Correlation Of Factors Affecting Road Traffic Accidents in Macarthur Highway, Barangay Sampaloc, Apalit, Pampanga Using Multinomial Logit Model

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Abstract- The concept of road safety is considered critical to transportation networks, as it involves ensuring the safe arrival at one's destination without physical harm or functional loss. The MacArthur Highway in the Philippines is an essential national road, and this study aimed to determine the correlation of factors that affected road traffic accidents on this highway. A mixed-method research design, utilizing both quantitative and qualitative data, was employed to analyze the correlation of factors that contributed to road traffic accidents and collision types in Barangay Sampaloc, Apalit, Pampanga using Multinomial Logistic Regression analysis. The study identified various factors, such as driver age, sex, alcohol use, weather conditions, vehicle type, road lane width, and condition, which were significant predictors of road accidents. The research highlighted the importance of engineering strategies that focus on road visibility and adequate lane width, as well as targeted education campaigns and driver education programs, which can help prevent accidents. The study recommended the implementation of sobriety checkpoints, improvements in road visibility, and the provision of real-time updates on weather and road conditions to reduce the likelihood of accidents. By taking a comprehensive, multi-faceted approach that focuses on engineering strategies, education, and policy implementation, it may be possible to reduce the frequency and severity of road traffic accidents on the MacArthur Highway. It is recommended that local authorities continue conducting research to identify other contributing factors to road accidents. Regular road safety audits should also be carried out to address any potential hazards on the road. With this approach, road safety can be improved, and the number of accidents can be reduced, leading to a safer and more efficient transportation system.

Indexed Terms- Road Safety, Road Accident, Multinomial Logit Model, Collision Type

I. INTRODUCTION

Road safety is one of the most crucial aspects of transportation networks. It is merely the act of reaching your destination without suffering any physical harm or functional loss. Vehicles such as cars, trucks, motorbikes, pedestrians, public utility vehicles, animals, and other types of travelers who share the road around the world help many nations flourish economically and socially.

Road Traffic Accident (RTA) occurs when a vehicle collides with another vehicle, pedestrian, and animal, among others, resulting in injuries, property damage, and death [1]. RTA is the 15th leading cause of death worldwide and one of the world's most serious public health threats, killing 1.35 million people and injuring 20 to 50 million people each year [2]. They are caused by a combination of factors related to the transportation system, which includes the road, its environment, vehicles, and road users, with crash outcomes ranging from property damage to death. Notably, there are two types of classified crashes: single vehicle accidents and two-vehicle accidents. A single-vehicle crash is classified into three types: off-road, collision with a fixed object (parked vehicle), and collision with a pedestrian (animal). A two-vehicle crash is also divided into five categories: rear-end crashes, head-on crashes, angular crashes, sideswipe crashes in an opposite direction, and sideswipe crashes in the same direction [3].

In line with this, over speeding contributes to roughly half of road deaths in high-income countries and territories, while it accounts for 37% and 13% of deaths in the middle- and low-income countries, respectively. The burden of road traffic deaths falls disproportionately on vulnerable road users, with pedestrians, cyclists, and motorcyclists accounting for more than half of all fatalities. The proportion of fatalities among these vulnerable road users is higher in emerging economies, where rapid economic growth is accompanied by urbanization and motorization. Many of these countries have lagged behind in terms of infrastructure development, policy changes, and policy enforcement [2].

Infractions committed by drivers play a very important role in accidents that can occur in many ways, such as the driver's age and gender [4]. Likewise, human error is the most frequently cited contributing factor with 99.20% in the total number of accidents, followed by environmental (5.40%) and vehicle factor (.50%). Moreover, most crashes and associated injuries and fatalities can be linked to some form of unsafe driving habits. Furthermore, factors such as alcohol, sleep, and use of drugs were found to be associated with the nature of injuries [5].

In this study, it deals with the occurrence of road traffic accidents which are of major concern since these affect the safety and lives of the people in a community. It is vital to determine the different factors that relate to the accidents in order to prepare and recommend engineering strategies and management that are useful for the improvement of the roads.

1.1 BACKGROUND OF THE STUDY

Safety is one of the vital characteristics of transportation networks. It implies arriving at the destination with no injuries or caused death. In the Philippines, motor vehicle traffic is prevalent on major islands due to their archipelagic nature, significant cities, and economic activities. The increasing number of vehicles and significant traffic volumes lead to many more opportunities for traffic road crashes [1]. The increase in motor vehicles that comes with economic growth usually results in an increase in road traffic accidents. Despite having 54% of the world's vehicles, low- and middle-income countries account for 90% of road fatalities [6]. Given these data, it is important to know and understand the risk factors that may be associated with traffic crashes and prevent or reduce the number of fatalities.

With this, MacArthur Highway as the locale, also known as the Manila North Road, a tertiary and principal national highway in Luzon, the Philippines, that runs for 684.855 kilometers, connecting Aparri in Cagayan to Caloocan in Metro Manila. There is an urgent need to discover how the factors correlate with road traffic accidents along the highway. In line with this, the route has been evident to be accident prone area. With the abovementioned information, the current study aimed to determine the correlation of factors that affected road traffic accidents along MacArthur Highway, Barangay Sampaloc, Apalit, Pampanga through the integration of Multinomial Logistic Regression.

1.2 LITERATURE REVIEW

1.2.1 Road Traffic Accident

Road traffic accident usually occurs on a public road or street, results in the death or injury of one or more people, and involves at least one moving vehicle. It is a collision between vehicles, between vehicles and pedestrians, and between vehicles and animals or fixed obstacles. It involves a single vehicle (and no other road user) are included. Multi-vehicle collisions are only counted as one accident if the collisions happen at very close intervals [7]. Vehicular crashes are classified into two types: single-vehicle accidents and two-vehicle accidents [3].

In line with this, road crashes are categorized into fatal where it is a high risk of death and non-fatal accidents is the opposite that could happen to one or more than one person. In addition, RTAs are increasingly being recognized as one of the most serious public health issues estimating 1.3 million deaths have been recorded based on the data on WHO. Unfortunately, this is also the leading cause of death of children and young adults ages 5 to 29 [8].

Notably, road traffic injuries cause considerable economic losses to individuals, their families, and to nations as a whole. These losses arise from the cost of treatment as well as lost productivity for those killed or disabled by their injuries, and for family members who need to take time off work or school to care for the injured. Road traffic crashes cost most countries 3% of their gross domestic product [9].

Moreover, road users' low normative awareness and undeveloped driving skills contribute to accidents and traffic congestion [10].

1.2.2 Road Safety

Road safety can be greatly enhanced by changes made to the planning, building, and maintenance of our transportation system. That's why road signage is an important component of traffic safety and convenient driving where it warns and gives awareness to multiple users about traffic to avoid casualties [11].

The most frequent causes of traffic accidents among those at risk for them have been examined, such as Seniors, young drivers, and reckless drivers. Lack of driving experience increases the likelihood of getting in traffic violations and accidents, both of which result in fines. Investigations are also ongoing on the mechanisms by which a lack of experience may influence accident risk in combination with actual knowledge and abilities, individual level of development and maturity, and lifestyle [12] [13].

According to numerous studies, human mistake such as speeding, distractions, errors caused by drinking, violating traffic laws, exhaustion, and drowsiness are the primary causes of RTAs [9] [14].

Meanwhile, according to new research due to psychological position and inexperience, young drivers are more at danger. Therefore, for this set of drivers, multitasking while driving may be more hazardous. Due to their risk-taking behavior and overconfidence in their driving abilities, teenage drivers in particular frequently use their phones while driving and it was recorded to be 33.5% spend their time using mobile phones [15] [16].

Another factor would be distracted driving where it takes the driver's attention away from driving and can increase the chance of a motor vehicle crash. With this, driver interaction and attention span are a must [17] [18].

The transportation industry faces a severe problem with driving weariness, which impairs performance and raises the danger of accidents. These includes driving sleepy or fatigued and driver could be deemed "impaired" to operate a vehicle if they have slept less than five hours. [19] [20].

Notably, the motorcycle is one of the most popular vehicles in the world due to its low cost, ability to transport people to any location, and ease of navigating traffic. It is a minor subset of all motor vehicles and one of the most basic modes of land mobility in the country [21]. Because it is one of the world's most dangerous modes of transportation, it is compact and thin, provides less protection than inside a vehicle, and is designed for significantly faster speeds and performance levels than automobiles [22].

In the Philippines, motor vehicle traffic is prevalent on major islands due to their archipelagic nature, significant cities, and economic activities [23]. The increasing number of vehicles and significant traffic volumes lead to many more opportunities for traffic road crashes [24] [25].

1.3 PRIOR STUDIES

1.3.1 RTA Factors

Many risk factors can contribute to the severity levels of injuries after an accident; these include drivers, vehicles, temporal, environmental, and geometry characteristics. It was proven that perceptions of friends' speeding were strongly associated with speeding behaviors in male drivers between the ages of 18 and 28. Particularly, older drivers tend to drive faster relative to drivers in younger age groups. Since younger drivers are more likely to sustain rising degrees of injury severity [26] [27].

In India, it was denoted that the distribution of road accidental deaths and injuries varies according to age, gender, month, and time. Moreover, road accidents are more common in bad weather and during working hours. The risk of death in 16 of the 35 states and union territories is higher than the national average. Although the burden of road accidents in India's metropolitan cities is marginally lower, nearly half of the cities face a higher fatality risk than their mofussil counterparts [28].

Numerous studies have compared the accident rates for male and female drivers of automobiles. In England, it is established that there were only minor changes in the proportion of drivers, both sexes, who were believed to have been engaged in a collision. The male drivers tended to drive too quickly for the road conditions and were more likely to be drunk and a greater road risk-taker. On the other hand, distracted driving was a problem among female drivers. With lesser observation on dangers and less experience than male drivers who were involved in an accident [29].

In line with this, male has a higher risk of suffering a fatal or catastrophic injury. On business journeys, young male drivers (18) are particularly affected with a (20.1% chance). This is when the chance of young female drivers is (18.7%). Another significant age and gender-related aspect is that those over the age of 60 had a lower risk of being seriously injured or dying in an accident [30]. It was found out that only women expressed anxiety when it comes to dangerous circumstances making them have less risk in committing traffic crashes [31].

Studies have found that the chance of fatal injury is higher in low light, at night, or when street lights are on [32]. Similarly, weather conditions and time of day have also been found to influence the severity of traffic accidents involving pedestrians. On the contrary, bad weather (rain, smog, snow, fog) reduces the probability of a fatality.

It was discovered that wet surfaces are less likely to result in death. The study suggests that in bad weather (where wet roads or other harsh conditions may be prevalent), drivers adapt to their behavior, slow down and become more cautious. For the time of the day, afternoon peak hours, 3pm to 5:59 pm showed that there's a decrease in fatality. While night hours, from 6 pm to 12 am increase the probability of pedestrian deaths [33] [34] [35].

A study about the human factors influencing the severity of traffic accidents related to pedestrians in Tehran, in the accidents that were studied using Meta-analysis, there were 4, 070 (63.5%) and 2335 (36.5%) injured or killed pedestrians who were men and women, respectively. The final model demonstrated that the dependent variable is linked with gender, age, pedestrian location, and fault, kind of driver's license, and pedestrian fault. Men, pedestrians who were crossing at the side of the road, pedestrian error, and drivers with a grade 1 license had a much greater percentage of the events that caused the death (Moradi et al., 2018) [36].

As stated by the Institute of Road Safety Research, the occurrence of accidents has been influenced by many factors. These are poor drainage system, quality of the road surface, and vehicle speed. In addition, the efficiency of braking and controlling the vehicle on wet surfaces become worse than that on the dry surfaces. Notably, the average speeds on a slippery road surface lower than in a good road surface conditions which are roughly 4 km per hour in terms of speed [37] [38] [39].

Various studies found that slippery road surfaces might increase the risk of fatal injury crashes. However, several studies introduced the relationship between injury severity and weather conditions. During rainfall, slight injuries were relatively more frequent than serious injuries. In addition, the relative increase in the slight crashes can be due to reduce friction between the tires and road surface [40]. Moreover, adverse climate is one of the environmental factors that is recognized to influence driver performance on the road, particularly in the case where visibility is poor the friction on the road is reduced.

On the other hand, other factors such as speeding and faults in traffic signs operations have major impacts on road safety. The probability of accident occurrence can be increased as the humidity level and rainfall increased. Research states that speeding is one of the adverse driving behaviors which is affected by weather conditions. It was confirmed that the adverse weather and road conditions, such as rain, snowfall and changing temperature, are significant contributors to a high risk of traffic accidents occurring [41] [42].

In comparison to other weather variables, dusty weather had the highest mortality rate (5.07%). Oily surfaces had the highest death rate (3.45%). Roadway flaws are the most common cause of accidents and fatalities [43].

In the Philippines, there has been an increase in motorcycle-related traffic accidents. These are caused by environmental and individual factors, including age, illumination, and traffic flow, weather, the nature of the road, the type of junction, the hour, the day, the surface conditions, and driving habits [44] [45].

1.3.2 RTA Mapping

There are studies which utilized a technique to map out the distribution of traffic accidents in the city, the introduction of the geographic information system. GIS is capable of analyzing 1276 road traffic accidents, which is a high density of RTA in Tagaytay City. This GIS program can identify city neighborhoods with a lot of RTAs. Additionally, the technique revealed that RTA distribution follows a dispersed pattern. SEM produces the statistical investigation, where the factors' link is established. Young ages have been confirmed by the program to have the chance of becoming a victim and raising the likelihood of fatalities. The weather was also revealed as determinants of the rise in RTA [46].

Meanwhile, a study on the road accidents using data investigation and visualization in Los Baños, Laguna, Philippines, using algorithm prediction found no conclusive relationship between the location of an accident and the victim's demise. However, the time of day and the severity of the victims of road accidents, particularly car collisions, have a significant impact [47].

One of the occupations with the greatest accident rates is truck driving. Truck drivers consequently suffer a number of work risks [48]. Likewise, heavier vehicles are more likely to be involved in serious accidents. The age of the driver also influences road accident severity. It implies that older drivers are more likely than younger ones to be involved in serious traffic accidents. The severity of traffic accidents on the road also depends on how congested the road is [1].

Study shows that bus drivers worked an average of 16 hours per day and engaged in unsafe driving practices like over speeding and road racing to meet their daily quota [49].

Additionally, the street-level study reveals that deadly pedestrian collisions occur near various types of transportation stations. The results of this study of three cities in Metro Manila reflect the double challenge to pedestrian safety in rapidly urbanizing areas in lower-middle-income countries such as the Philippines. Therefore, policies and planning that promote pedestrian safety must address this dual problem in contexts where they are most necessary [50].

Commonly, a road accident is caused by the collision of automobiles, pedestrians, or objects, resulting in death, disability, and property damage. Accidents on the road were caused by driver error (26%), mechanical failure (12%), excessive speed (18%), drinking before driving (1%), and deteriorated roads (5%). There were more traffic accidents during the day than at night. The study focused on the occurrence of road accidents from 2001 to 2006 in Philippines, and accidents were evaluated based on their contributing variables. Using the causes of accidents and their occurrence period, an empirical model was developed to predict the number of accidents.

Given that the number of occurrences of a road accident is expressed in positive integers, Poisson Regression analysis was employed in this study to investigate the number of events given the causes of traffic accidents and the time of occurrence [51].

Using the traffic accident dataset that was compiled between the years of 2016 and 2019 in CALABARZON, Philippines, a study was carried out to assist the general public and traffic policy makers in preventing road mishaps. Using data mining and a classification algorithm, a prediction model for traffic accident occurrence was created and found that public vehicles are more likely to be involved in accidents than private vehicles, regardless of the stage of the crime, and accidents might happen between or on 6:00pm and 3:00pm [52].

The GIS was again utilized to map out the distribution of traffic accidents in the Philippine city of Tagaytay. It was found that the contributing factor to the rise in RTA is the weather. It is advised to enroll in the rigorous driving instruction program, which is strictly enforced, and to organize your trips properly. Additionally, it is advised to view weather conditions in real-time. According to some research, vehicles should include technology that can track the weather and safety aspects in real-time. The study suggested a light-emitting diode that acts as a traffic guidance light [46].

1.3.3 RTA Models

There are various studies that applied Multinomial Logistic Regression (MNL) Model to correlate the relationship of the crash severity with the independent variables. This was used in analyzing the vehicle crash data of the Interstate I70 in the State of Missouri, USA for the years (2013-2015). This was used for a wider range of independent variables (i.e. risk factors) in crash severity modeling, given that past research has only made use of limited numbers/types of independent variables.

In addition, a variety of new procedures in presenting the results of the MNL applications that have not been reported in other crash severity models, including: 1) the use of the odd ratios as regression estimates instead of using regression coefficients to interpret the results of prediction; 2) a focus on the assumption of the independence of irrelevant alternatives (IIA) that is very important in the MNL modeling, using the Hausman specification test; 3) consideration of the generalized Hosmer-Lemeshow test as an important goodness of fit measure to assess whether or not the observed incidents match the predicted incidents; 4) the use of the classification table as a measure of goodness of fit to determine the percent of corrected prediction cases; 5) testing for the multicollinearity among the independent variables as precondition assumption; 6) the use of the pseudo R squares as potential goodness of fits instead of classical measures of goodness of fit, such as the Deviance, the Akaike Information Criteria (AIC), and the Bayesian Information Criteria (BIC); and 7) presenting the marginal effects of all independent variables upon the dependent variable has been introduced. Results showed the effectiveness of the MNL approach in crash severity modeling [53].

Compared to univariate analysis, multivariate analysis can be used to determine the influence of multiple factors on the causes of an accident. It examines the variations in accident-contributing elements for six collision types for both divided- and undivided-highway nonjunctions, given that a crash has occurred, using a multivariate analysis technique called the multinomial logistic regression (MLR) model. The investigation of (1) single-vehicle and (2) multivehicle crashes, including (1) angular, (2) head-on, (3) rear-end, (4) sideswipe-samedirection, and (5) sideswipe-opposite-direction collisions, using multinomial logistic regression. It was discovered that varied vehicle behaviors had a considerable impact on the hazards related to various collision types.

On the other hand, Transport for Greater Manchester and the US National Highway Traffic Safety Administration was compared. Comparisons are made between the performances of four ordinal regression algorithms: logistic all-threshold, logistic immediate-threshold, ordinal ridge, and least absolute deviations. Additionally, we examine the impact of random oversampling and undersampling on the suggested risk assessment framework for the US dataset. Empirically, random oversampling and the logistic all-threshold ordinal regression approach had the greatest prediction performance [54].

1.4 Implementation

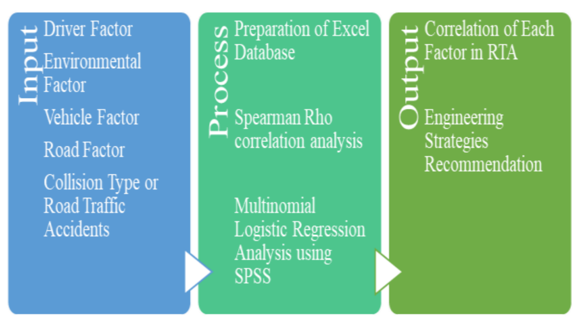

Figure 1. Conceptual Framework of the Study

As shown, the input demonstrated the vital data that was recorded from traffic accident reports such as driver factor, environmental factor, vehicle factor, road factor, and collision type or road traffic accidents. The input variables were processed using engineering data analysis method (Multinomial Logit Model). In the process, an excel database was prepared and underwent Spearman Rho correlation analysis, followed by Multinomial Regression Analysis in SPSS. The expected outputs were the factors that significantly affected road accidents and their correlation with each other, and engineering strategies recommendations.

II. METHODOLOGY

This chapter presents the research design of the study, research locale, and the instruments to be used in the data collection, research ethics, data gathering procedures, and statistical treatment of data in the conduct of the study.

2.1 Methodological Framework
2.1.1 Research Design

The study utilized a mixed-method research design involving both quantitative and qualitative data. As Watson (2015) mentioned, Quantitative Research encompasses a range of methods concerned with the systematic investigation of social phenomena, using statistical or numerical data. It was also defined as methodical research of events utilizing quantitative data and statistical, mathematical, or computational tools. Qualitative research, on the other hand, entailed gathering and evaluating non-numerical data (such as text, video, or audio) in order to better comprehend concepts, opinions, or experiences. Qualitative research was a method of study, designed to capture, analyze and interpret data, relevant to people's concepts and experiences of their social world. It could be utilized to get in-depth understanding of a subject or to develop fresh research ideas.

Specifically, the quantitative data included the collected numerical information from Traffic Enforcement Unit Office. Furthermore, the qualitative data were those involving qualitative recorded written statements about the road traffic accidents.

2.1.2 Research Locale & Respondent Sampling
The study was conducted in Barangay Sampaloc, Apalit, Pampanga in which the target location under study was the MacArthur Highway, also known as the Manila North Road. It was a tertiary and principal national highway in Luzon, the Philippines, that ran for 684.855 kilometers, connecting Aparri in Cagayan to Caloocan in Metro Manila. After Maharlika Highway, it was the second-longest road in the Philippines [55].

All road traffic accidents in MacArthur Highway were collected as well as the geographical characteristics of the accident location. This study was implemented on the accidents in Barangay Sampaloc, Apalit, Pampanga, along the MacArthur Highway.

The goal of the study was to determine the correlation of the factors affecting road traffic accidents along MacArthur Highway, Barangay Sampaloc, Apalit, Pampanga. Therefore, accident information was gathered from the Traffic Enforcement Unit Office in the mentioned area.

No sampling population was used in the study since the primary focus of data collection was based on the data records available in the chosen locale.

2.1.3 Research Instrument
The researchers prepared a formal letter signed by the adviser for the collection of the data from the Traffic Enforcement Unit Office regarding the road traffic accidents along MacArthur

Highway. After the approval of the office personnel, Microsoft Excel was used in the data recording of both quantitative and qualitative data available about road traffic accidents from the agency.

2.1.4 Research Ethics
The research standards were governed by legal and ethical principles that were centered on the well-being of all confidential information in the permitted research study.

To compose and regulate ethics in conducting this study, researchers adhered to keep all personal information about the persons involved in the road traffic accidents and make it confidential. Also, appropriate document retrieval and legal reference of materials were implemented to promote copyright law.

The proper citation of authors and other sources was also cited and acknowledged. Notably, the researchers did not plagiarize any of the study's content.

For clarity, the researchers submitted an authorized letter to ask permission for the data information needed for the conduct of the study. The researchers assured the personnel in the agency that all collected data would be for research purposes only.

1.2 Data Collection

The study was conducted in Barangay Sampaloc, Apalit, Pampanga using the traffic accident records in MacArthur Highway from the Municipal's Traffic Management Unit (TMU). To access the needed data, the researchers secured a request letter to the TMU office signed by the researchers and their research adviser. After the acceptance of the request letter, the researchers immediately worked on gathering the data. With Microsoft Excel and Word as mediums of sorting the data, the researchers then proceeded on assigning numerical values to the encoded words, in order to start the treatment of data.

2.3 Data Analysis and Evaluation

The data was assembled, categorized, arranged, and tabulated as soon as the researchers gathered it. In order to answer the study's questions, they were subjected to statistical treatment.

The following statistical tools were employed in the study:

- Frequency Distribution and Percentage. Frequency distribution was used to obtain the characteristics of road traffic accidents in terms of driver factor, environmental factor, vehicle factor, road factor, and collision type. Frequency Distribution is an ordered representation of the number of items in each group. It displayed the observations of probabilities separated between the standard deviations (Young, by 2020). As defined by Zulueta and Costales (2004) frequency count referred to the number of observations and occurrences of a variable while percentage technique (Likert, 1995) was used to measure and show the relation of a certain portion of data to the entire data. Things were categorized using a certain scheme, and an arithmetic count of the number of items inside the text that belonged to each classification (or type) in the scheme was performed. Percentage was the amount obtained by multiplying a number in percent. The formula used was:
- Spearman Rho. Spearman Rho correlation was used to determine the relationship between the road factors under study and the collision type in road traffic accidents. The said statistical treatment was used in this study with the same intent so as to specify the correlational relationship of the quantitative variables present in this investigation.
- Multinomial Logistic Regression. Multinomial logistic regression was used to predict categorical placement or the probability of category membership on a dependent variable based on multiple independent variables. The independent variables could be either dichotomous (i.e., binary) or continuous (i.e., interval or ratio in scale). Multinomial logistic regression was a simple extension of binary logistic regression that allowed for more than two categories of the dependent or outcome variable (Starkweather & Moske, 2002). In the analysis, the dependent variables were all factors considered in the road traffic accidents, while the independent variable was the collision type.

III. RESULTS AND DISCUSSION

This chapter comprises of the data analysis, results, and discussion of the findings. Furthermore, the results of the study are based on the problem statements and research objectives focusing on the traffic accidents in MacArthur Highway, Barangay Sampaloc, Apalit, Pampanga from year 2018-2022.

3.1 Road Traffic Accidents per Year

Table 1. Number of Accidents in Sampaloc, Apalit, Pampanga Per Year

Year	Frequency	Percent
2018	20	25.6
2019	13	16.7
2020	21	26.9
2021	10	12.8
2022	14	17.9
Total	78	100.0

Table 1 presents the distribution of number of accidents per year from 2018-2022. The data shows that out of the total 78 drivers surveyed, 25.6% (20) have been in the accident in the year 2018, 16.7% (13) have been in the accident in the year 2019, 26.9% (21) have been in the accident in the year 2020, 12.8% (10) have been in the accident in the year 2021, and 17.9% (14) have been in the accident in the year 2022.

3.1.1 Driver Factor

3.1.1.1 Age

Table 2. Driver Factor in Terms of Age Group

Age Group	Frequency	Percent
16-28	18	23.1
29-41	22	28.2
42-54	26	33.3
55-67	10	12.8
68 and above	2	2.6
Total	78	100.0

Table 2 presents the distribution of driver factor in terms of age group. The data shows that out of the total 78 drivers surveyed, 23.1% (18) were in the age group of 16-28, 28.2% (22) were in the age group of 29-41, 33.3% (26) were in the age group of 42-54, 12.8% (10) were in the age group of 55-67, and only 2.6% (2) were in the age group of 68 and above.

3.1.1.2 Sex

Table 3. Driver Factor in Terms of Sex

Sex Group	Frequency	Percent
Male	75	96.2
Female	3	3.8
Total	78	100.0

Table 3 shows the distribution of the driver factor based on sex. Of the total 78 drivers surveyed, 75 (96.2%) were male, and only 3 (3.8%) were female.

3.1.1.3 Psychological Condition

3.1.1.3.1 Drug Used

Table 4. Psychological Condition of Driver in Terms of Drug Used

Drug Used	Frequency	Percent
No	77	98.7
Yes	1	1.3
Total	78	100.0

Table 4 shows the psychological condition of drivers in terms of drug use. Out of 78 drivers, 77 drivers reported that they did not use drugs, while only one driver reported using drugs. This means that 98.7% of the drivers did not use drugs, while only 1.3% of the drivers reported using drugs.

3.1.1.3.2 Alcohol Used

Table 5. Psychological Condition of Driver in Terms of Alcohol Used

Alcohol Used	Frequency	Percent
No	74	94.9
Yes	4	5.1
Total	78	100.0

Table 5 presents the psychological condition of drivers in terms of alcohol usage. The table shows the frequency and percentage of drivers who have used alcohol and those who have not. Out of the 78 drivers surveyed, 74 (94.9%) did not use alcohol, while 4 (5.1%) reported using alcohol.

3.1.2 Environmental Factor

3.1.2.1 Weather Condition

Table 6. Weather Condition

Weather Condition	Frequency	Percent
Partly Sunny	11	14.1
Scattered Clouds	17	21.8
Passing Clouds	27	34.6
Mostly Cloudy	1	1.3
Partly Cloudy	5	6.4
Light Rain/Mostly Cloudy	1	1.3
Light Rain/Overcast	3	3.8

Light Rain	1	1.3
Broken Clouds	9	11.5
Thunderstorm	1	1.3
Scattered Shower	2	2.6
Total	78	100.0

Table 6 shows the frequency and percentage of different weather conditions during the time of the accident. The most common weather condition was passing clouds (34.6%), followed by scattered clouds (21.8%), and broken clouds (11.5%). Partly sunny (14.1%), partly cloudy (6.4%), and light rain/overcast (3.8%) were also observed, as well as a few instances of mostly cloudy, light rain/mostly cloudy, light rain, scattered shower, and thunderstorm.

3.1.2.2 Temperature

Table 7. Temperature

Temperature in Celsius	Frequency	Percent
21.00	2	2.6
22.00	1	1.3
23.00	2	2.6
24.00	11	14.1
25.00	18	23.1
26.00	11	14.1
27.00	10	12.8
28.00	9	11.5
29.00	10	12.8
30.00	3	3.8
31.00	1	1.3
Total	78	100.0

Table 7 shows the frequency and percentage of temperature in Celsius in the dataset. The temperature ranges from 21.00 to 31.00 degrees Celsius. The most common temperatures are 25.00 degrees Celsius with a frequency of 18 and a percent of 23.1%, followed by 24.00 degrees Celsius with a frequency of 11 and a percent of 14.1%. The least common temperature is 31.00 degrees Celsius with a frequency of 1 and a percent of 1.3%

3.1.2.3 Time of the Day

Table 8. Time of the Day

Time of the Day	Frequency	Percent
Morning	32	41.0
Afternoon	15	19.2
Evening	15	19.2
Night	16	20.5
Total	78	100.0

Table 8 shows the frequency and percentage of the time of the day during which the driving accidents occurred. The majority of accidents occurred in the morning, with a frequency of 32 (41.0%), followed by 16 accidents (20.5%) occurring at night. There were 15 accidents (19.2%) each that occurred in the afternoon and evening.

3.1.3 Vehicle Factor

3.1.3.1 Vehicle Type

Table 9. Vehicle Type

Vehicle Type	Frequency	Percent
Two-wheels	24	30.8
Three-wheels	9	11.5
Four-wheels	30	38.5
More than four wheels	15	19.2
Total	78	100.0

Table 9 shows the frequency and percentage of different types of vehicles involved in the accidents. Out of the total of 78 vehicles, 30.8% were two-wheeled vehicles, 11.5% were three-wheeled vehicles, 38.5% were four-wheeled vehicles, and 19.2% were vehicles with more than four wheels.

3.1.4 Road Factor

3.1.4.1 Road Lane Width

Table 10. Road Lane Width

Road Lane Width	Frequency	Percent
3.45	4	5.1
3.50	74	94.9
Total	78	100.0

Based on Table 10, the road lane width for the dataset is either 3.45 meters or 3.50 meters. The majority of the data, 74 out of 78 cases (94.9%), has a road lane width of 3.50 meters. Only 4 cases (5.1%) have a road lane width of 3.45 meters.

3.1.4.2 Road Elevation

Table 11. Road Elevation

Road Elevation	Frequency	Percent
-.03	21	26.9
.01	17	21.8
.03	40	51.3
Total	78	100.0

Table 11 shows the frequency and percentage of road elevation in the dataset. The road elevation is categorized into three levels: -.03, .01, and .03. Out of the 78 data points, 21 (26.9%) have a road elevation of -.03, 17 (21.8%) have a road elevation of .01, and 40 (51.3%) have a road elevation of .03.

3.1.4.3 Road Condition

Table 12. Road Condition

Road Condition	Frequency	Percent
Bad	4	5.1
Fair	49	62.8
Good	25	32.1
Total	78	100.0

Table 12 shows the frequency and percentage distribution of road condition in the study. A total of 78 drivers were included in the analysis. Among them, 4 drivers (5.1%) encountered bad road conditions, 49 drivers (62.8%) experienced fair road conditions, and 25 drivers (32.1%) had good road conditions.

3.1.5 Collision Type

Table 13. Collision Type

Collision Type	Frequency	Percent
Angular Collision	2	2.6
Head-On Collision	7	9.0
Multivehicle Collision	4	5.1
Rear-End Collision	25	32.1
Sideswipe-OppositeDirection	6	7.7
Sideswipe-Same-Direction	24	30.8
Single-Vehicle Collision	10	12.8
Total	78	100.0

Table 13 shows the frequency and percentage distribution of the collision types involved in the accidents. The most frequent type of collision is the Rear-End Collision with 25 cases, accounting for 32.1% of all accidents. The second most common type is the Sideswipe-SameDirection Collision, with 24 cases or 30.8% of all accidents. The least common collision type is Angular Collision with only 2 cases, representing 2.6% of all accidents. The Head-On Collision and Multivehicle Collision are also relatively uncommon, with 7 cases (9.0%) and 4 cases (5.1%), respectively. Overall, the results suggest that Rear-End Collision and Sideswipe-Same-Direction Collision are the most prevalent types of collisions in the dataset, while Angular Collision is the least common.

2.2.1 Spearman Rho Correlation

Table 14. Spearman Rho Correlation among the Factors and Collision Types in MacArthur Highway

Variables			Collision Type
Spearman's rho	Driver Age	Correlation Coefficient	-0.104
		Sig. (2-tailed)	0.365
		N	78
	Sex	Correlation Coefficient	-0.077
		Sig. (2-tailed)	0.505

		N	78
	Drug Used	Correlation Coefficient	-0.071
		Sig. (2-tailed)	0.539
		N	78
	Alcohol Used	Correlation Coefficient	-0.071
		Sig. (2-tailed)	0.538
		N	78
	Weather Condition	Correlation Coefficient	0.044
		Sig. (2-tailed)	0.700
		N	78
	Temperature (Celsius)	Correlation Coefficient	0.186
		Sig. (2-tailed)	0.103
		N	78
	Time of the Day	Correlation Coefficient	0.091
		Sig. (2-tailed)	0.427
		N	78
	Vehicle Type	Correlation Coefficient	-0.034
		Sig. (2-tailed)	0.768
		N	78
	Road Lane Width	Correlation Coefficient	0.083
		Sig. (2-tailed)	0.471
		N	78
	Road Elevation	Correlation Coefficient	-0.034
		Sig. (2-tailed)	0.765
		N	78
	Road Condition	Correlation Coefficient	0.081
		Sig. (2-tailed)	0.480
		N	78
	Collision Type	Correlation Coefficient	1.000
		Sig. (2-tailed)	
		N	78
*. Correlation is significant at the 0.05 level (2-tailed).			
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 14 shows the Spearman's rho correlation coefficients among the different factors and collision types in MacArthur Highway. The table presents the correlation coefficients, the corresponding p-values (two-tailed), and the sample size (N) for each variable.

The results show that there are no significant correlations between any of the factors (driver age, sex, drug used, alcohol used, weather condition, vehicle type, road lane width, road elevation, and road condition) and collision type. All correlation coefficients have p-values greater than 0.05, indicating that the correlations are not statistically significant at the 0.05 level.

However, it is important to note that there is a positive correlation (r = 0.186) between temperature (in Celsius) and collision type. Although this correlation is not statistically significant at the 0.05 level (p = 0.103), it suggests that higher temperatures may be associated with a higher incidence of collisions on MacArthur Highway. Overall, the results suggest that the factors examined in this study may not be strong predictors of collision type on MacArthur Highway.

3.2.2 Multinomial Logistic Regression

3.2.2.1 Model Fitting Information

Table 15. Model Fitting Information for Road Accidents and its Factors in MacArthur Highway

Model Fitting Information				
Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	257.498			
Final	157.869	99.629	66	0.005

Table 15 shows the model fitting information for road accidents and its factors in MacArthur Highway. The two models presented are the "Intercept Only" model and the "Final" model. The "Intercept Only" model serves as a baseline model, where only the intercept is included in the model. This model has an -2 log likelihood value of 257.498. The "Final" model includes all the factors that were studied in the previous tables. This model has an -2 log likelihood value of 157.869, which is significantly lower than the "Intercept Only" model. The likelihood ratio test shows a chi-square value of 99.629 with 66 degrees of freedom and a significance level of 0.005. This indicates that the "Final" model is a better fit for the data compared to the "Intercept Only" model.

3.2.2.2 Pseudo R-Square

Table 16. Pseudo R-Square for Road Accidents and its Factors in MacArthur Highway

Pseudo R-Square	
Cox and Snell	0.721
Nagelkerke	0.749
McFadden	0.387

Table 16 shows the pseudo R-squared values for the Final model. The Cox and Snell value is 0.721, the Nagelkerke value is 0.749, and the McFadden value is 0.387. These values indicate that the Final model explains a substantial amount of the variance in the data, with the Nagelkerke value suggesting the best fit.

3.2.2.3 Likelihood Ratio Tests

Table 17. Likelihood Ratio Tests for Road Accidents and its Factors in MacArthur Highway

Likelihood Ratio Tests				
Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	179.053[a]	21.184	6	0.002
Driver Age	186.548	28.679	6	0.000
Sex	178.966	21.097	6	0.002
Drug Used	158.978	1.109	6	0.981
Alcohol Used	170.603	12.734	6	0.047
Weather Condition	167.705	9.836	6	0.132
Temperature (Celsius)	173.484	15.615	6	0.016
Time of the Day	173.359	15.490	6	0.017
Vehicle Type	184.361	26.492	6	0.000

Road Lane Width	175.340	17.471	6	0.008
Road Elevation	161.996	4.127	6	0.659
Road Condition	165.710	7.841	6	0.250
The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.				
a. The log-likelihood value cannot be further increased after maximum number of step-halving.				

Table 17 presents the results of the likelihood ratio tests for the effects of various factors on road accidents in MacArthur Highway. The table shows the -2 log likelihood of the reduced model (which omits one factor at a time) compared to the final model (which includes all factors), as well as the chi-square statistic, degrees of freedom (df), and significance level for each effect.

The null hypothesis for each test is that all parameters of the effect are equal to zero, which means that the effect has no significant impact on the likelihood of a road accident. The alternative hypothesis is that at least one parameter of the effect is non-zero, indicating that the effect does have a significant impact on the likelihood of a road accident.

The results show that all effects except for "Drug Used," "Weather Condition," "Road Elevation," and "Road Condition" have a significant impact on the likelihood of a road accident, as indicated by their significant chi-square values ($p < 0.05$). Specifically, the effects of "Driver

Age," "Sex," "Alcohol Used," "Temperature (Celsius)," "Time of the Day," "Vehicle Type," and "Road Lane Width" are all significant predictors of road accidents.

3.2.2.3 Parameter Estimates

Table 18. Parameter Estimates for Road Accidents and Factors in MacArthur Highway

				Parameter Estimates					
Collision Type[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Angular Collision	Intercept	-469.177	108.963	18.54 0	1	0.00 0			
	Driver Age	0.071	0.080	0.804	1	0.37 0	1.074	0.919	1.255
	Sex	2.090	62.029	0.001	1	0.97 3	8.088	1.285E-52	5.09E+53
	Drug Used	6.292	96.215	0.004	1	0.94 8	540.461	6.826E-80	4.28E+84
	Alcohol Used	-5.754	37.434	0.024	1	0.87 8	0.003	4.334E-35	2.32E+29
	Weather Condition	-0.341	0.479	0.505	1	0.47 7	0.711	0.278	1.820
	Temperatur e (Celsius)	-0.576	0.649	0.787	1	0.37 5	0.562	0.157	2.007
	Time of the Day	0.097	0.752	0.017	1	0.89 7	1.102	0.252	4.813

	Vehicle Type	-0.460	0.888	0.268	1	0.60 5	0.631	0.111	3.600
	Road Lane Width	137.450	0.000		1		4.94E+59	4.94E+59	4.94E+59
	Road Elevation	5.851	43.384	0.018	1	0.89 3	347.538	4.093E-35	2.95E+39
	Road Condition	-0.994	1.867	0.284	1	0.59 4	0.370	0.010	14.372
Head-On Collision	Intercept	165.452	175.377	0.890	1	0.34 5			
	Driver Age	0.145	0.061	5.587	1	0.01 8	1.156	1.025	1.303
	Sex	3.415	42.422	0.006	1	0.93 6	30.423	2.363E-35	3.92E+37
	Drug Used	0.350	56.431	0.000	1	0.99 5	1.419	1.312E-48	1.54E+48
	Alcohol Used	-0.507	3.004	0.028	1	0.86 6	0.602	0.002	217.246
	Weather Condition	-0.349	0.289	1.454	1	0.22 8	0.706	0.400	1.244
	Temperatur e (Celsius)	-0.398	0.435	0.841	1	0.35 9	0.671	0.286	1.573
	Time of the Day	-0.229	0.653	0.124	1	0.72 5	0.795	0.221	2.857
	Vehicle Type	-0.968	0.708	1.868	1	0.17 2	0.380	0.095	1.522
	Road Lane Width	-46.928	44.769	1.099	1	0.29 5	4.162E-21	3.251E-59	5.33E+17
	Road Elevation	7.380	32.840	0.051	1	0.82 2	1603.906	1.784E-25	1.44E+31
	Road Condition	1.110	1.652	0.452	1	0.50 2	3.036	0.119	77.412
Multivehicl e Collision	Intercept	-661.637	3964.31 3	0.028	1	0.86 7			
	Driver Age	-0.067	0.090	0.564	1	0.45 3	0.935	0.784	1.115
	Sex	-3.221	39.834	0.007	1	0.93 6	0.040	4.947E-36	3.22E+32
	Drug Used	13.388	70.335	0.036	1	0.84 9	652051.383	8.805E-55	4.83E+65
	Alcohol Used	-0.765	18.405	0.002	1	0.96 7	0.465	1.002E-16	2.16E+15
	Weather Condition	-1.167	1.103	1.118	1	0.29 0	0.311	0.036	2.708
	Temperatur e (Celsius)	0.953	0.713	1.789	1	0.18 1	2.595	0.642	10.492
	Time of the Day	0.086	1.263	0.005	1	0.94 5	1.090	0.092	12.966

	Vehicle Type	0.080	1.070	0.006	1	0.94 0	1.084	0.133	8.827
	Road Lane Width	182.100	1132.34 6	0.026	1	0.87 2	1.22E+79	0.000	.[b]

	Road Elevation	18.304	35.759	0.262	1	0.609	89013816.718	3.244E-23	2.44E+38
	Road Condition	-3.466	2.020	2.944	1	0.086	0.031	0.001	1.638
Rear-End Collision	Intercept	-497.602	2834.354	0.031	1	0.861			
	Driver Age	0.012	0.045	0.069	1	0.793	1.012	0.927	1.105
	Sex	7.497	27.108	0.076	1	0.782	1801.766	1.518E-20	2.14E+26
	Drug Used	7.126	36.239	0.039	1	0.844	1243.820	1.772E-28	8.73E+33
	Alcohol Used	-0.552	1.768	0.098	1	0.755	0.576	0.018	18.419
	Weather Condition	0.120	0.189	0.403	1	0.525	1.128	0.778	1.633
	Temperature (Celsius)	-0.302	0.259	1.358	1	0.244	0.739	0.445	1.229
	Time of the Day	0.019	0.388	0.002	1	0.961	1.019	0.476	2.180
	Vehicle Type	0.073	0.502	0.021	1	0.885	1.075	0.402	2.875
	Road Lane Width	141.057	809.689	0.030	1	0.862	1.82E+61	0.000	.[b]
	Road Elevation	-23.474	19.479	1.452	1	0.228	6.388E-11	1.679E-27	2431094.627
	Road Condition	-1.060	0.910	1.356	1	0.244	0.346	0.058	2.063
Sideswipe-OppositeDirection	Intercept	696.571	373.324	3.481	1	0.062			
	Driver Age	0.086	0.071	1.467	1	0.226	1.090	0.948	1.252
	Sex	17.794	27.745	0.411	1	0.521	53410464.654	1.290E-16	2.21E+31
	Drug Used	16.882	64.164	0.069	1	0.792	21466143.932	5.194E-48	8.87E+61
	Alcohol Used	-20.109	25.161	0.639	1	0.424	1.847E-09	7.068E-31	4828463896274.270
	Weather Condition	0.286	0.339	0.711	1	0.399	1.331	0.685	2.586

	Temperature (Celsius)	-0.309	0.567	0.297	1	0.586	0.734	0.242	2.231
	Time of the Day	3.193	1.587	4.045	1	0.044	24.352	1.085	546.756
	Vehicle Type	-2.817	1.280	4.843	1	0.028	0.060	0.005	0.735
	Road Lane Width	-204.655	105.476	3.765	1	0.052	1.317E-89	2.18E-179	7.964
	Road Elevation	-40.144	46.887	0.733	1	0.392	3.679E-18	4.527E-58	2.99E+22
	Road Condition	1.338	1.851	0.522	1	0.470	3.810	0.101	143.360
	Intercept	-590.174	2823.210	0.044	1	0.834			
Sideswipe-Same-Direction	Driver Age	0.067	0.045	2.215	1	0.137	1.069	0.979	1.167
	Sex	-0.252	31.647	0.000	1	0.994	0.777	8.960E-28	6.74E+26
	Drug Used	4.639	44.619	0.011	1	0.917	103.394	1.084E-36	9.86E+39
	Alcohol Used	-5.001	11.725	0.182	1	0.670	0.007	7.044E-13	64319921.107
	Weather Condition	0.007	0.184	0.002	1	0.969	1.007	0.702	1.445
	Temperature (Celsius)	0.323	0.262	1.527	1	0.217	1.382	0.827	2.307
	Time of the Day	-0.173	0.420	0.170	1	0.680	0.841	0.369	1.916
	Vehicle Type	-1.133	0.505	5.039	1	0.025	0.322	0.120	0.866
	Road Lane Width	167.426	806.469	0.043	1	0.836	5.15E+72	0.000	.[b]
	Road Elevation	-5.902	18.875	0.098	1	0.755	0.003	2.348E-19	3.19E+13
	Road Condition	-0.871	0.924	0.887	1	0.346	0.419	0.068	2.563

a. The reference category is: Single-Vehicle Collision.

b. Floating point overflow occurred while computing this statistic. Its value is therefore set to system mis sing.

Table 18 presents the parameter estimates for road accidents and their factors in MacArthur Highway. The table shows the estimated regression coefficients (B) for each independent variable, as well as their standard error, Wald statistic, degrees of freedom, significance level (Sig.), and corresponding odds ratios (Exp(B)) and confidence intervals (CI).

For the Angular Collision type, driver age, sex, drug used, alcohol used, weather conditions, temperature, time of day, vehicle type, road elevation, and road condition are not statistically significant to the number of expected number of accidents. Only the road lane width shows significance to the number of accidents per year.

For the Head-On Collision type, driver age, drug used, and road lane width shows significance when it comes to the increase number of accidents per year. While sex, alcohol used, weather condition, temperature, time of day, vehicle type, road elevation, and road condition show no significance.

For the multivehicle collision model, only road condition shows significance when it comes to the number of accidents recorded per year. While driver age, sex, drug used, alcohol used, weather condition, temperature, time of day, vehicle type, road lane width, and road elevation show no significance.

For the Rear-End Collision type, the logistic regression model does not find any significant predictors that are associated with this type.

For Sideswipe-Opposite-Direction Collision type, driver age, sex, drug used, alcohol used, weather condition, temperature, road lane width, road condition, and road elevation show no significance when it comes to prediction of number of collisions. Only the time of the day and vehicle type shows significance.

For the Sideswipe-Same-Direction collision model, only the vehicle type among all the collision types show significance when it comes to the number of collisions.

CONCLUSION

The paper concluded that driver demographics, weather conditions, and road infrastructure were the most common factor why many people have been in a road traffic accident. With this, improved driver education and awareness campaign should be imposed and practiced mostly with male drivers ages 29-54. To prevent such accidents, real-time monitoring and driver education on adjusting behavior based on time of day could also be effective. Overall, the study provides valuable insights that can inform the development of effective measures to prevent road traffic accidents on MacArthur Highway.

In line with this, the study found that various factors, such as driver age, sex, drug and alcohol use, weather conditions, vehicle type, road lane width, elevation, and condition, do not have a significant correlation with collision type, except for temperature, which showed a positive correlation with collision type. Furthermore, driver age poses a significant factor in head-on collisions. Time of the day and vehicle type are significant factors that affect sideswipe-opposite direction. Lastly, vehicle type affects sideswipe-same-direction.

To sum it up, the study sheds light on various factors that contribute to road traffic accidents, including driver age, vehicle type, time of day, and road infrastructure. The findings suggest that engineering strategies can play a crucial role in reducing the likelihood of accidents caused by these factors. Specifically, targeted education campaigns, driver education programs, and vehicle design modifications can help address the issues identified in this study. Additionally, implementing sobriety checkpoints, improving road visibility, and providing real-time updates on weather and road conditions can further reduce the risk of accidents caused by alcohol-impaired driving and extreme weather conditions. It is essential to continue researching and identifying other contributing factors to road accidents to develop comprehensive strategies to ensure safe and secure roadways for everyone. By taking a multi-faceted approach and implementing engineering strategies, we can work towards preventing road traffic accidents and ensuring the safety of all road users.

4.1 recommendation

The following recommendations are enlisted to assist future researchers who will choose a related study or aim to improve the existing one.

- It may be useful for local authorities to conduct further research to identify any other factors that may contribute to accidents, such as driver fatigue or distracted driving.

- Regular road safety audits could also be carried out to identify and address any potential hazards on the road.
- It is recommended that measures be put in place to address the significant factors identified as predictors of road accidents. Specifically, policies and interventions should be implemented to reduce the number of road accidents caused by factors such as driver's age, sex, alcohol use, time of the day, vehicle type, and road lane width. Additionally, temperature should be taken into consideration when designing road safety interventions.
- Particular attention should be paid to driver age. Strategies that aim to reduce the number of young and inexperienced drivers on the road should be prioritized. Moreover, reducing the number of vehicles on the road during peak hours and ensuring that vehicles are appropriately designed and maintained. Interventions should focus on the design and maintenance of vehicles.
- It is recommended that targeted education campaigns should be developed and implemented to increase awareness among younger drivers about safe driving practices and the importance of adhering to traffic rules and regulations.
- There are vehicle design modifications can be made to address the risk factors identified in this study, such as increasing the height to width ratio of vehicles to reduce the likelihood of sideswipe accidents in the same direction.
- The road infrastructure should be designed to accommodate a variety of vehicle types and ensure adequate lane width for safe travel. This can be achieved through the development of engineering strategies that prioritize road safety, such as improving road visibility through the use of street lighting, reflective road markings, and warning signs.
- There should be checkpoints and public transportation options should be implemented to reduce the likelihood of accidents caused by alcohol-impaired driving.
- Technological advancements, such as systems that monitor and provide real-time updates on temperature and road conditions to drivers, can also be developed to reduce the risk of accidents during extreme weather conditions.

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