

CAUSATIVE FACTORS TO THE UNAUTHORIZED VEHICLE FATAL ACCIDENTS IN DHAKA METROPOLITAN CITY

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ABSTRACT

Over the last decade, the transport infrastructure in Bangladesh has witnessed a revolutionary expansion of unauthorized vehicles throughout the whole country. However, in the absence of government intervention, these unregistered vehicles primarily consisted of battery-run three-wheelers circulating in most cities of the country, and Nosimon, Korimon, Motor van driving, especially in rural highways, are causing a nuisance for permitted vehicles on roads and highways. Structural defects that make them less stable than other permitted motorized vehicles and unskilled drivers that use them have made them increasingly prone to accidents. These unauthorized vehicles are named Alamshadhu, Auto Borak, Auto Salo, Auto van, Borak, Chader Gari, Easy Bike, Human Hola, Kakra, Korimon, Latahumbre, Meshuk, Mesi, Natagari, Nosimon, Pakhi Van, Pakundia, Thelagari, Tomtom, Votvoti. From 2016 to 2020, these unauthorized vehicles were responsible for 10.66% of all accidents in the Dhaka Metropolitan (DMP) area, with 73.8% being fatal. Even if the victims escape death by chance, the long-term consequences include physical disfigurement, disability, and financial ruin. The purpose of this paper is to examine the risk and accident patterns associated with the circulation of vehicles that are not government-listed, and our research area comprises the DMP entailed Thanas that had more than three fatal accidents in the year between 2016 to 2020. In this study, the police-recorded accident database stored at the Accident Research Institute (ARI) of Bangladesh University of Engineering and Technology (BUET) using MAAP5 (Micro-computer Accident Analysis Package) was investigated from 2016 to 2020 for DMP area, and study area consisting of 11 Thanas was identified and analyzed accordingly. Here, ArcGIS was adopted to get a detailed overview of the variation of fatal accident patterns for the study area using data from the aforementioned source. For in-depth accident analysis, data gathered was analyzed using several statistical tools, and the findings were summarized in either tabular or pictorial forms for everybody to comprehend. The study also revealed trends of fatal crashes and fatalities, root causes of fatal crashes, severity by road users, and several characteristics of fatal accidents. The findings will contribute to a better understanding of the transportation sector's dreadful situation and motivate policymakers to implement effective strategies and countermeasures to reduce road accidents caused by unauthorized vehicles.

Keywords: *Road Accident, Transportation Safety, Traffic Risk, Accident Analysis, ArcGIS*

1. RESEARCH BACKGROUND

1.1 Introduction

Road accident – the biggest misfortune in People's life has become a pretty normalized term for the people of Bangladesh lately. Over the last decade, unauthorized vehicles evolved notably on the country's roads, adding fuel to the fire in road accident scenarios. Unauthorized vehicle refers to any vehicle or trailer, except for those exempt from registration under country law, that does not have current registration plates, or that has fictitious registration plates attached to it, or that is otherwise

not registered under country regulations. In Bangladesh, these unauthorized vehicles include Alamshadhu, Auto Borak, Auto Salo, Auto Van, Borak, Chader Gari, Easy Bike, Human Hola, Kakra, Korimon, Latahumbre, Meshuk, Mesi, Natagari, Nosimon, Pakhi Van, Pakundia, Thelagari, Tomtom, Votvoti. Unfortunately, the number of these vehicles has steadily increased over the years, oblivious to the potential for accidents. The lack of adequate and convenient public transportation also contributes to the demand. These vehicles facilitate the transportation of many passengers over a short distance, making travel more affordable than many other modes of transportation and allowing numerous drivers to make a living. Nonetheless, the hazards associated with these vehicles far outweigh their benefits and must not be underestimated. Several studies were conducted upholding these vehicles' sustainability and popularity in our country, however, no analytical study regarding accident patterns or causative factors to accidents was carried out by far. From 2016 to 2020, only unauthorized vehicles caused 10.66% of all accidents in the Dhaka Metropolitan Police (DMP) area, and 73.8% of these accidents were found to be fatal, indicating fatal accidents to be the most frequent type for these unauthorized vehicles. Noting this fact, in our study, we identified 11 Thanas (police stations) in the Dhaka Metropolitan Police (DMP) area, which had more than three fatal accidents caused by unauthorized vehicles in the five consecutive years of 2016 to 2020. About 77.1% of accidents were fatal of all the accidents caused by unauthorized vehicles reported in these 11 Thanas, and the fatality rate was 84.2% in terms of all casualties. Our research questions are:

- How do the characteristics of these fatal accidents vary for the selected 11 Thanas?
- What are the factors that are affecting these fatal accidents?

1.2 Literature Review

Many studies have been carried out assessing accident patterns and factors in different countries as traffic accidents have become common scenarios worldwide. The most popular source for collecting accident records in Bangladesh is the police recorded accident database stored at Accident Research Institute (ARI), BUET. A review was done on the accident reporting and recording system of Bangladesh (Ahsan et al., 2011). The paper also identified the variables involved in accidents and reviewed error sources in data collection. Around 61% of road accidents occur in the national and regional highways of Bangladesh, resulting in a 66% fatality rate of total accidents (Hoque et al., 2020). The analysis of the study showed that informal vehicles like Nosimon, Korimon, etc., involves 9% of all accidents on the highway (Hoque et al., 2020). It was shown in an article that three-wheelers could obtain speeds up to 70 mph, and some unfortunate accidents caused by these vehicles were highlighted (Cogbill et al., 1985). A paper was published assessing the different patterns of injuries by three-wheeler users and compared the result with other vehicles (Vadysinghe et al., 2018). Study samples were the users of three-wheelers who were reported to be undergone three medico-legal units in Sri Lanka. The study found most cases of accidents to be fatal for three-wheelers, fatal head injury (78.8%) being the most common. A study was carried out to show patterns of injuries and causative factors of three-wheeler accidents in Colombo (Silva et al., 2000). A paper was established to evaluate the structural crashworthiness of a three-wheeler passenger auto-rickshaw in India (Prakash, 2009). They considered two cases- frontal impact collision and rear impact collision and showed the results consecutively. A paper was published regarding three-wheelers in east Alabama (Haynes et al., 1986). In the study, accidents associated with three-wheelers were reviewed and analyzed. Through the study, they concluded that three-wheelers are unstable and difficult to control.

Despite being unstable, one of the few positive things about three-wheelers is that they are run by batteries and can introduce the concept of electric batteries. Many countries are now implementing government-level policies to eliminate personal vehicles with increased shared mobility, such as metros and BRT systems. Three-wheeler can also serve 'the last-mile connectivity' concept. A study showed techno-commercial aspects of retrofitted three-wheelers and the way to introduce economically viable hybrid three-wheelers in India (Uttekar et al., 2021). Easy bikes are quite popular among the people of Bangladesh for their comforting vibe while riding. The supply chain and popularity of battery-based electric charged vehicles were evaluated through a questionnaire survey selecting three different stakeholders-passengers, drivers, importers, or assemblers of the easy bike (Hossain & Hossain, 2019). The contribution of the easy bike towards sustainability was evaluated by

identifying its route, network, coverage (Anjum, 2018). In this paper, some recommendations were also given for the proper management of easy bikes. The fact that data showed that small electric passenger vehicles contributed immensely to reducing the carbon footprint of transport in the small city of Cox's Bazar, Bangladesh, was highlighted in a paper (Hossein, 2020). It also evaluated the case to build urban transport strategy and policy around such vehicles. The gaps of e-rickshaw sustainability issues and policies were addressed, and stakeholder theory (ST) and resource dependency theory (RDT) were accumulated (Khan & Quaddus, 2020). The paper applied fuzzy quality function development (QFD) accumulated with 0-1 non-linear optimization technique.

As traffic safety has become a significant issue in Dhaka city, Bangladesh, much research has been carried out assessing traffic safety and risks. Different characteristics of road traffic accidents were examined in Dhaka Metropolitan Area from 2007 to 2011 (Ishtiaque & Ahmed, 2013). They also established a GIS database showing accident locations and details.

A study was carried out showing the prevalence, reasons, and patterns of motorcycle accidents and casualties in the Dhaka Metropolitan city area from 2000 to 2014 (Akter & Pervaz, 2019). They also represented accident scenarios for different Thanas using GIS tools. A study identified common vehicular defects and their impact on road accidents on Jamuna Multi-purpose Bridge (JMB) approach roads, and possible remedies were discussed (Hoque & Hasan, 2006). The actual number, causes, and types of accidents in Dhaka city were evaluated from 2016 to 2020 (Siraj et al., 2021). The characteristics of road traffic accidents of Dhaka city were determined from 2007 to 2011 based on several accident parameters (Ahmed et al., 2014). A report developed a road accident-related database using GIS for 2007-2011 in Dhaka city ("TRAFFIC ACCIDENT STUDY IN DHAKA CITY", 2012). This study also discussed the road safety situation, addressing contemporary issues and priorities. Road accident cost was estimated for 2020 (Ahsan et al., 2021). The estimation was performed by the Human Capital method and a questionnaire survey was conducted to carry out vehicle damage cost and administrative cost. The research was conducted to identify roadway, traffic, and environmental influencing factors of injury severity of accidents in Dhaka city from 2007 to 2011 by establishing an ordered probit model (Kamruzzaman et al., 2014).

As pedestrians are the most vulnerable road users, many studies have been carried out in Dhaka city addressing the safety and risks of pedestrians. A study was conducted to find out the possible reasons behind the death of pedestrians in Dhaka city, analyzing the data from 1998 to 2014, and solutions were proposed for the safety improvement of the people (Bhuiyan & Islam, 2018). An assessment was made of the crash risk associated with various pedestrian groups using a two-stage, multi-criteria decision-making approach in Dhaka (Zafri et al., 2020). The study also revealed pedestrian road crossing behaviors at intersections in Dhaka, Bangladesh. Environmental, road, and vehicular factors to influence pedestrian-single-vehicle crash severity were identified in Dhaka (Zafri et al., 2020). In this paper, a binary logistic regression model was developed using a dataset of pedestrian-single-vehicle crashes involving casualties from 2010 to 2015. A qualitative evaluation of the comfort level of pedestrians was done in terms of six broad categories (Rahaman et al., 2005). Data were collected through an observation survey and questionnaire survey from the pedestrians in Dhaka city.

2. DATA COLLECTION AND METHODOLOGY

This study aimed to analyze the characteristics and contributing factors of accidents for Dhaka Metropolitan Police (DMP) stations which had more than three fatal accidents for the consecutive years of 2016 to 2020 caused by unauthorized vehicles. Out of 50 Thanas in DMP, 11 Thanas were identified to fulfill the abovementioned criteria. The area of research included the Thanas named Adabor, Dakshin Khan, Hatirjheel, Khilkhet, Kotwali, Mugdha, Ramna Model, Rampura, Sher E Bangla Nagar, Tejgaon Industrial, and Uttara West.

To conduct the research, secondary data of accidents were collected from police recorded accident database stored at the Accident Research Institute (ARI) of Bangladesh University of Engineering and

Technology (BUET) using MAAP (Micro-computer Accident Analysis Package) (Figure 1) and was investigated for 2016 to 2020 for the mentioned research area. The whole of Thana's accident characteristics were assumed to be the same for the station under it.

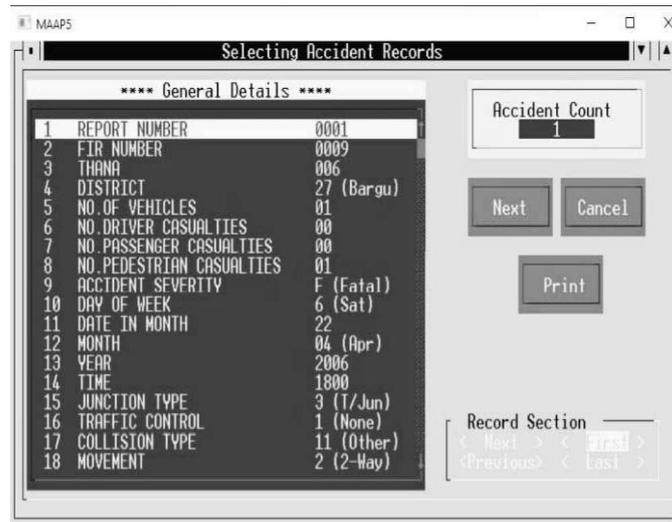


Figure 1: Overview of Accident Database

For in-depth accident analysis, accident data collected from the aforementioned source is analyzed using Microsoft Excel, and the results are represented in pictorial forms with the best possible unambiguity. Then the data is analyzed using ArcGIS to get an overview of their variation pattern. The study period included five consecutive years of 2016 to 2020. Here, it is to be noted that the analysis results for the year 2020 have a pandemic impact. The research methodology is shown in Figure 2.

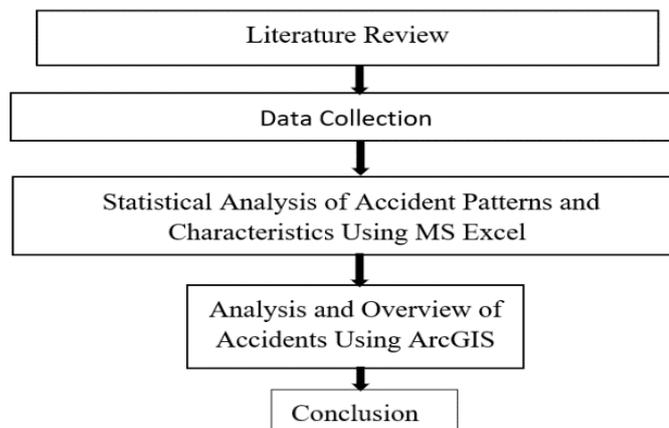


Figure 2: Research Methodology

3. ANALYSIS AND RESULTS

3.1 Road Traffic Accidents in DMP

The number of people killed and injured on the roads of Bangladesh is continuously growing with each passing year. The misery of road traffic accidents amplifies when it involves Dhaka Metropolitan (DMP) area. In DMP, 70.74% of the total accidents were fatal between 2016 and 2020, resulting in the deaths of thousands of innocent people. According to Figure 3, the most significant contributors to these fatal accidents were buses (39%), motorcycles (13%), heavy trucks (10%), unauthorized vehicles (10%), and minibusses (9%). It is impossible to overlook the risk of unauthorized vehicles, which account for the fourth-highest percentage of this contribution. In addition, it has been identified

that 11 out of 50 Thanas under the DMP area had more than three fatal accidents from 2016 to 2020, and our paper focuses on these 11 Thanas to examine the underlying factors.

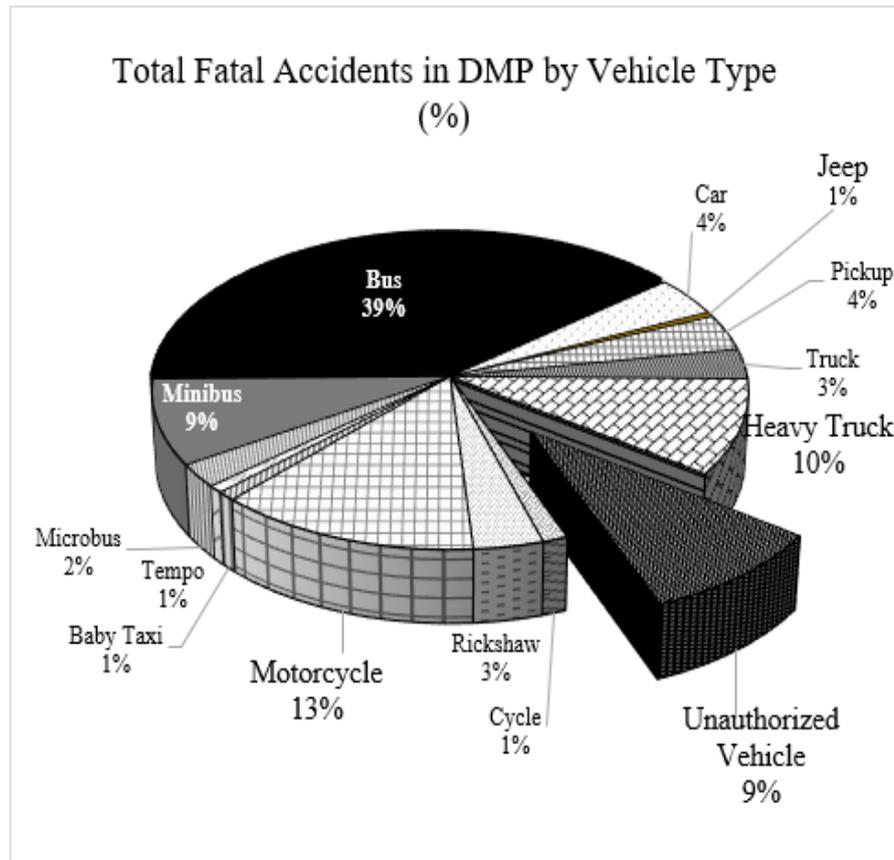


Figure 3: Contribution of Various Vehicle Types to Fatal Accidents in DMP

3.2 Fatal Crashes and Fatalities by Year

Figures 4 and 5 show the trend of fatal crashes and fatalities by year for 2016 to 2020. Among the 11 Thanas comprising our study area, it is shown that fatal crashes and fatalities are on the increasing trend for maximum Thanas. Considering total fatal accidents, the rate of accidents is getting higher with each passing year- 2016 (10.94%), 2017 (17.19%), 2018 (25%), 2019 (25%), 2020 (21.88%). It is to be noted that results for the year 2020 have a pandemic impact. This trend of increase indicates the increasing movement of these unregistered vehicles on the roads with time. Both the figures show a significant fluctuation in 2018 for Ramna Model Thana. This indicates that Ramna Model Thana faced a sudden increase in unauthorized vehicles functioning on roads, causing fatal crashes and deaths over 2018.

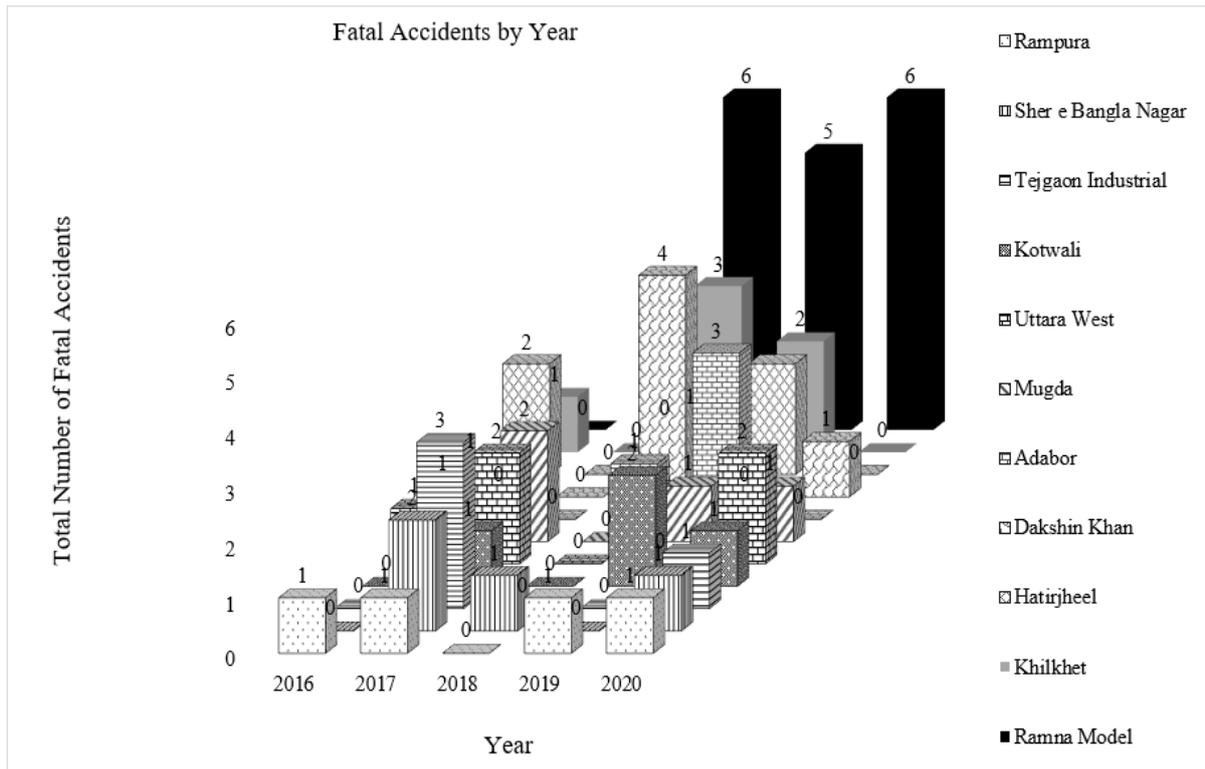


Figure 4: Fatal Accidents by Year

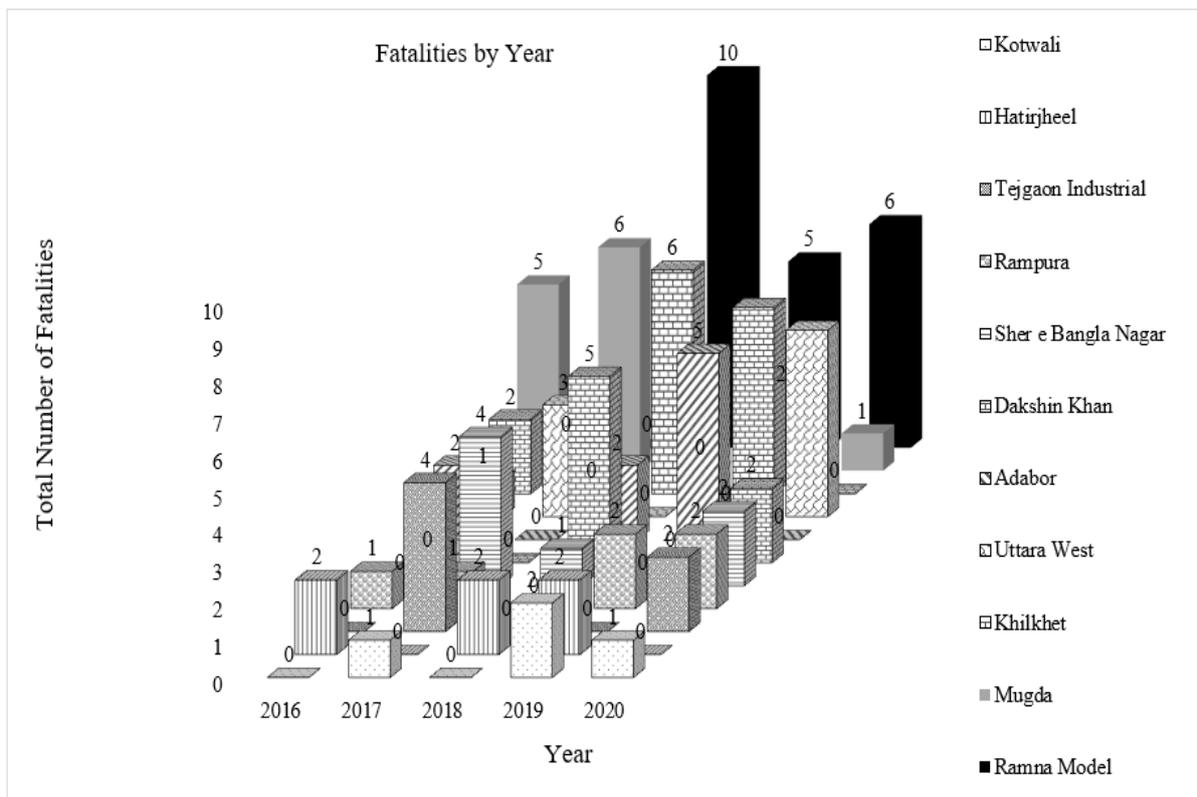


Figure 5: Fatalities by Year

3.3 Accident Severity Index

The accident severity index, which is measured as total road accident fatalities per 100 accidents, is a critical accident-related parameter used to assess the level of intensity of an accident. From 2016 to 2020, the severity of accidents that occurred in eleven Thanas in DMP is shown in Table 1. The severity index is significantly high in all eleven Thanas, indicating that accidents involving unauthorized vehicles nearly always result in death. A low of 83.3 can be found in Kotwali, while a high of 200 can be seen in Uttara West. Except for Tejgaon Industrial (100.0) and Kotwali (83.3), all other Thanas have an index higher than 100, indicating that each accident results in more than one fatality on average.

Table 1: Accident Severity Index (Fatalities per 100 Accidents)

Thana	Number of Injuries	Number of Fatalities	Number of Casualties	Number of Fatal Accidents	Number of Total Accidents	Accident Severity Index (col.3*100/col.6)
Adabor	1	9	10	5	7	128.6
Dakshin Khan	0	10	10	5	6	166.7
Hatirjheel	1	6	7	5	5	120
Khilkhet	8	11	19	6	7	157.1
Kotwali	0	5	5	4	6	83.3
Mugda	3	12	15	5	9	133.3
Ramna Model	2	24	26	17	22	109.1
Rampura	3	7	10	4	5	140
Sher e Bangla Nagar	2	7	9	4	5	140
Tejgaon Industrial	2	6	8	4	6	100
Uttara West	4	10	14	5	5	200

3.4 Fatal Crashes by Collision Type

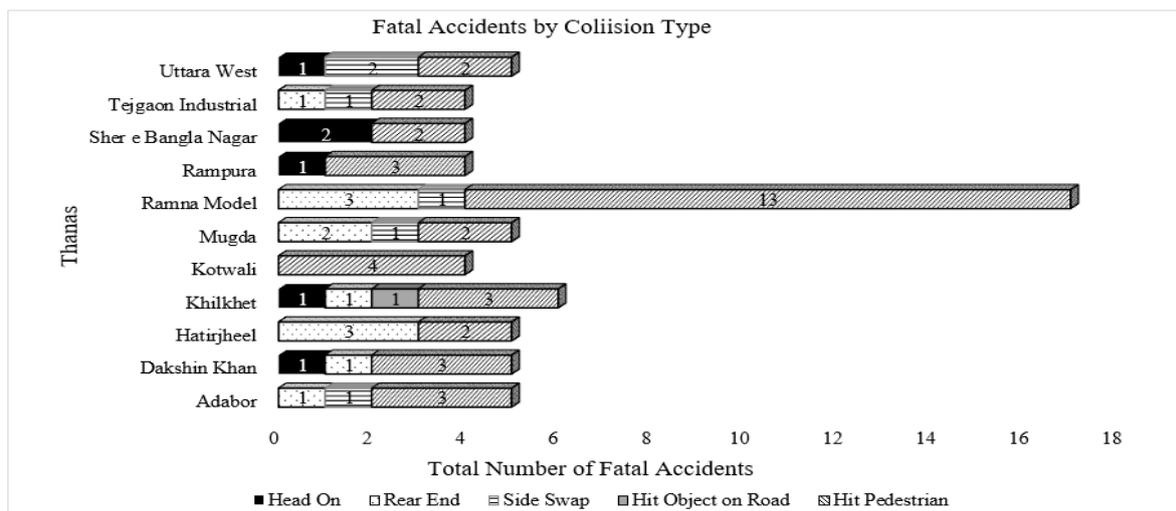


Figure 6: Fatal Accidents by Collision Type

In this study, we identified the most frequent collision type for the unauthorized vehicles within our study area for fatal accidents (Figure 6). Of the total fatal crashes, hit pedestrians appear as the most

common type of collision for the selected 11 Thanas, amounting to 60.94%. This is followed by the rear end (18.75%), head-on (9.38%), and side swap (9.38%). The high percentage of pedestrians hit by an unauthorized vehicle is a severe alarm regarding the safety of pedestrians, so their safety issues must be addressed.

3.5 Fatalities and Injuries by Road Class

Figure 7 and 8 depicts the prevalence of fatalities and injuries involving unauthorized vehicles by road class. As can be observed, fatal accidents and deaths are more commonplace on national highways and city roads than feeder roads. Fatal accidents occurred only on city roads in Sher e Bangla Nagar and Uttara West. As national highways do not pass through these thanas, it is logical that fatal accidents only took place on city roads and feeder roads in Rampura and Mugda. Although Tejgaon Industrial and Khilkhet had equal percentages (50%) of fatal accidents on national highways and city roads, mortality was more significant on national highways in both cases. This might be because greater speeds facilitated by lower traffic volumes increase the likelihood of a serious injury. National highways dominate Kotwali, Dakshin Khan, and Ramna Model, accounting for 75%, 80%, and 65% of fatal accidents, respectively, with comparable fatality rates. Whereas, In Adabor and Hatirjheel, city roads govern for 60% and 80% of fatal accidents and 55.6% and 66.7% of fatalities, respectively.

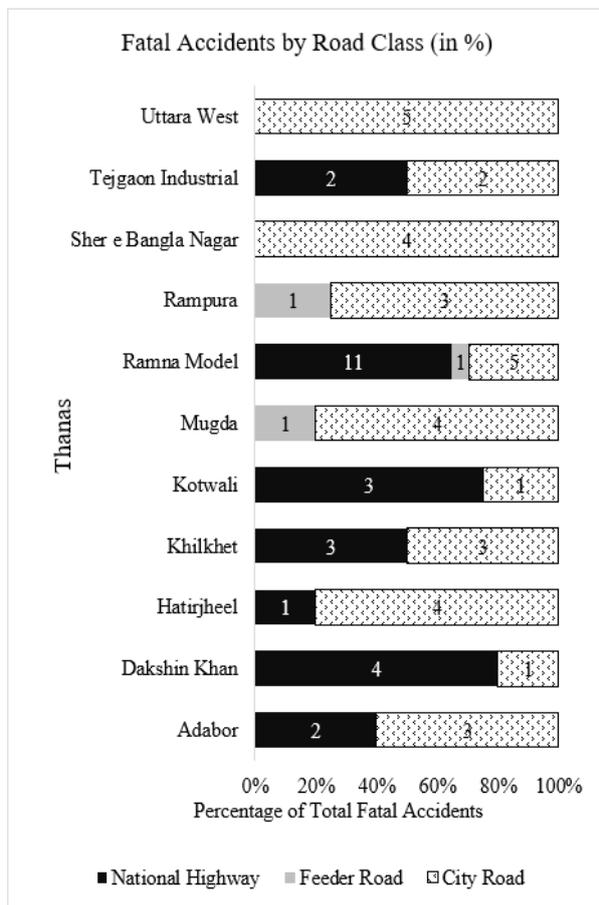


Figure 7: Fatal Accidents by Road Class (in percentage)

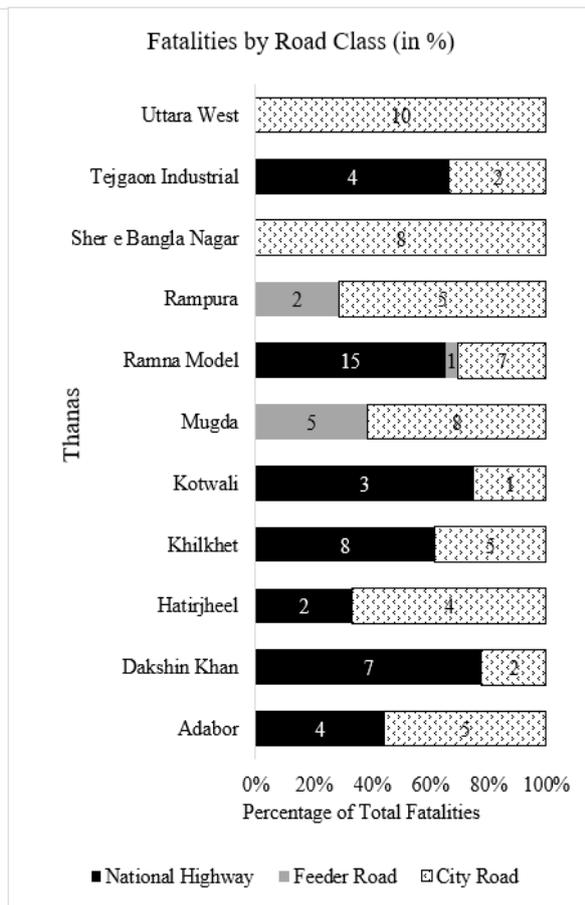


Figure 8: Fatalities by Road Class (in percentage)

3.6 Fatalities and Injuries by Road Users

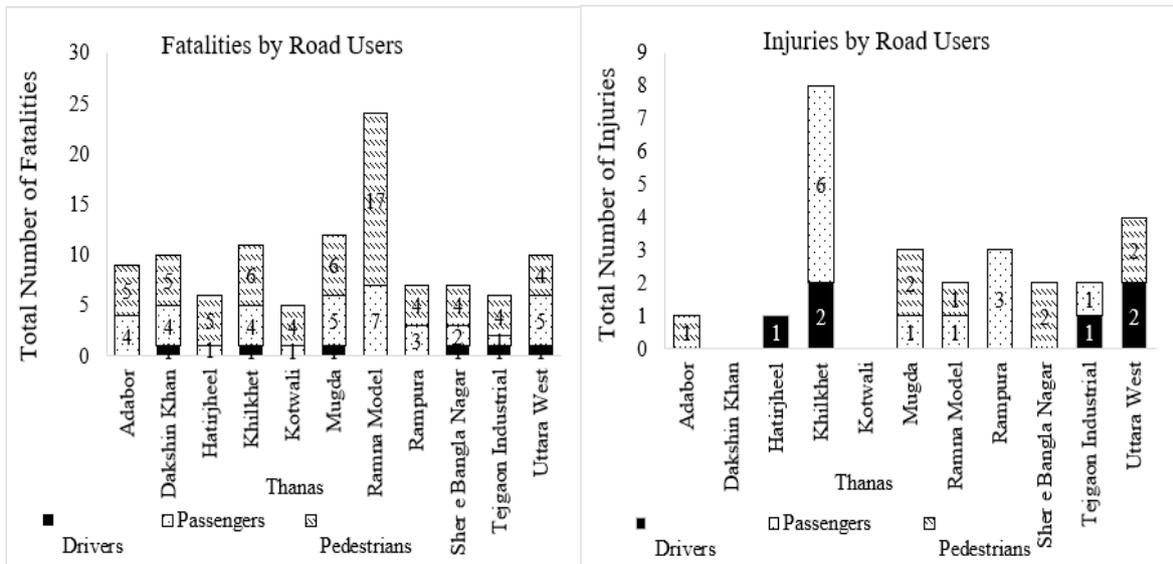


Figure 9: Fatalities and Injuries by Road Users

From Figure 9, it can be seen that the total amount of fatalities and injuries among road users are 107 and 26, respectively. This finding suggests that most fatal accidents result in more fatalities than injuries. The fatality rate is also most dominant for pedestrians (59.81%), the injury rate is also significant (30.77%). This is followed by passengers (fatality rate 34.58%, injury rate 46.15%) and drivers (fatality rate 5.61%, injury rate 23.08%). This result highly justifies the attention towards pedestrian safety and highlights the seriousness of crashes for these vehicles.

3.7 Fatal Crashes by Junction Type

We discovered that 29 fatal accidents did not occur at any kind of junction (crash rate 45.31%) out of 64 fatal accident instances, demonstrating that junction types had little effect on fatal accidents for these vehicles. This rate is followed by other types of junctions (28.13%) and Cross-Intersections (12.5%). Figure 10 depicts the results of this research.

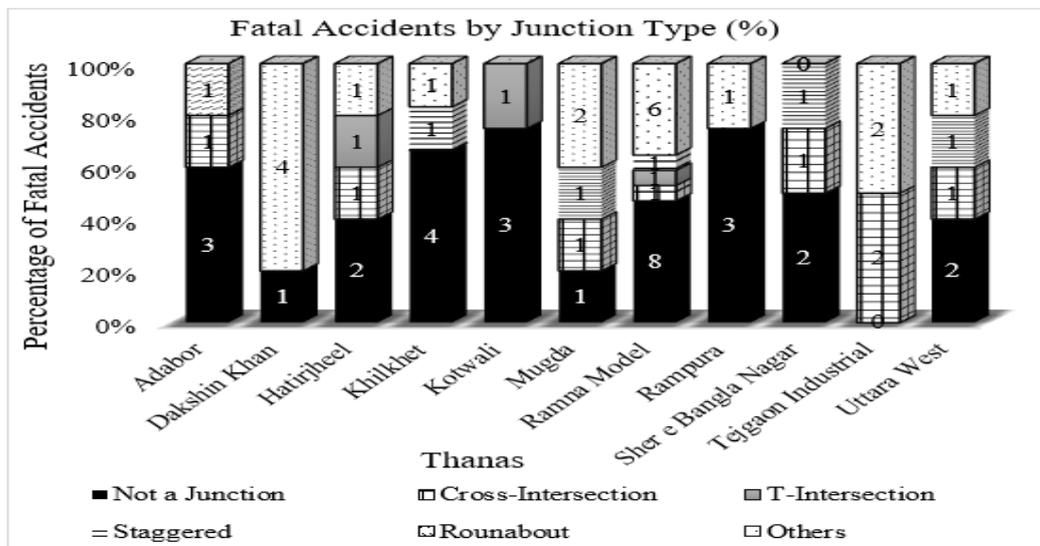


Figure 10: Fatal Crashes by Junction Type (in Percentage)

3.8 Fatal Crashes by Surface Quality

From the collected data, it is found that out of a total of 64 fatal cases, 61 fatal crashes took place at good surface conditioned roads (95.31%), one fatal crash took place at the rough conditioned road (1.56%), 2 took place at under-construction roads (3.13%). Therefore, the result explains that surface quality is not a contributing factor in fatal crashes for unauthorized vehicles. The number of fatal crashes by surface quality for the 11 Thanas is shown in Figure 11.

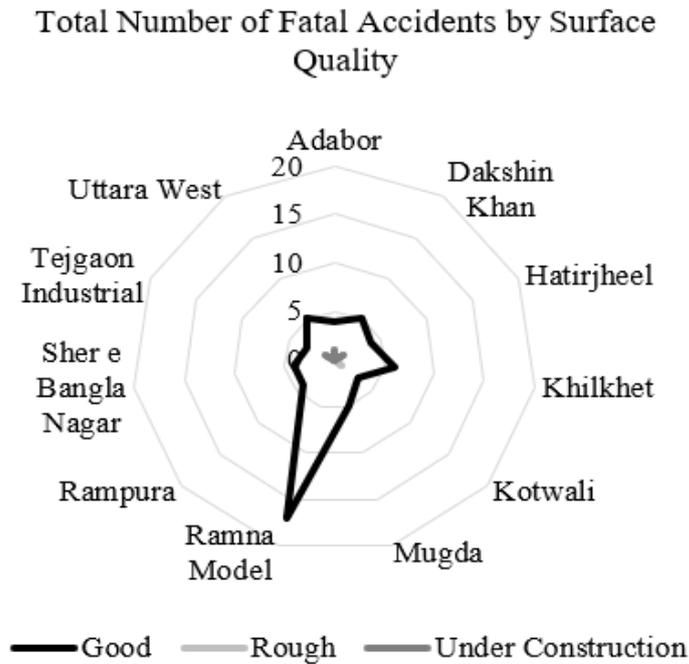


Figure 11: Fatal Accidents by Surface Quality

3.9 Pedestrian Fatalities and Injuries by Age Group

Figure 12 demonstrates pedestrian fatalities by age group. The analysis revealed that age group 31-45, which is the most economically active group, faces the highest fatality rate (42.42%). The Injury rate for this group is 50%. The fatality rate then follows for age group 18-30 (21.21%), injury rate being 50%. Children aged under 18, faces 12.12% fatality rate. People aged over 60, faces the lowest fatality rate of 6.06%.

3.10 Passenger Fatalities and Injuries by Age Group

Figure 13 illustrates passenger fatalities by age group. Unfortunately, from the data analysis, only 9 deaths and 9 injuries were found in total where age information was provided, which is quite low compared with pedestrian cases. The highest fatality rate is found for the age group 46-60 (44.44%), with no injuries. Fatality rate then follows for age group 18-30 (33.33%), with 33.33% injury rate. Here, records on fatalities and injuries for all ages are dispersed and indicate no prominence for any particular age group.

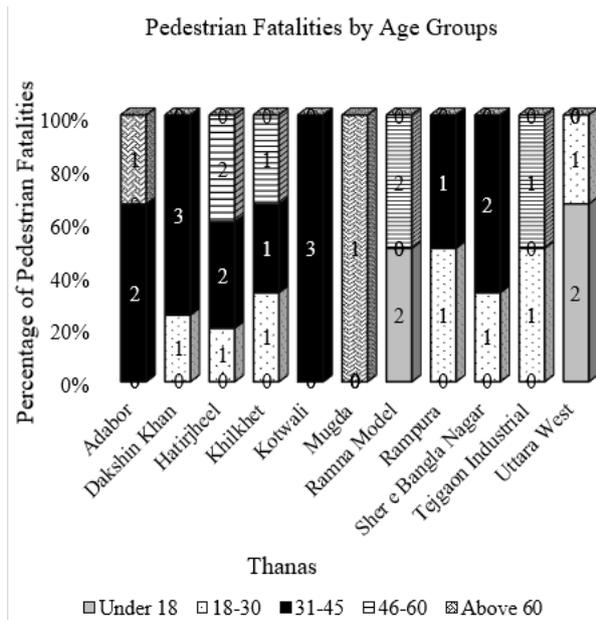


Figure 12: Pedestrian Fatalities by Age Group (%)

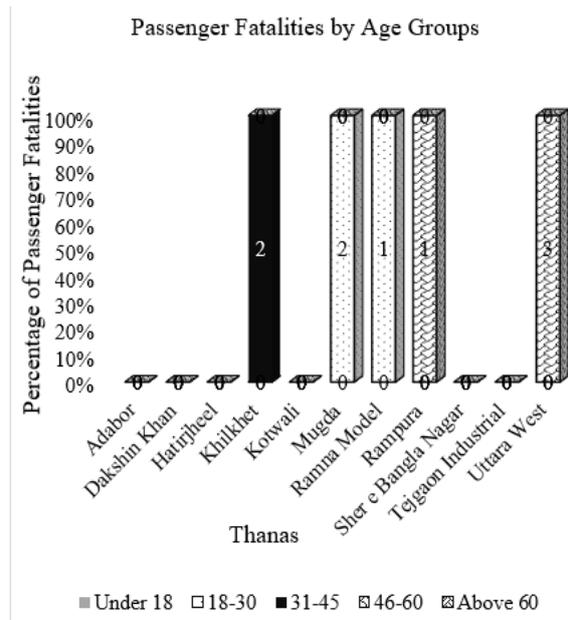


Figure 13: Passenger Fatalities by Age Group (%)

3.11 Fatalities and Injuries by Sex

Figures 14 and 15 show pedestrian fatalities and injuries by gender, and Figures 16 and 17 depict passenger deaths and injuries based on gender. From Figures 14 and 15, it is observed that male pedestrians are more prone to fatalities and injuries than females. For 5 Thanas (Adabor, Dakshin Khan, Khilkhet, Mugdha, Rampura), the male pedestrian fatality rate is 100%, and for other Thanas, the male pedestrian fatality rate is also higher than female pedestrians. This is because, among pedestrians, males have more walking exposure, vehicle-pedestrian collision risk. From Figures 16 and 17, it is observed that female passengers are more likely to be killed and or injured than male passengers.

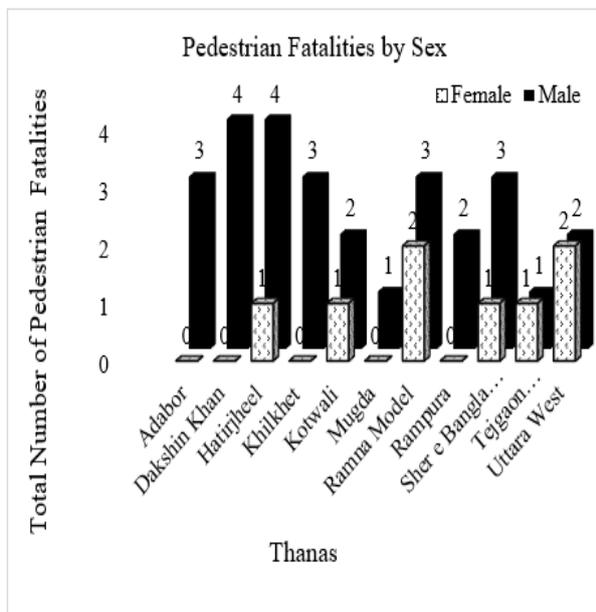


Figure 14: Pedestrian Fatalities by Sex

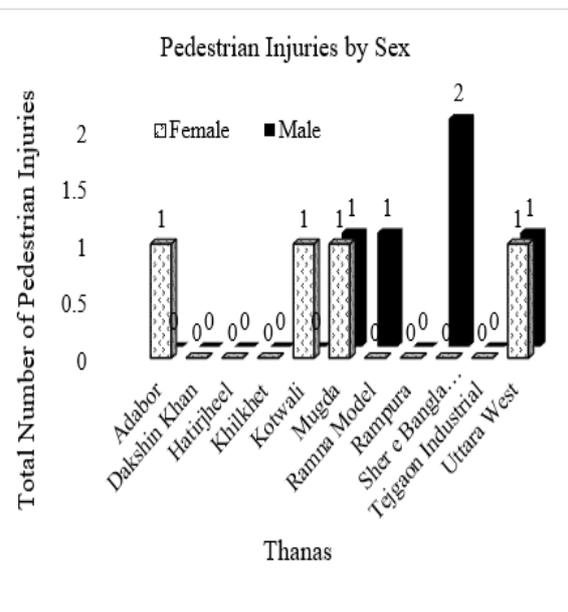


Figure 15: Pedestrian Injuries by Sex

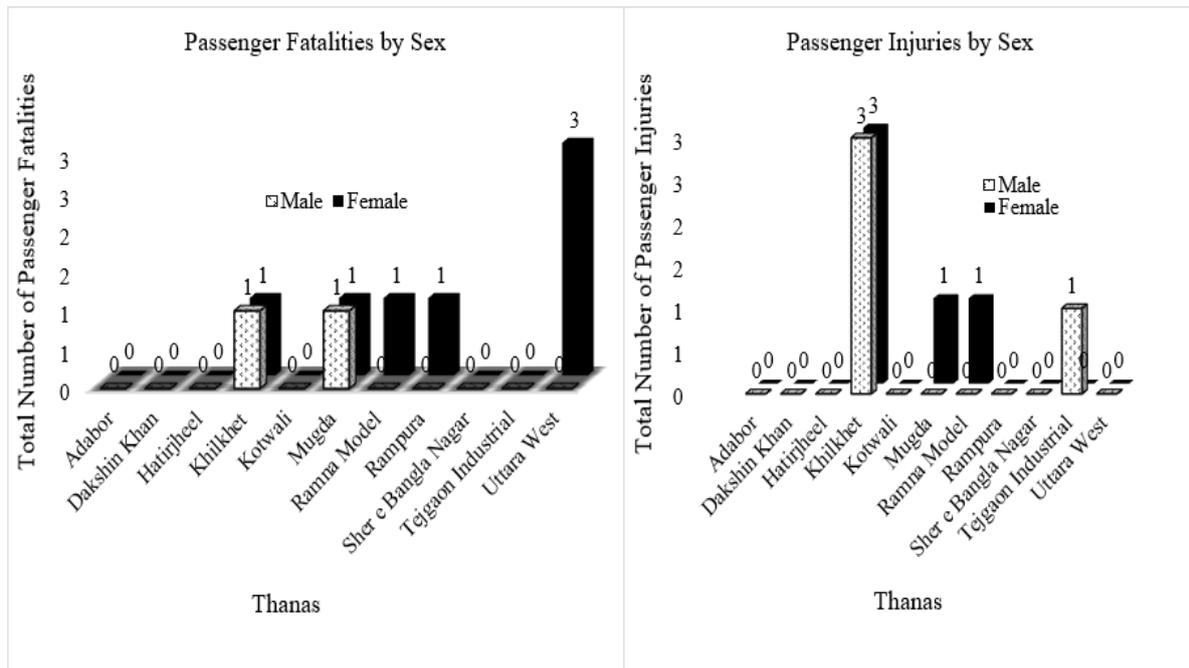


Figure 16: Passenger Fatalities by Sex

Figure 17: Passenger Injuries by Sex

3.12 Factors Contributing to Fatal Accidents

According to the findings of the study, these unauthorized vehicles often cause fatalities while operating on public roadways. Because they are structurally unfit, they lack appropriate brake controllers, leading to a heavy impact on the victims. As a result, the death rate for these vehicles is substantially greater than that of other vehicles. Over-speeding and reckless driving are also two major contributing causes in these fatal accidents, according to Accident Recorded Database, ARI, BUET. In this article, out of a total of 64 fatal accident case studies, over-speeding and reckless driving were responsible for 100% of the collisions (Accident Research Institute, BUET). Furthermore, the majority of the drivers of these vehicles do not have the necessary expertise or license to drive, nor do they follow any safety precautions. According to Figure 18, Drivers were discovered not wearing seatbelts in 96% of the 64 fatal accident cases, placing themselves at risk.

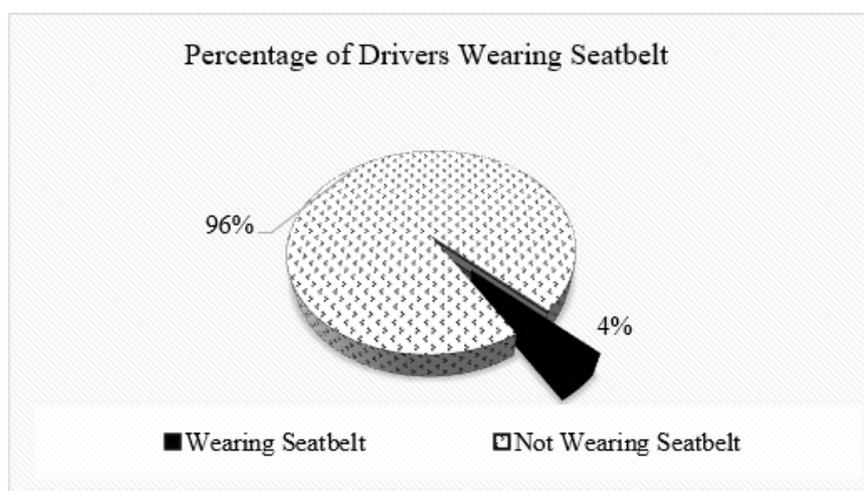


Figure 18: Drivers Wearing Seatbelt (%)

3.13 Spatial Representation using ArcGIS

In Figure 19, bar graphs depicting the overall number of fatal accidents, deaths, and injuries in our well-respected research region prepared using ArcGIS are shown. The Geographical Information System (GIS) analysis of eleven DMP Thanas reveals that when compared to other thanas, Ramna Thana has a significantly greater number of fatal accidents (17), followed by Khilkhet Thana (6). In all other Thanas, the total number of fatal accidents varies little. The plot clarifies that mortality rates are consistently greater than fatal accident rates in almost all Thanas. This also reveals that, despite having fewer fatal accidents than the other Thanas, Uttara West has the fourth-highest number of deaths, after only Ramna Model, Mugda, and Khilkhet Thana.

Thana wise Fatal Accident Scenerio in DMP for Unauthorized Vehicles

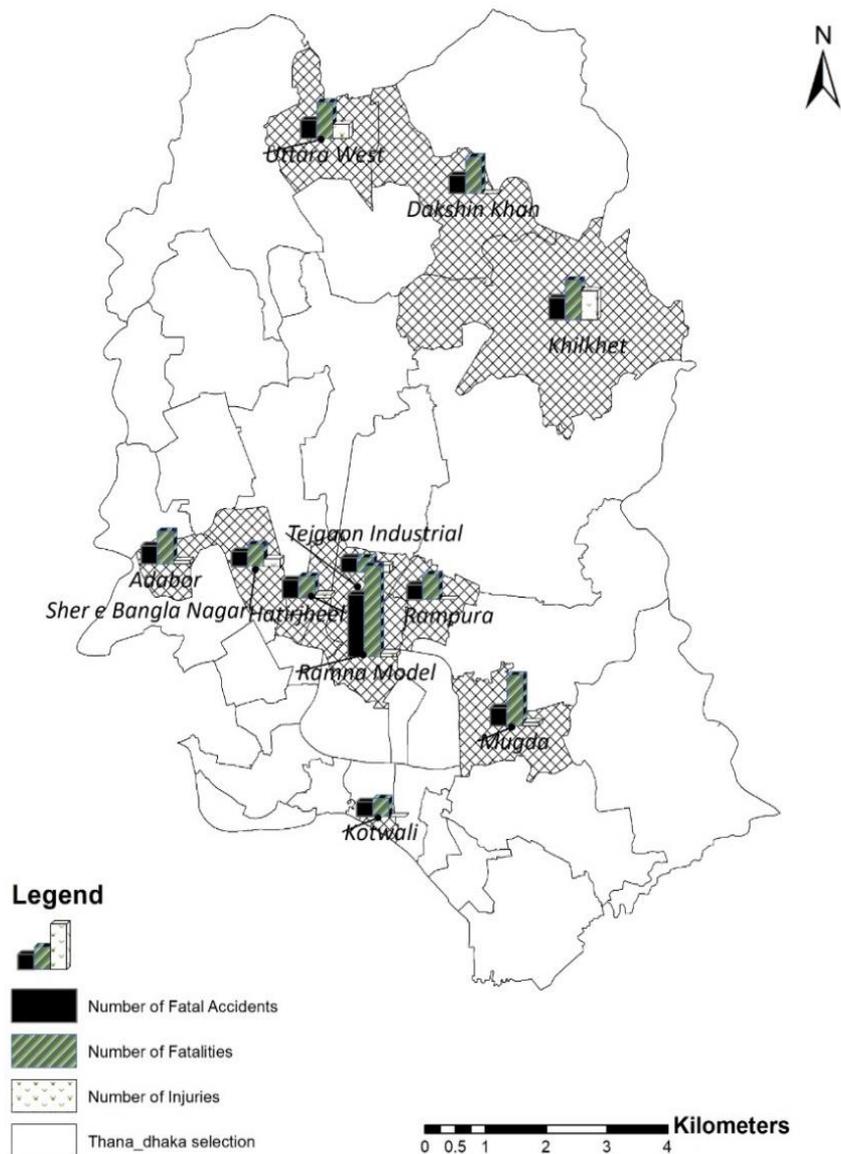


Figure 19: Spatial Representation of Fatal Accident Situation for Eleven Thanas on the Map of DMP

4. CONCLUSIONS

The paper evaluated the patterns, characteristics, and contributing factors of the fatal accidents where unauthorized vehicles were involved for specified 11 Thanas having more than three fatal accidents from 2016 to 2020. Excluding Tejgaon Industrial (100.0) and Kotwali (83.3), all other Thanas have an accident severity index higher than 100, suggesting that each accident causes more than one death on average. Out of all the Thanas studied, the Ramna Model has the highest number of fatal accidents (17), nearly four times greater than the average number of fatal accidents in all other Thanas. It is found that hitting a pedestrian is the most common collision type for these Thanas (60.94%) followed by the rear end (18.75%), head-on (9.38%), and side swap (9.38%). The mortality rate for pedestrians (59.81%) is also much higher than that of passengers (34.58%) or drivers (5.61%). It shows that among pedestrians, economically active people (age 31 to 45) face the highest fatality rate (42.42%), and people aged over 60 face the lowest fatality rate (6.06%). Male pedestrians are more exposed to fatal accidents and fatalities than female pedestrians, whereas the reverse is true for passengers. National highways and city roads have a higher rate of fatal crashes and mortalities than feeder roads. The study also showed an increasing trend of fatal crashes and fatalities for maximum Thanas, indicating the increase in the number and movement of unauthorized vehicles with time. However, junction type, alcohol consumption, weather conditions, and road surface quality have very little impact on fatal accident characteristics, so these factors do not contribute to fatal accidents. According to the data taken from ARI (Accident Research Institute), BUET, over-speeding and reckless driving are two principal factors that contributed to all of our study accidents apart from the structural instability of the vehicle. As it is found in the study, pedestrians are the primary victims of fatal accidents and fatalities, so their safety must be prioritized on an urgent basis.

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