



## Analysis of Traffic Accidents Characteristics in Rural Roads of Riau Province

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### INFO ARTIKEL

Accepted : 4 July 2020

Online : 19 July 2020

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### ABSTRACT

The study aims to analyze the characteristics of traffic accidents rural roads in Riau Province. The data was obtained from Directorate of Traffic of the Riau Police from year 2014 to 2018. Statistical analyze were conducted using the SPSS software version 20. Mann-whitney and Kruskal Walls analysis were used to analyze the data. There was no significant difference in the number of victims seen from the aspect of the gender of the vehicle that was hit. Based on the the road geometry, there were significant differences in the number of victims, speed, and density of traffic flows. There were significant differences in the traffic speed and density, the number of victims is not significantly different. There were significant differences in traffic speed and density based on road surface conditions, but the number of victims was not significantly different. Based on the pavement conditions, there was no significant difference in density and the number of victims. While, there was a significant difference on vehicle speed. Based on weather conditions, there was no difference in traffic density and the number of victims, but significantly different in terms of speed. Based on the type of road shoulder, there are differences in speed, traffic density, and the number of victims. There are significant differences in speed, traffic density, and the number of victims on the three observed lines. Rantau Berangin- Pasir Pengaraian route was lower than the speed in the other two routes. The average ADT rating for each group on Pekanbaru-Teluk Kuantan route was lower than the vehicle speed on the other two lines. The average rating for each number of victims per group, on Rantau Berangin- Pasir Pengaraian route, was lower than the speed on the other two routes. There are significant differences in speed, traffic density and the number of victims on the three observed lines.

**Keywords:** Traffic Accidents; Number of Victims and Gender; Average Daily Traffic and Vehicle Speed; Road Surface Conditions, Weather Conditions and Road Shoulder Conditions

### I. INTRODUCTION

Traffic accidents had become negative excess from infrastructure utilization. It also a risk to the road user safety and material losses due to vehicles and good damages. Moreover, the loss of life became an invaluable loss in accident because they could not be replaced. Therefore, road safety audits are essential in order to minimize the potential for traffic accidents. Traffic accidents is one of the highest causes of death

in Indonesia. According to the Indonesia National Police data, there were 109,038 accident cases with 27,441 deaths, with a potential socio-economic loss of around Rp. 203 Trillion to Rp. 217 Trillion per year (2.9% - 3.1%). of Indonesia's Gross Domestic Product/GDP) in 2012. Meanwhile, there were 109,776 accidents, with 31,185 deaths in 2011. (Herawati, 2019)

Traffic accidents has been being international

concern. In 2009, WHO stated that 1.3 million people died due to traffic accidents, in which 90% of accidents were occurred in developing countries, particularly Indonesia. Furthermore, it could impact the economic situation in its countries. In the past 10 years, WHO was already launched a preventive program named Decade of Action for Road Safety. Indonesia was participated in that program by divided the program in to 5 pillars, including road safety management, infrastructure, safe vehicles and post-accident handling. The five pillars are based on 3 (three) sections of road safety that are interconnected with traffic operations, namely drivers, vehicles, and roads. (Libres, Galvez, and Cordero 2008).

Data from Directorate General of Bina Marga, Indonesia indicated that human factor was the biggest cause of accidents occurred in Indonesia. While, vehicles accident was caused by road factors such as geometrics and the lack of complementary facilities. Thus, it is pivotal to arrange a road safety management (Fahza and Widyastuti, 2019). There have been numerous attempts to overcome traffic accidents, began with road maintenance, repair of road facilities and socialization to the society about the importance of traffic safety. However, to achieve the optimal results of safe and secure traffic, the characteristics and causes of accidents should be determined. As a result, decision makers or parties who are responsible for traffic safety should develop proper actions. Hence, this study aimed to identify the characteristics of traffic accidents in rural roads of Riau Province.

## II. MATERIALS AND METHODS

### 2.1 Literature review

Analysis and identification of accidents causes are the basic step. The causes of accidents are including negligence driver, damage street, vehicle factors, weather and the lack of road facilities (Putri, 2014). Most of accidents occurred are caused by human factors (Pamungkas, 2014). According to Law No.22 year 2009, accident victims, such as fatalities, are individuals who are positively identified as having passed away as a result of a traffic accident within 30 days after the incident. Severe injury victims are those whose wounds requires regular hospital care or leave them permanently disabled more than 30 days after the accident. Victims who are not categorized as dead or badly injured are considered slightly injured victims (Herawati, 2019)

According to the Ministry of Settlements and

Regional Infrastructure's Guidelines for Handling Traffic Accident Prone Locations (Decree Number: 375 of 2004), the characteristics of traffic accidents are categorized into the most common types of accidents. The data approach employed is 5W+1H, which refers as to why (the accident-causing factor), what (the type of collision), where (the accident location), who (the involvement of road users), when (the incident's timing), and how (type of vehicle movement). As shown by Libres et al. (2008), human errors, the type of vehicle, and the condition of the roads are the main causes of accidents. The day of the accident, the time of the incident, the type of collision, the type of vehicle, the victim's condition, gender, age, the reason for the accident, and the location of the accident are some of the accident's characteristics. All users of the road find traffic accidents to be highly unpleasant because they include both on- and off-road vehicles, cause significant material losses, and result in unquantifiable fatalities. Traffic accidents are caused by a combination of human, road, vehicle, and environmental variables (Utomo 2012).

The National Transportation Safety Committee (NTSC) Indonesia revealed that road traffic accidents are currently the dominant cause of death, injury, and disability in worldwide. Road accidents lead to significant in over 1.3 million fatalities and 20–50 million injuries annually. The findings of the NTSC investigation demonstrated that road geometry issues prevailed as the accident's cause. Majority of the roads in Indonesia are not specifically constructed. Instead, they are roads that were left over from the Dutch era, mouse tracks, sidewalks, and environmental roads that were gradually widened and cemented for aesthetic purposes. The road is built without adhering to good infrastructure safety standards, which include audits, inspections, impact analyses, management of accident-prone areas, and vehicle safety. As a result, the road could be full of hazards that might result in accidents at any time (<http://knkt.go.id/post/read/faktor-dominan-penyebab-kecelakaan-lalu-lintas-jalan>, accessed on August 16, 2022).

Wijayana (2018) examined the contributing factors to traffic accidents in Bengkalis Regency, Riau Province between 2015 and 2017 indicated that a number of factors, including human factors (drivers), cars, and the road environment, contributed to the incidence of traffic accidents. The findings revealed that individuals are the primary cause of accidents.

### 2.2 Method

A structured analysis method known as Knowledge Discovery in Databases (KDD) is used to extract accurate, novel, and useful information as well as identify trends in large and complicated data sets. The KDD process is focused on data mining (DM), using specific algorithms to examine data, create models, and identify previously unknown patterns. Several methods can be used in the data mining process, including classification (mapping data into multiple groups), clustering (categorizing and classifying data based on similarities/similarities

in attribute data sets), and dependency modeling (build a model which significantly explains the connection between attributes). Data mining and plotting were used in the study's quantitative research to support qualitative examination of the problem of the description phenomenon. Data mining techniques employ statistical algorithms. The Riau Police's database of traffic accidents on the three sections of rural roads are used as the baseline. Details parameters and data attributes are explained in Table 1.

**Table 1.** Parameters, Attributes and Data Types

Parameter	Attribute	Scale/Type Data
Location	roads	Ordinal/String
Number of Victims	Number of Victims	Nominal/Integer
Road Surface Condition	Road Surface	Nominal
Speed	Speed	Nominal
Weather Conditions	Weather	interval
Shoulder Condition	Roadside	Nominal
Gender	Gender	Nominal
Traffic Flow Density	Number of passing vehicles	interval

### III. RESULTS AND DISCUSSION

Descriptive analysis in this study demonstrated that the gender of the person involved in the accident, or the so-called gender of the first vehicle, is the gender characteristic of the culprit (Sex1), while the gender of the victim (Sex2) refers to the person driving

the second car, who also has involved in the accident as the victim. In this study, the geometric road conditions, pavement conditions, weather circumstances, and shoulder kinds are divided into two categories.

**Table 2.** Descriptive Statistics of Traffic Accidents on the Pekanbaru- Simpang TB (Kampar) Line

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Sex1	134	1.00	2.00	1.1045	.30703	.094
Sex2	134	1.00	2.00	1.1940	.39694	.158
Road Geometrics	134	1.00	2.00	1.1716	.37848	.143
Roadway surface condition	134	1.00	2.00	1.1940	.39694	.158
Pavement condition	134	1.00	2.00	1.0448	.20759	.043
Weather condition	134	1.00	2.00	1.2985	.45932	.211
Shoulder Type	134	1.00	2.00	1.6791	.46857	.220
Speed	134	45.00	72.00	61.3582	5.78227	33.435
Average Daily Traffic	134	5.67	7.75	6.6430	.80125	.642
Number of victims	134	.00	10.00	1.9552	1.39745	1.953

The descriptive data result illustrated that there were 134 accidents examined in this study. The variables for average daily traffic (ADT), speed, and number of victims were provided in numerical form. The average ADT was 6.6430, with the range between

7.75 and 5.67. The vehicle involved in the collision had an average speed of 61.3582 km/h, with the greatest speed recorded at 72 km/h and the lowest recorded at 45 km/h. Ten insiders were victims, which is the maximum amount, while there were none at all

at the lowest number.

**Tabel 3.** Descriptive Statistics of Traffic Accidents on Rantau Berangin-Pasir Pengaraian (Rokan Hulu)

Variabel	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Sex1	389	1.00	2.00	1.0771	.26713	.071
Sex2	389	1.00	2.00	1.2853	.45216	.204
Road Geometrics	389	1.00	2.00	1.2031	.40281	.162
Roadway surface condition	389	1.00	2.00	1.0231	.15053	.023
Pavement condition	389	1.00	1.00	1.0000	.00000	.000
Weather condition	389	1.00	2.00	1.0977	.29727	.088
Shoulder Type	389	1.00	2.00	1.7841	.41200	.170
Speed	389	41.00	66.00	47.6838	4.77486	22.799
Average Daily Traffic	389	6.08	8.73	7.2148	.63949	.409
Number of victims	389	.00	4.00	1.3625	.55588	.309

ADT, speed and number of victims were found in numerical data. The highest ADT was 8.73 and the lowest was 6.08 with an average of 7.2148. While the highest speed of the vehicle involved in the accident

was 66 km/h, and the lowest was 41 km/h with an average speed of 47.68 km/h. The highest number of victims is 4 people and the lowest is zero or no victims.

**Tabel 4.** Descriptive Statistics of Traffic Accidents on Pekanbaru- Teluk Kuantan (Kuantan Singingi)

Variabel	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Sex1	252	1.00	2.00	1.1587	.36615	.134
Sex2	252	1.00	2.00	1.1548	.36240	.131
Road Geometrics	252	1.00	2.00	1.5317	.49998	.250
Roadway surface condition	252	1.00	2.00	1.1706	.37694	.142
Pavement condition	252	1.00	1.00	1.0000	.00000	.000
Weather condition	252	1.00	2.00	1.1508	.35856	.129
Shoulder Type	252	1.00	2.00	1.4802	.50060	.251
Speed	252	42.00	52.00	48.4563	2.30409	5.309
Average Daily Traffic	252	3.63	4.44	4.0191	.29448	.087
Number of victims	252	.00	7.00	1.7976	1.04229	1.086

Based on table 4, the highest ADT was 4.44 and the lowest was 3.63 with an average of 4.0191. While the highest speed of the vehicle involved in the accident was 52km/h, and the lowest was 42 km/h with an average speed of 48.45 km/h. The highest number of victims was 7 people and the lowest was zero or no victims.

Along with the population increase in developing countries, it would encourage higher levels of community mobility within a region or city. If this situation was not supported by appropriate infrastructure and facilities of traffic, this could contribute to the emergence of a variety of problems in the traffic sector. There were many different types of traffic accidents, both in terms as to how often it occurred and what caused them (Utomo, 2012). Since the Police still do not have any current relevant traffic

accident data, it has been difficult to measure traffic safety in Indonesia properly up to now. Since some cases were not reported to the police by the victims or those involved, not all information can be collected. The majority of Indonesia's traffic accident data is inaccurate due to poor recording, making it difficult to use it for analyses of road safety. Traffic accidents are accidents that take place on the road intentionally or unintentionally, include automobiles and/or other road users, and typically result in fatalities or property loss (Soehodho, 2007; Enggarsasi & Sa'diyah, 2017). Traffic accidents had an effect on placing users' lives in danger and leading in losses and damage to goods and vehicles. The impact on the victim was more lethal and the amount of material loss was greater when an accident was more fatal [3].

**Table 5.** Mann Withney Difference Test for Speed, Average Daily Traffic (ADT) and Number of Victims (NoV)

	Nilai Asymp-sig (2-tailed)		
	Speed	Average Daily Traffic	Number of victims
Sex1	0.626	0.088	0.547
Sex2	0.776	0.008	0.506
Road Geometris	0.024	0.000	0.000
Roadway Surface Condition	0.000	0.000	0.709
Pavement Condition	0.002	0.171	0.456
Weather Condition	0.002	0.897	0.249
Shoulder Type	0.022	0.000	0.001

The test result revealed that there was no significant difference in speed based on gender (sex1), shown by p value 0.626. Furthermore, the ADT p value was 0.088, so there was no difference in traffic density based on sex1. The value of the asymp sig number of victims was 0.547, so there was no difference in the number of victims. Based on the sex of the victim, the asymp sig speed value is  $0.776 > 0.05$ , so there is no difference in speed based on the sex of Sex2. The ADT asymp sig value is  $0.008 > 0.05$ , so there is no difference in traffic density based on Sex2. The value of the asymp sig number of victims is  $0.506 > 0.05$ , so there is no difference in the number of victims based on sex. Sex2.

According to Road Geometrics, the asymp sig speed value is  $0.024 > 0.05$ , indicating that there is no speed difference. Since the asymp sig ADT value is 0.000, the traffic density varies. There is a variation in the number of victims since the asymp sig number of victims has a value of 0.000. According to the results of the various tests conducted based on the state of the road's surface, the asymp sig speed value is 0.000, indicating that there is a difference in speed. Since the asymp sig ADT value is 0.000, the traffic density varies. There is no variation in the number of victims because the asymp sig number is equal to 0.709.

From the test results, there was a difference in

speed since the asymp sig speed value was 0.002 based on the condition of the pavement. The ADT asymp sig value was 0.171, therefore the traffic density was similar. There was no difference in the number of victims because the asymp sig number was equal to 0.456. The test results demonstrate that there was a difference in speed since the value of asymp sig speed was 0.002 based on the weather. Since the ADT asymp sig value was 0.897, the traffic density remains the same. There was no difference between the number of victims because the asymp sig number is equal to 0.249. The findings also indicated that the asymp sig speed value was 0.022 if seen from the shoulder type, indicating that there was no difference in speed. There was a difference in traffic density when the asymp sig ADT value was 0.000 and a difference in the number of victims when the asymp sig number of victims was 0.001.

Every traffic accident had characteristics that could be recognized by where the accident happened (TKP). The details of where the accident happened included the type of car, the type of accident, the day and time of the incident, the weather, the location, the roads, and the victim's condition. To see the difference in speed, traffic density, and the number of victims based on the road segment, it was done using the mean ranks, the results were presented in table 6.

**Table 6.** Mean Rank Results of Three Roads Based on Speed, Average Daily Traffic and Number of Victims

Variabel	Line	N	Mean Rank
Speed	Pekanbaru - Simpang TB	134	680.91
	Rantau Berangin- Pasir	389	302.16
	Pengaraian		
	Pekanbaru-Teluk Kuantan	252	364.76
	Total	775	
Average Daily Traffic	Pekanbaru - Simpang TB	134	450.16
	Rantau Berangin- Pasir	389	535.99
	Pengaraian		
	Pekanbaru-Teluk Kuantan	252	126.50
	Total	775	
Number of victims	Pekanbaru - Simpang TB	134	440.04

Rantau Berangin- Pasir Pengaraian	389	343.23
Pekanbaru-Teluk Kuantan	252	429.44
Total	775	

The mean rank or average rating of each group in the vehicle speed category, the Rantau Berangin-Pasir Pengaraian route was lower than the vehicle speed in the other two lanes. The mean rank or average ADT rating for each group, on the Pekanbaru-Taluk Kuantan route, is lower than the vehicle speed on the other two

lines. The mean rank or average rating of each NoV group, on the Rantau Berangin-Pasir Pengaraian route, is lower than the vehicle speed on the other two lanes. Then the Kruskal Wallis test was carried out on these three aspects for the three roads observed in this study, the results are as follows.

**Table 6.** Results of Kruskal Wallis Difference Test for Three Roads Based on Speed, Average Daily Traffic and Number of Victims

	Speed	Average Daily Traffic	Number of victims
Chi-Square	290.721	525.072	39.435
df	2	2	2
Asymp. Sig.	.000	.000	.000
a. Kruskal Wallis Test			
b. Grouping Variable: Roads segment			

As shown in Table 6 that the p value was lower than 0.05 which means that there were significant differences on speed, ADT and NoV at the three observed roads.

Since there are a lot of traffic accidents in Indonesia, this is still the most alarming issue. According to the National Police data, more than 28,000 fatalities on Indonesian roadways were reported. The road infrastructure in Indonesia, particularly in Riau Province, was still insufficient, and the amount of traffic made accidents much more likely to happen. Indonesia has one of the lowest ratios of road length to land area per square kilometer in the region, demonstrating that the country's transportation system is unable to cover the almost 2 million square kilometers of land area (Jusuf et al., 2017; Marsaid et al., 2013).

Currently, the number of deaths and injuries due to traffic accidents is a global phenomenon. Authorities are now concerned about the rise in the number of people killed and injured on their roads, including Indonesia. Since it has a detrimental impact on the economy, road safety has become a primary priority for governments, policymakers, and even individuals around the world [6]. Since a traffic accident is an undesirable incident, it inevitably occurred without warning and is always avoided by anybody using a motor vehicle. However, the cause could be detected from the impact that occurs due to the accident. Accidents not only result in financial damages, but

they also put the lives of those involved in danger. The severity of the victims' injuries could be classified into three types based on the level of fatality, including fatal or dead, serious injuries, and minor injuries. There were three primary factors that contributed to accidents in general, which were human errors, poor road conditions, and vehicle conditions. Additionally, environmental factors might play a part in some accidents [7]–[9]. Another factor that contributed to the frequency of traffic accidents was the geometry of the road; for example, abrupt bends that commonly resulted in fatalities [10], [11]. Traffic accidents are frightening incidents because of the potential for fatalities, injuries, and financial losses. Furthermore, accidents can hinder transportation systems and result in heavy traffic [12].

Speed of vehicles was also being a concern of the governments. As stated in the in the Traffic Law no. 22 year 2009 article 21 that the government has set a speed restriction. According to Article 80 of Government Regulation of the Republic of Indonesia No. 43 year 1993, the maximum speed limit for vehicles on class I, II, and IIIA in the primary road network system was 100 km/h. It refers to passenger cars, buses, goods cars, and motorbikes [13], [14]. In addition, the growing number of vehicles on the road without an equivalent improvement in the quality of the roads had increased traffic density and raised the likelihood of more accidents [15]–[17].

#### IV. CONCLUSION

Based on the research findings, it could be concluded that the number of victims on the Pekanbaru-Simpang TB (Kampar) route was the highest during the observation period in one accident which achieved 10 people. Regarding the gender of the vehicle that was hit or that hit, there was no significant difference in the number of victims. Seen from the road geometry, there were differences in the number of victims, speed and density of traffic flows. Based on the condition of the road, there were significant differences in traffic density and speed, but not in the number of victims. On the pavement conditions, there was no difference in density and the number of victims. However there was a significant difference as shown by vehicle speed. Moreover, seen from weather conditions, there was no difference in traffic density and the number of victims, but significantly different on speed. There are differences in speed, traffic density and the number of victims on the type of road shoulder. The Rantau Berangin-Pasir Pengaraian route had a lower speed than the other two routes according to the average ranking of each group in the category of speed. On the Pekanbaru-Taluk Kuantan route, the average ADT rating for each group was lower than the average vehicle speed on the other two lines. Rantau Berangin-Pasir Pengaraian route had a lower average rating for the number of victims per group than the other two routes. On the three observed lines, there were noticeable disparities in the three metrics of speed, traffic density, and number of victims.

#### REFERENCES

- [1] S. SOEHODHO, "Motorization in Indonesia and Its Impact To Traffic Accidents," *IATSS Res.*, vol. 31, no. 2, pp. 27–33, 2007, doi: 10.1016/s0386-1112(14)60219-3.
- [2] U. Enggarsasi and N. K. Sa'diyah, "Kajian Terhadap Faktor-Faktor Penyebab Kecelakaan Lalu Lintas Dalam Upaya Perbaikan Pencegahan Kecelakaan Lalu Lintas," *Perspektif*, vol. 22, no. 3, p. 228, 2017, doi: 10.30742/perspektif.v22i3.632.
- [3] A. Zauardi and H. Suprayitno, "Analisa Karakteristik Kecelakaan Lalu Lintas di Jalan Ahmad Yani Surabaya melalui Pendekatan Knowledge Discovery in Database," *J. Manajemen Aset Infrastruktur Fasilitas*, vol. 2, no. 1, pp. 45–55, 2018, doi: 10.12962/j26151847.v2i1.3767.
- [4] A. Jusuf, I. P. Nurprasetio, and A. Prihutama, "Macro data analysis of traffic accidents in Indonesia," *J. Eng. Technol. Sci.*, vol. 49, no. 1, pp. 133–144, 2017, doi: 10.5614/j.eng.technol.sci.2017.49.1.8.
- [5] Marsaid, M. Hidayat, and Ahsan, "Faktor yang Berhubungan dengan Kejadian Kecelakaan Lalu Lintas pada Kendaraan Bermotor di Wilayah Polres Kabupaten Malang," *J. Ilmu Keperawatan*, vol. 1, no. 2, pp. 98–112, 2013.
- [6] G. A. Toto and P. Limone, "Road transport accident analysis from a system-based accident analysis approach using Swiss cheese model," *Int. J. Eng. Educ.*, vol. 1, no. 2, pp. 99–105, 2019, doi: 10.14710/ijee.1.2.99-105.
- [7] E. I. Mahendra, S. S. Igrisa, and A. Ahmad, "Analysis of traffic accident rates during the Covid-19 pandemic in Gorontalo City," *Int. J. Educ. Vocat. Stud.*, vol. 3, no. 6, p. 409, 2021, doi: 10.29103/ijevs.v3i6.5168.
- [8] P. C.E, "Analisis Karakteristik Kecelakaan dan Faktor Penyebab Kecelakaan Pada Lokasi Blackspot di Kota Kayu Agung," *Tek. Sipil dan Lingkungan.*, vol. 2, no. 1, pp. 154–161, 2014.
- [9] L. Gicquel, P. Ordonneau, E. Blot, C. Toillon, P. Ingrand, and L. Romo, "Description of various factors contributing to traffic accidents in youth and measures proposed to alleviate recurrence," *Front. Psychiatry*, vol. 8, no. JUN, pp. 1–10, 2017, doi: 10.3389/fpsy.2017.00094.
- [10] R. Manggala, J. A. J., D. Purwanto, and A. K. Indriastuti, "Studi Kasus Faktor Penyebab Kecelakaan Lalu Lintas Pada Tikungan Tajam," *J. Karya Tek. Sipil*, vol. 4, no. 4, pp. 462–470, 2016.
- [11] Santosa and Et.al, "Anatomy of Injury Severity and Fatality in Indonesian Traffic," *J. Eng. Technol.Sci.*, vol. 49, no. August, pp. 412–422, 2017.
- [12] F. Zong, H. Zhang, H. Xu, X. Zhu, and L. Wang, "Predicting severity and duration of road traffic accident," *Math. Probl. Eng.*, vol. 2013, 2013, doi: 10.1155/2013/547904.
- [13] A. Hidayati and L. Y. Hendrati, "Traffic Accident Risk Analysis by Knowledge, the Use of Traffic Lane, and Speed," *J. Berk. Epidemiol.*, vol. 4, no. 2, p. 275, 2017, doi: 10.20473/jbe.v4i2.2016.275-287.
- [14] H. Fitrianti, Y. P. Pasaribu, and P. Betaubun, "Modeling factor as the cause of traffic accident losses using multiple linear regression approach and generalized linear models," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 235, no. 1, 2019, doi: 10.1088/1755-1315/235/1/012030.
- [15] P. Kharya, A. Gupta, and H. K. Solanki, "Road

traffic accidents so easy to occur , so difficult to prevent : a Review . Review Article Road Traffic Accidents So Easy To Occur , So Difficult To Prevent : A Review Pradip Kharya , \* Arti Gupta and Hariom Solanki,” no. October 2018, 2013.

[16] Y. J. Yasin, M. Grivna, and F. M. Abu-Zidan, “Global impact of COVID-19 pandemic on road traffic collisions,” *World J. Emerg. Surg.*, vol. 16,

no. 1, pp. 1–14, 2021, doi: 10.1186/s13017-021-00395-8.

[17] S. McIlvenny, “Road traffic accidents - A challenging epidemic,” *Sultan Qaboos Univ. Med. J.*, vol. 6, no. 1, pp. 3–5, 2006.