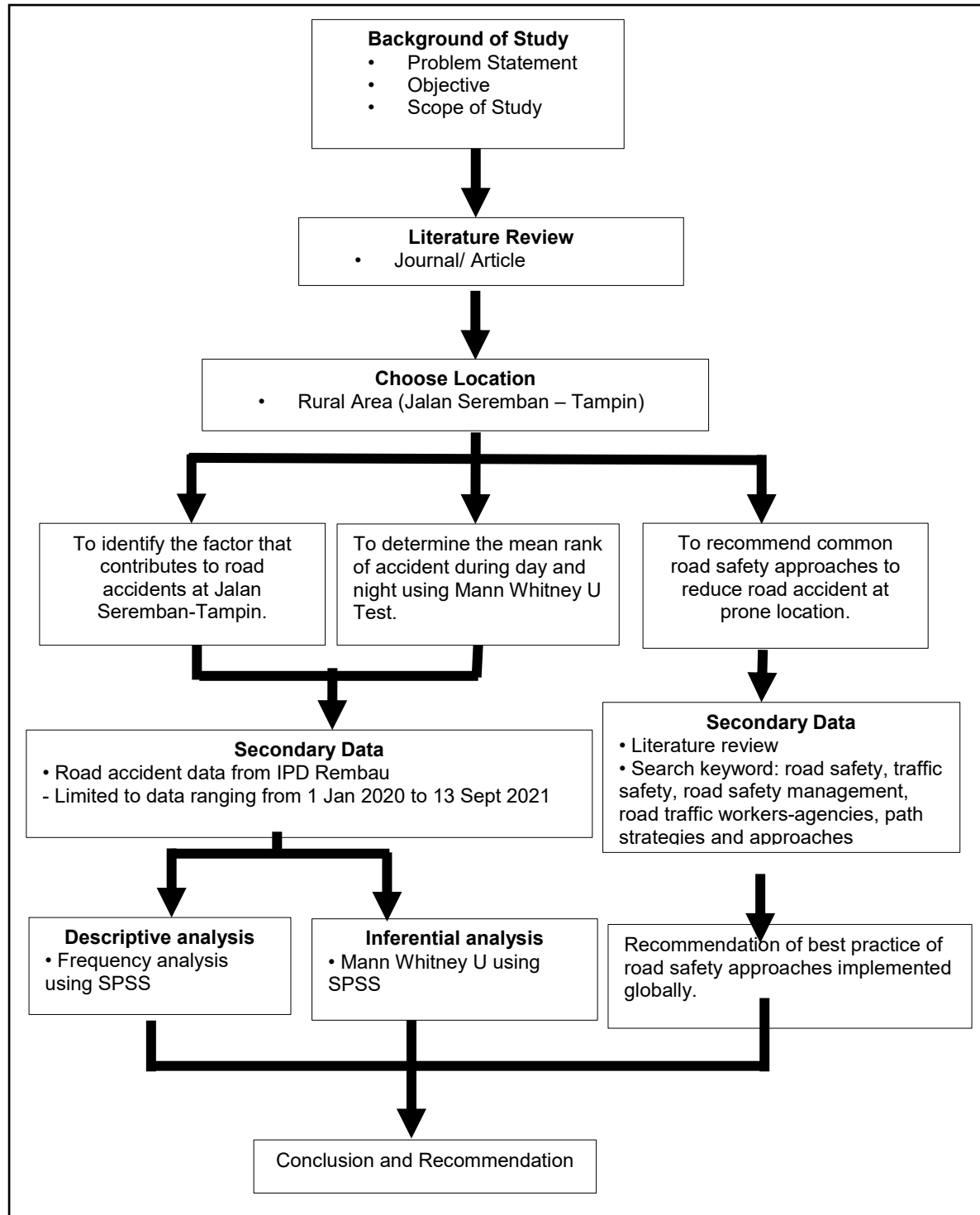


Figure 2. The flowchart of research methodology.

### 3.1 Data collection

This study used secondary accident data from the Royal Malaysian Police (PDRM), obtained from the Rembau District Police Headquarters (IPD) traffic unit, Negeri Sembilan, Malaysia. Limited data range from 1<sup>st</sup> January 2020 to 13<sup>th</sup> September 2021 in Rembau, Negeri Sembilan. Road accident information such as date, time, type of injuries, type of vehicle, the factor contributing to the road accident, and street name at Rembau was collected from the Rembau District Police Headquarters (IPD) traffic unit, Negeri Sembilan, Malaysia.

### 3.2 Data analysis

This study used descriptive analysis to characterize the road accident scenario in Jalan Seremban-Tampin. The descriptive analysis was to depict the pattern of a factor of road accident cases and the percent of each factor contributing to road accidents. This study used statistical tests in inferential analysis to examine research ideas. Non-parametric approaches were applied in this study's inferential analytical procedure, and more flexible approaches were used for data with unknown distributions and staged data. The Mann-Whitney U test was chosen and used in this research for the analysis and interpretation of data by using Statistical Packages for Social Sciences (SPSS). The interpolation data was made manually by using the formula:

$$T = \frac{S_{n_1}(n_1+1)}{2} \quad (1)$$

where;

S is the sum of ranks in the sample

$n_1$  is the number of items in the sample

This study uses inferential analysis, which consists of procedures, methodologies, and statistical methods using SPSS software. The Mann-Whitney U test was chosen in this study to compare differences between two independent groups, namely factors contributing to road accidents, and the ordinal dependent variable, namely during day or night. The results from this analysis are complemented with discussion in the following section.

## 4. Results and Discussion

### 4.1 Factors Contributing to Road Accidents at Jalan Seremban - Tampin

Table 1 shows factors that contribute to road accidents at Jalan Seremban-Tampin. The result indicates that each factor's frequency, percent, and ranking contribute to road accidents. Based on Table 1, the significant factor contributing to road accidents at prone locations is the human factor, precisely due to risky driver behaviour. It can be asserted that the road accidents at Jalan Seremban-Tampin were mainly due to the driver's negligence. However, road accidents caused by blurred vision were not classified as human factors, which may be due to road geometry, road alignment, or road infrastructure such as streetlights.

Furthermore, based on Table 1, the main contributing factor to the road accident at Jalan Seremban-Tampin was the driver's behaviour of closely following the vehicle ahead with 348 cases of 787 cases, equivalent to 44.2%, approaching half of the total number of

accidents. The second lead factor was followed by reckless driving when exiting or entering junctions, with 144 cases equivalent to 18.3%. Other factors are below 80 per case, such as skidded, blurred vision, reckless driving during overtaking vehicles and u-turns, fatigue, and violating traffic lights. There was also an accident caused by a bicycle and pedestrian who was careless crossing the street, with one (1) case for each.

Figure 3 shows the frequency of factors contributing to road accidents in rural areas during day and night at Jalan Seremban-Tampin, Negeri Sembilan. The result shows either day or night, and the main contributing factor is a following close vehicle ahead, followed by reckless driving exiting and entering the junction. All listed factors are higher in the daytime than night-time except for blurred vision, and this may be due to an inadequate lighting system at night. Drivers may face significant night-time visibility challenges if they do not adjust their speed appropriately to compensate for reduced night-time visibility (Tyrrell *et al.*, 2004). A closely following vehicle ahead caused the driver to lose control when the emergency brake from the vehicle ahead. Following the vehicle in front closely will reduce the ability to estimate conditions, distance, and speed correctly, and their ability is also specific to a cognitive reduction in reaction time (Bucsuházy *et al.*, 2020). Usually, the driver will become panic if something undesirable happens. Therefore, their ability to avoid accidents is inaccessible, especially for female drivers (Özkan & Lajunen, 2006). Panic reactions are decisive instinctual, and emotional actions without cognitive components that appear in response to an unexpected or unfamiliar stimulus that is unknown and potentially harmful to the driver (Taylor *et al.*, 2011).

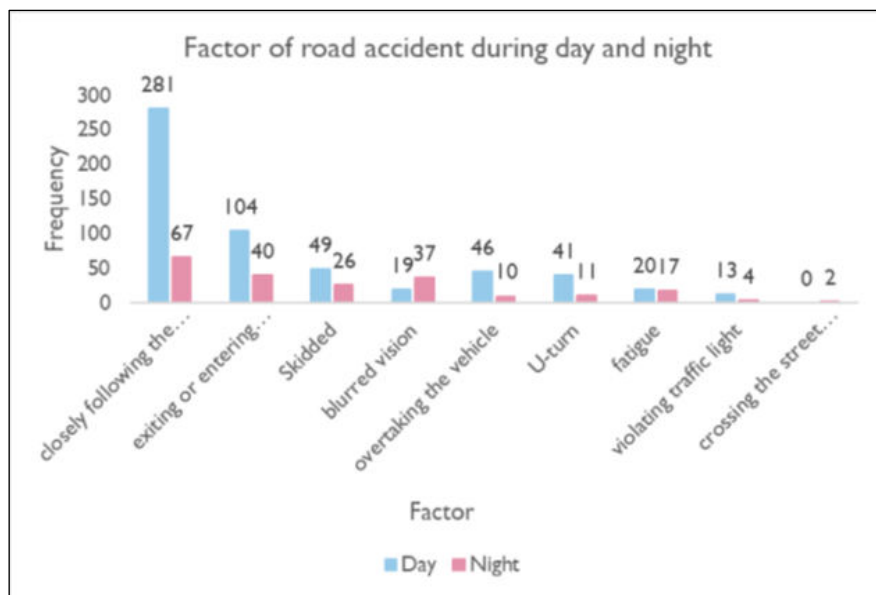


Figure 3. The frequency of factors contributes to road accidents in rural areas day and night.

#### 4.2 Mean ranking analysis of accidents occurs during day and night using Mann Whitney U-Test

Table 2 shows the mean rank of an accident during day and night. The daytime was from 7 am to 7 pm, while the night-time was from 7 pm to 7 am. The results show that accidents predominantly occur during the day than at night on Jalan Seremban-Tampin. A Mann-Whitney test p-value of less than 0.05 (<5% significance level) shows significant differences in the number of accident cases between day and night. Based on Table 2, the number of

accidents during the day is higher than at night, with 573 and 214 cases, respectively. So, the mean rank result from Mann Whitney U for day and night are 287.5 and 107.5, respectively. 65.3% of road accidents at Jalan Seremban-Tampin occurred during the day, and the remaining occurred at night.

Table 2. The mean ranking analysis of accidents during day and night.

Hypothesis	N		Mean Rank	
	Day	Night	Day	Night
There is a difference between the rank of the accident during the day and night.	573	214	287.50	107.50

Table 3 shows vehicles involve in road accident day versus night. Road accident cases in Rembau were higher during the day than at night. The results also show that accidents occurred mainly with cars as the predominant mode of transportation as Rembau is a rural area surrounded by forests, the socio-economy is more active during the day than at night. This situation happens primarily because the Rembau population consists of farmers, government employees, and factory workers in the district’s industrial areas in Seremban. According to (Lankarani et al., 2014), during the daytime, the traffic was heavy compared to night because residents went out to carry out daily activities such as working and sending children to school. Therefore, road usage and the number of vehicles is higher during the day compared to night, contributing to increased road accidents during the day. According to probability theory, the higher the number of vehicles, the higher the probability of a road accident.

Table 3. Types of vehicles involved in road accident day versus night.

Types of vehicles	Frequency	
	Day	Night
Car	416	150
Motorcycle	96	46
Lorry	32	8
4WD	22	7
Van	6	0
Bus	1	1
Bicycle	0	1
Pedestrian	0	1

### 4.3 Road safety approaches to reduce road accidents at prone locations.

Table 4(a) and Table 4(b) shows the current approach to road safety based on global best practices countries, retrieved from the standard road safety approach: a scoping review and thematic analysis (Safarpour et al., 2020). The sustainable safety approach is one of the systemic approaches in which the Netherlands is a pioneer. The positive effects of implementing sustainable safety can be seen in the Netherlands. In recent years, the Netherlands has maintained an excellent road safety record, with the number of fatalities decreasing from 811 in 2006 to 613 in 2017 (Statista Research Department, 2020). A safe systems approach has been implemented in several countries, such as Australia and, to a lesser extent, Germany. Even in Australia, this approach has reduced national road safety by only about 3.3 % per year. It agrees with Australia’s new road safety strategy: 2011-2020, which is more in line with vision zero and the Dutch sustainable safety approach (Hughes et al., 2015). Sweden is at the forefront of the vision zero approach.



Many other countries, including Norway, Canada, the United States, the United Kingdom, and Poland, are inspired by this approach to road safety management. These countries' experiences, notably Sweden's, show that the vision zero approach significantly prevents road traffic injuries. Sweden, for example, reduced road traffic fatalities by more than half between 2007 and 2017 (International Transport Forum. Road Safety Annual Report, 2018). The success of Sweden's vision zero approach has inspired similar efforts in the United States to improve road safety (Cushing et al., 2016). Following Vision Zero, some states achieved remarkable successes, including a 43% reduction in fatal RTIs in Minnesota, a 48% reduction in Utah, and a 40% reduction in Washington state (WHO, 2015) and Vision Zero Philadelphia (2015) (Vision Zero Philadelphia, 2015).

Table 4(a). Global best practice countries in terms of road safety approaches and key principle.

Country	Current Approach to Road Safety	Key Principle
Sweden	Vision Zero	<ul style="list-style-type: none"> <li>Human life and health are prioritized within all aspects of transportation systems.</li> <li>Safety work should focus on systems-level changes above influencing individual behaviour.</li> </ul>
Norway	Vision Zero	<ul style="list-style-type: none"> <li>Speed is recognized and prioritized as the fundamental factor in crash severity.</li> <li>Increased focus on monitoring the risk level in the road system, and related to this, on the authorities' responsibility.</li> <li>Emphasis on rationality and science as the basis for road safety policy.</li> </ul>
Canada	Vision Zero	<ul style="list-style-type: none"> <li>Ethics, responsibility, safety, and mechanisms for change</li> </ul>
Netherland	Sustainable Safety	<ul style="list-style-type: none"> <li>The functionality of the road.</li> <li>State of awareness of road users.</li> </ul>
United Kingdom	System approach	<ul style="list-style-type: none"> <li>Safer drivers - training and testing.</li> <li>Safer infrastructure.</li> <li>Better enforcement.</li> </ul>
United State	Vision Zero	<p><b>The Four E's approach:</b></p> <ul style="list-style-type: none"> <li>Engineering</li> <li>Education</li> <li>Enforcement</li> <li>Emergency response</li> </ul>
Australia	The safe system, vision zero, and sustainable safety	<ul style="list-style-type: none"> <li>Building a national road safety culture.</li> <li>Safe systems principles.</li> <li>Corporate responsibility.</li> <li>International collaboration.</li> </ul>

Table 4(b). Global best practice countries in terms of road safety approaches and key principle.

Country	Current Approach to Road Safety	Key Principle
Poland	Vision Zero	<ul style="list-style-type: none"> <li>● Road safety improvement is based on “vision zero” and “safe system”, with strategic interventions comprising the fundamental pillars of safety: road safety management, safe road, safe vehicle, safe road users, and post-crash response.</li> <li>● Focusing on the main road safety problems when identifying the priority interventions.</li> </ul>
Germany	Multiplicity approach	<ul style="list-style-type: none"> <li>● Improvements in road infrastructure</li> <li>● Vehicle improvement</li> <li>● Improvement in road user education</li> </ul>
Japan	System approach	<ul style="list-style-type: none"> <li>● Maintenance of the road environment.</li> <li>● An improved rescue and emergency medical system.</li> </ul>

## 5. Conclusion

In conclusion, the factors contributing to road accidents on Jalan Seremban-Tampin consist of closely following the vehicle in front, skidding, risky cutting, U-turns, fatigue, violating traffic lights, and crossing the road. These factors can be classified as human factors because they are caused by the driver’s negligence or human behaviour. Meanwhile, blurred vision can be classified as an environmental factor as Rembau, Negeri Sembilan is a rural area surrounded by forests with limited lighting sources for the roadway network. In addition, the blackspot area in Rembau is in the sharp curvature area where the curve can only be driven at less than 40 km/h; this causes drivers to be unable to recognize danger or vehicles in front or coming from the opposite direction. Identifying several factors that cause road accidents, the first objective of the research, has been achieved. This study shows that the mean ranking value of road accidents during the day was higher (287.5) than at night (107.5). This difference in mean rank is due to the number of road accident (N) samples that vary daily and night. Vehicles during the day more than at night because economic activities in Rembau are more concentrated during the day because Rembau is a rural area road network.

There are three general approaches to road safety; a traditional approach to road safety includes a road-user and causal approach, focusing on human errors and road users. Sustainable safety, the safe system, and the United Nations plan for a decade of action are all examples of systemic approaches. These approaches regard fatal road traffic injuries (RTI) prevention as a system for which road users and designers are accountable, each having different road safety principles and goals. The vision zero approaches is another option. According to ethical philosophy, Vision Zero is a more comprehensive approach than a systemic one, as well as a more comprehensive perspective on safety. Although each approach has its own goals and principles, the end goal is to reduce fatal RTCs. Most developed and developing countries appear to welcome a systemic approach to road safety, and a paradigm shift toward a safe system has occurred.

Furthermore, given the success of vision zero implementation in leading countries, most countries are attempting to design and implement this approach. Finally, each country’s principles, priorities, and infrastructure influence the selection and implementation of road safety prevention approaches. Proper modeling, combined with successful road safety practices principles, can aid in improving RTC safety and management in various countries.

Thus, the objective of this study has been achieved by proving the results of common road safety approaches that can reduce road accidents in prone locations.

It is suggested that future studies can be conducted to find the relationship between the factors of road accidents, such as the correlation between human and environmental factors, human and environmental factors, and human and road factors. In addition, the study can be improved by collecting primary data through questionnaires or interviews of accident victims involved to obtain more accurate data on how accidents can occur. Thirdly, the information on the driver's age range involved in accidents should be included in the analysis to identify the problem of possible accidents due to lack of driving experience or their over-estimated skill. Finally, knowing the cause of accidents more clearly and in detail can find ways to reduce road accidents more accurately.

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### **Author Contribution**

This study was designed, supervised and coordinated by Fatin Najwa Mohd Nusa as the principal investigator, who provide the conceptual and technical guidance for all aspects of this research. Nur Amalia Zulaikha Bahari performed the preliminary study, data collection and data analysis using the Mann Whitney U analysis. Nur Farizan Tarudin, Nur Dalila Mohamad and Ainatul-Fatima Md Murozi participated in the sequence alignment and drafted the manuscript. All authors contributed to the manuscript conceptualisation, writing, editing, review for submission, read and approved the final manuscript.

### **Conflict of Interest**

This study is a part of a completed Bachelor of Engineering (Hons.) Civil, Final Year Project (FYP) thesis at the School of Civil Engineering, College of Engineering, University Teknologi MARA (UiTM). The authors have no conflict of interest to declare. All co-authors have seen and agree with the contents of the manuscript and there is no financial interest to report.

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