

ADDIS ABABA UNIVERSITY
ADDIS ABABA INSTITUTE OF TECHNOLOGY
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING



**Safety and Security Evaluation of Three-Wheeler Taxis as a Public
Transport Mode in Kombolcha City**

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**A Thesis Submitted to the School of Graduate Studies of Addis Ababa
University in Partial Fulfillment for the Award of the Degree of Masters of
Science in Civil Engineering (Road and transport Engineering)**

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DECLARATION

I hereby declare that the work which is being presented in this thesis, entitled "**Safety and security evaluation of three-wheeler taxis as a public transport mode in Kombolcha city,**" is entirely my own work, has not been presented for a degree at any other university, and that such materials as have been obtained from other sources have been duly acknowledged in this thesis. This work is being submitted to the department of civil engineering as part of the Master of Science in road and transport engineering program.

This research is carried out under the supervision of **Dr. Getu Segni**.

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ABSTRACT

In Kombolcha city, three-wheeler motor vehicles (Bajajs) serve as the primary mode of public transportation. Even though these motor vehicles have been designed for the purpose of public transport in developing countries, there is a lack of sufficient studies on their safety and security as a public transport mode. Based on that, this study examined the safety and security status of these three-wheeler taxis as a means of public transportation in Kombolcha city. To do that, questionnaire data from 395 respondents (passengers and drivers) and police-recorded crime as well as crash data were collected and analyzed. From the analysis, it was found that pedestrian collisions, overturning or toppling, and passengers jumping and falling while the vehicle was in motion were the most common types of accidents in 3-wheeler (Bajaj) taxis. In addition, multinomial logistic regression analysis was used to predict the severity level of crashes; in doing so, vehicle type involved in a crash, accident type, and accident causes were the factors that affect injury severity level at a significant level of $p = 0.05$ and a 95 percent confidence interval. According to the findings, the most common type of injury in 3-wheeler accidents was injury crashes, and pedestrian collisions were found to be the leading cause for the severity levels.

On the other hand, three years of crime data indicated that 3-wheeler-related crimes show an increasing trend, and as per the logistic regression analysis result, male passengers were more likely than female passengers to be beaten or hit, whereas female passengers were more likely to be robbed, snatched, or stolen. Additionally, the study indicated that 3-wheeler stations, the vehicle itself, and the way to or from 3-wheeler stations exposed travelers to crime incidents. For instance, theft crimes were higher inside 3-wheelers, whereas robbery/snatching and beating/hitting crimes were more common outside the three-wheelers. In general, passengers' feelings of safety and satisfaction level with security-related services significantly depended on gender, age, travel frequency, and occupation, with female passengers feeling more unsafe and dissatisfied than male travelers.

Overall, on Wednesday and Saturday, traffic and criminal activity in Kebele 03 of the city were higher and need close supervision by the city's traffic and regular police, respectively.

Key words: *Three-wheeler, safety, security, public transport, crime, Kombolcha, Ethiopia*

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LIST OF ABBREVIATIONS

RTAs	Road traffic accidents
WHO	World health organization
ANOVA	Analysis of Variance
MANCOVA	multivariate analysis of covariance
ANRS	Amhara National Regional State
GDP	Gross Domestic Product
KTF	Kombolcha Textile Factory
ERC	Ethiopian Railway Corporation
SPSS	Statistical Package for the Social Sciences
US	United State
MLR	Multinomial logistic regression
LR	Logistic regression
OLR	Ordinal logistic regression
VIF	Variance inflection factor
CI	Condition index
GENLIN	Generalized linear regression
PLUM	Polytomous universal model
PPO	partial proportional odds
OR	Odds ratio

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the study

Transportation is defined as a method of transporting people, products, and animals from one point to another. It has existed since the beginning of time, when only wooden carts and animals such as horses, donkeys, and bulls were used (Bhasin, 2020). It is an indispensable component of any society, and it is closely related to the way of life, the variety and location of activities, and the goods and services that will be available for use (Mathew, 2009). Its advancements have enabled changes in the style of life and the organization of communities, and have thus had a significant impact on the development of civilizations (Mathew, 2009) (Bhasin, 2020). Transportation is important because it facilitates trade, commerce, and communication, all of which help to develop civilization. It is effective planning that handles traffic flows and allows for uninterrupted and consistent transit from one location to another. Moreover, an efficient transport system provides social, economic, political, and cultural benefits such as market access, investor infusion, resource distribution, and so on, all of which have an indirect impact on a country's growth and development (Bhasin, 2020). Even though, transportation has the above benefits it has its own negative impact like safety problems, air pollution, noise pollution and energy consumption. Transportation, for example, has a tremendously negative impact on society in terms of accidents. Increased fluctuation in speed and vehicle density resulted in a significant risk of accidents, which resulted in loss of life, permanent disability, injury, and property damage (Bhasin, 2020). Furthermore, security is another issue with transportation, particularly public transportation. In terms of modes, city buses, mini-buses, and 3-wheel rickshaw (Bajaj) taxis are the types of public transportation in Ethiopia; particularly, minibuses and 3-wheeler taxis are extensively available modes of public transportation in secondary cities and towns of the country. Therefore, safety and security problems should be investigated separately by mode of transportation, and for that reason, this study concerns the safety and security of 3-wheeler (Bajaj) taxis in Kombolcha city.

1.1.1 Importance of 3-wheelers and problems related to them

The majority of residents in Kombolcha city rely on public transportation rather than private transportation. One of the basic public services that the city administration provides is public transportation, and three-wheeler taxis are the city's primary mode of public transportation (98%

of the city's public transport service) for all transit areas in the city and around it. However, there are some four-wheeled public transport vehicles (minibus taxis and others that have a loading capacity of from 6 to 12 passengers) that cover only 2% of the city's public transport service. All around the world, 3-wheeled motor vehicles have been produced for public transportation, particularly in developing countries, and they are known by different names like tuk-tuks in Thailand, baby taxis (CNGs) in Bangladesh (Mains, D., & Kinfu, E., 2017), three-wheeler/Bemo/Helicak in Indonesia, Jumbo in Laos, Tempo in Nepal, trishaws in Sri Lanka, auto rickshaws in India, and tricycles in the Philippines are all terms used to describe 3-wheeled taxis (Phun, V. K., & Yai, T, 2016). In Ethiopia, those 3-wheeler autorickshaws are known by the name "Bajajs", and both sides of these three-wheeler bodies are open, allowing for free airflow (Mains, D., & Kinfu, E., 2017). In some rural and peri-urban areas of the country, where there is no traffic control and no other public transport modes are available, the drivers load up to six and seven passengers in a single journey. This problem exists in other countries also (Starkey, P., Batool, Z., & Younis, M. W, 2019). With only three passengers, the 3-wheeler makes few stops to allow passengers to load and unload, resulting in shorter waiting times at stations. In addition, travelling with small children and bags of items from the city's main market, door-to-door journeys are very common and an advantage of 3-wheelers. They provide options for independent movement (locally known as "contracts"), for women who are frequently verbally assaulted in public transport or public spaces if they travel alone at night or even during the day, but they also have a negative side for them if the driver is rogue or not reliable (Mains, D., & Kinfu, E., 2017).

More on this, several factors influence the growth of motorized 3-wheelers and increased the attraction of motorized 3-wheeler vehicle ownership, such as the inability of public transport systems to keep up with the increasing demand for mobility, lower acquisition costs, their door-to-door service provision, being small sized, better fuel economy compared to cars, and their service provision in rural areas where there is no asphalt or suitable travel route (Posada, F., Kamakate, F., & Bandivadekar, A., 2011). Generally, these vehicles become popular means of transportation in towns, secondary cities and the city sides of large cities in Ethiopia, and they fill the gaps that can't be covered by other public transport systems. Specifically, for Kombolcha City, these 3-wheelers cover most all services of public transport and serve as an ambulance during emergency cases and urgent situations at an affordable cost.

On the other hand, the rapid increase in the number of 3-wheeled vehicles became problematic in terms of the safety, security, and mobility of the cities and towns' transport systems. For instance, to show this in context, Kombolcha city is the center for transporting goods and industrial products that come from Djibouti and are transported to the northern part of the country and the central part of the country as well. Industrial products produced in the city are also transported to different parts of the country. For these and similar reasons, many vehicle types, especially trucks and lorries, have extensive experience in the city at any time of the day. The socio-economic activity of the city is also high, and it needs transport to move and perform tasks. Related to this, during the past years, there has been tremendous growth in the number of vehicles, especially three-wheeler (Bajaj) autos, in the city, which has resulted in an increase in traffic accidents, criminal activities, and a reduction in mobility due to congestion in the city's center during rush hours and market days (on Wednesday and Saturday). During the mentioned market days, the city experiences congestion around the Borkena bridge and the public transport vehicle station, and it also extends to the downtown up to the total fuel station. The situation resulted from the inefficiency of existing transport infrastructure and facilities to meet the needs of the rapidly growing vehicle and human populations in the city and it followed by the emission of pollutants and the delay of vehicles, which resulted in the wastage of productive time and a decrease in production. In addition to that, the city's congestion and crowdedness create favorable conditions for perpetrators to commit a crime; particularly, thieves take advantage of this situation to steal materials and property from passengers and pedestrians.

On the whole, while motorized three-wheel vehicles provide certain transportation benefits mentioned above, they also contribute to an increase in road accidents, security problems, and traffic congestion. These problems should be studied in sufficient detail, and out of the mentioned problems, this paper concerns evaluating the safety and security of three-wheeler (Bajaj) taxis as a public transport mode in Kombolcha city.

1.2 Statement of the Problem

In recent days, the number of motorized three-wheeled vehicles (Bajajs) has expanded in all parts of the country to meet the mobility needs of society, and like other public transport modes, they become problematic in the event of an accident and passenger security concerns. As a country level, Ethiopia reported 4352 road traffic fatalities by the year 2015/16, with 4.5 deaths per 100,000 population, and is considered one of the worst countries in the world for road traffic accidents (WHO, 2018). More recently, the Federal Police Commission's 2023 report for the 2021/22 fiscal year indicates that public transport vehicles accounted for 38% of the total road traffic accidents and 45% of fatal crashes (Ethiopian Federal Police Commission, 2023). According to the report, three-wheeler crashes increased by 52% and 64% in three consecutive years (2019/20-2021/22). From the report, it can be seen that three-wheeler crashes increase year after year; therefore, it needs to be evaluated using case studies to identify the problem at a lower level. To narrow the situation, Kombolcha City is one of the cities found in Amhara regional state, and a large proportion of the population uses three-wheeler taxis as their main transport mode. However, they complained about their safety and security. Evidence obtained from the regional state indicated that safety and security are the main problems observed with these 3-wheeled motorized vehicles (Getachew, 2019).

Moreover, although there have been very few studies in Ethiopia on crimes involving public transport and its surroundings, the majority focused on Addis Ababa (directly on buses) and did not include regional cities as well as 3-wheeler taxis as a public transport mode. However, with the growth in the number of 3-wheelers, the problem is becoming increasingly prevalent in the country. By taking these gaps into consideration and the problems mentioned, the researcher was initiated to evaluate the safety and security of three-wheeler taxis as a public transport mode by using Kombolcha City as a case study. And by doing so, the researcher wants to provide some evidence on the mentioned problems to go further in identifying the problems at the country level in the future.

1.3 Research Objectives

1.3.1 General objective

The general objective of this study is to evaluate the safety and security status of three-wheeler taxis as a public transport mode in Kombolcha City.

1.3.2 Specific Objectives

The study has the following specific objectives:

- To investigate common types of 3-wheeler crashes and causes of crashes in Kombolcha city
- To examine the factors that affect the severity of crashes in Kombolcha city
- To identify three-wheeler-related crime types and crime-committing techniques
- To evaluate the relation between crime types, victim types, including the driver's involvement, and crime-occurring places

1.4 Research Questions

1. What are the common types of 3-wheeler crashes and causes of crashes in Kombolcha City?
2. What are the factors that affect the severity of crashes in Kombolcha City?
3. What are the three-wheeler-related crime types and crime-committing techniques in Kombolcha City?
4. How can variables like crime types, crime victims, and drivers' involvement in crimes be related to crime-occurring places?

1.5 Scope and limitations of the study

This study covers mainly the safety and security aspects of three-wheeled motorized vehicles (Bajaj taxis), and it deals with the demand for additional public transport service in Kombolcha city. As these three-wheeled motorized vehicles are the main modes of public transport in the city, their transportation services should be evaluated in terms of safety and security in all parts of the transit lines. The study uses information collected from Kombolcha city police offices (3-wheeler-related crime as well as crash data) and from passengers and drivers of three-wheeler taxis through structured questionnaire surveys. To avoid any bias in the output, data with missing variables from

both crash and crime incidents are neglected in the analysis. Even though the problem appears at the country level and there are other issues related to three-wheeler taxis like comfort and mobility, this study is limited to Kombolcha city and concerns only the evaluation of safety and security issues of three-wheeler taxis. This is due to time and financial constraints. Moreover, there is a limitation of research regarding three-wheeler as a public transport mode. Therefore, this study may serve as a starting point for future detailed studies about the issue in different parts of the country.

1.6 Significance of the Study

The basic and recent concerns of people living in cities and towns are safety and security. These are the main issues for Ethiopia, especially for users of public transport. In Kombolcha city, different road users (vehicles and pedestrians) share a road environment at a time, and this creates unfavorable conditions that lead to an expansion of crimes, road traffic accidents, and congestion of the road, which reduces mobility and exposes passengers to criminal activities. This study aims to evaluate the safety and security of three-wheeler taxis as a public transport mode in Kombolcha City. Since those variables are directly related to the mode of transport and driver characteristics, the driver characteristics of three-wheeled motorized vehicles and the service conditions of those three-wheeled vehicles in Kombolcha city were investigated.

The study attempted to address certain problems, and in doing so, it made important contributions. First, the study expands on previous research on the understanding of 3-wheelers' public transportation system and its impact on customer satisfaction. Even though the study is conducted for academic purposes and limited to a single area, it could be beneficial to have a more in-depth understanding of the three-wheeler taxis' transportation system and the drivers' characteristics in relation to the mentioned variables in general. With this in mind, the findings of this study will benefit the following:

Future Researchers: The study leaves opportunities for other researchers to use it as secondary data in their own research. These researchers can be students, government agents, or members of different companies and associations. It should be noted that there are no separate studies that directly concern the safety and security of three-wheeler public transport vehicles in Ethiopia, and this research may be the first for that mode of transport in the country. Besides this, the data

collected in this study was both primary (directly from the passengers) and secondary (from police officers, books, articles, and publications). Therefore, researchers can use the primary data of this study as the secondary data of their study in the future.

Safety and Security Concerned Sectors: This study will benefit those institutions involved in the transportation sector, such as **road and transportation authorities, traffic controlling sectors** (for safety issues), and government security coordinators, such as **local police officers** (for security issues), in order to improve their quality of decision-making role in planning and controlling transportation and passenger security systems, and to devise countermeasures for the problems under study. To show this, through the analysis presented in this study, the local police officers will get evidence about criminal issues related to 3-wheelers, including the type and patterns of crime, crime participants (drivers and others), perpetrator techniques that they used to commit crimes, three-wheeler-related crime-prone areas, and related crime-prone days, that will help them allocate sufficient human resources in order to enforce laws, monitor crimes, and minimize their effect on customers (transport users). Similarly, road and transportation authorities, traffic police officers, and public transportation coordinators use the findings of this study to strengthen their decision-making quality in establishing and managing urban transportation systems and to establish countermeasures for the problems investigated in this study.

Three-wheeler Users and Local Communities: Through improvements following the findings of the study on three-wheeler services at the enforcement level and manpower assignments taken by the concerned sectors, passengers can use 3-wheelers without fear of crimes and accidents. Moreover, a safe and secure environment provides favorable conditions for the local community to perform day-to-day activities.

Finally, the study would be used as a source, and it will open ways for future studies in the country related to 3-wheelers as a public transport mode, which is currently the subject of a low-level study about its positive and negative impacts. In general, this study tries to address the mentioned problems, and it would give us clear and precise evidence on 3-wheelers service level in terms of the variables, which may be used as a resource for taking measures of the problem. Additionally, from the study, the researcher would have evidence on the demand for additional alternative public transport modes (either taxi or bus) for the study area.

1.7 Organization of the study

The paper is organized into five chapters. The first chapter is an introduction, which talks about the background of the study and the importance of 3-wheelers in Kombolcha city and problems related to them. More importantly, this chapter contains the problems, objectives, questions, scope, and significance of the study.

Chapter Two deals with the reviews of different literatures relevant to the study, mainly literatures concerning the safety and security of public transportation services including 3-wheelers from different sources.

The third chapter describes the study area, which includes the location of the study area, population numbers, and the types and proportions of public transportation vehicles that are currently available in the city. Along with this, this chapter also discusses research type, sample size determination, sampling technique used in the study, method of data collection, sources of data, description of the data and analysis methods of the study.

The fourth chapter focuses on presenting the analysis results and discussing those results. It includes the analysis of both primary data obtained from questionnaires and secondary data taken from Kombolcha city police departments for both crime and traffic crash incidents. The final chapter contains conclusions drawn from the analysis, recommendations for concerned sectors, and implications for future research.

CHAPTER TWO

2. LITERATURE REVIEW

Cities in most developing nations, such as Ethiopia, have risen rapidly, and at the same time, the number of motor vehicle users has increased significantly. Due to that, human activities and their demand for transportation have increased over time. People with lower incomes, as well as those with a middle income, use various modes of public transportation to travel from place to place for work and other social and recreational purposes. In Ethiopia, Private vehicle users are concentrated in Addis Ababa, the capital city, and some may exist in secondary cities in a very small amount; however, the others are public transport users, and some use non-motorized transport systems. Public transport in Ethiopia refers to mass transit (light rail and city bus) offering transport at a predetermined price, and it also includes collective taxis, locally known as "blue taxis," and other forms of transport that have a limited passenger carrying capacity. There are different issues related to public transport services, like accessibility, reliability, frequency, flexibility, mobility, comfort, quality, safety, and security. Researchers argued that the primary feature to focus on is functionality, and attributes connected to travel safety perceptions require careful consideration (Friman, M., Lättman, K., & Olsson, L. E., 2020). Passengers' stress levels are greatly increased by uncertainties in journey times and traffic jams. A study conducted in Gothenburg indicates that comfort is a more important factor on public transport (İmre, Ş., & Çelebi, D., 2017). Nowadays, the emerging three-wheeled autorickshaws are treated as a form of public transport in developing countries. These 3-wheelers have advantages over other public transport modes in terms of availability and door-to-door service. They are available for passenger transport during the day and at night and fill the gaps that are not covered by other means of public transport systems. Without taking into account the cost, 3-wheelers are available and easy to order at any time of the day or night. The majority of users over the age of 30 imply that the service is primarily used by working people. Passengers in some of the studied areas said 3-wheelers saved time, were more comfortable than other modes of transportation, and were easy to contact at all hours of the day and night (Somasundaraswaran, 2008). Many users reported that 3-wheelers were a reliable mode of transportation in an emergency that would normally necessitate the use of an ambulance in low and victims of emergency conditions (Somasundaraswaran, 2008) (Takele, G. M., Ballo, T. H., Gebrekidan, K. B., & Gebregiorgis, B. G., 2021). As a result, it is apparent that many people

consider 3-wheelers to be highly useful and that their services should be well integrated in small towns (Somasundaraswaran, 2008). Another study at Ethiopia Raya University found that, from the descriptive statistics on comfort dimensions, 3-wheelers are in a good standard of cleanliness, there are good seats in the three-wheeler, the 3-wheeler seats are comfortable, they carry as per the specified capacity, and a 3-wheeler journey is comfortable for any type of climate (Getachew, 2019). The other issue related to public transport is mobility. It reflects the spatial of the transportation network and the level and quality of its service (Vencataya, L., Pudaruth, S., Dirpal, G., & Narain, V., 2018). Congestion can be seen in Kombolcha city during the morning commute to work and on market days (Wednesday and Saturday). However, it is not as sensitive as safety and security for the study area, and as a result, it is not the focus of this study.

2.1 Security

Security is defined as the state of ‘being free from danger or threat’, thus it is the basic right to be able to travel without fear of being a victim of some form of attack (Allen, H., Cárdenas, G., Pereyra, L., Sagaris, L., 2019), Or it can be defined as “freedom of threat from other people, for example terrorism, violence, theft, or intimidating behavior and it takes into account objective concerns about the effects of crime and antisocial behavior” (Beecroft, M., & Pangbourne, K., 2015). Public transportation security refers to the actions taken by a transit operator to protect its passengers and workers from intentional criminal or disruptive activities, to protect equipment and belongings, and to minimize other violations.

Because both insecurity and security are emotional reactions, people can interpret them as the situation happening on them (Allen, H., Cárdenas, G., Pereyra, L., Sagaris, L., 2019). Cognitive distress is brought on by public spaces like transportation that are affected by crime and antisocial behavior. This has an adverse effect on a traveler's sense of personal security. When paired with personal characteristics and vulnerabilities, it also has a negative effect on self-confidence.

Most of the time, the main challenge in the transportation sector is security. Travelers today have repeatedly expressed concerns about the safety and security of public transportation, particularly females (Kacharo, D. K., Teshome, E., & Woltamo, T. , 2022) (ITF, 2018) of young and adolescent ages (Tripathi, K., Borrion, H., & Belur, J., 2017), who are the most commonly victimized group in public transportation, fearing for their safety due to a lack of physical strength (Kim, 2021). They may feel more insecure, especially when traveling alone or at night, even if

they are not at higher risk for crime (Loukaitou-Sideris, A., & Fink, C., 2009). Women's movement is severely limited by the lack of a secure environment, as is their access to career opportunities, education, and health care services (ITF, 2018).

Violence in women can be physical, sexual, and psychological (Kacharo, D. K., Teshome, E., & Woltamo, T., 2022). Sexual violence is any unwanted, unwelcome, and uninvited physical or non-physical action that targets women because of their gender, making them uncomfortable or fearful for their own safety and personal security (Allen, H., Cárdenas, G., Pereyra, L., Sagaris, L., 2019). Women face multiple types of violence while traveling on public transportation (Kacharo, D. K., Teshome, E., & Woltamo, T., 2022), among this Harassment is the most common in females, the actions involved are diverse, ranging from leering, staring, and stalking to verbal innuendos, unwanted and uninvited touching or groping, and actual sexual assault (Allen, H., Cárdenas, G., Pereyra, L., Sagaris, L., 2019) (Kacharo, D. K., Teshome, E., & Woltamo, T., 2022). Another study indicates that, the likelihood of theft and harassment is higher when compared to other forms of security problems examined during the study. In contrast, the likelihood of sexual assault and terrorism was lower in values (Rundmo, T., & Nordfjærn, T., 2019). Volume of crime in public transport has a significant relation with frequency of usage and quality of public transport system (Odufuwa, B. O., & Fasina, S. O., 2012). The result obtained from multivariate analysis of covariance (MANCOVA) for assessment of the probability for theft, sexual assault and harassment shows that, the group of frequent users of public transportation estimated a higher likelihood of security issues than the group of frequent users of private motorized transportation options. (Rundmo, T., & Nordfjærn, T., 2019).

In the present days theft of property is the main problem under the security issue, which is observed in all types of public transport modes and all transport users without any difference in gender and age. Most cities in the country face this illegal and unwanted action, specifically in transport and public areas. That is why the researcher wants to deal with the safety and security of passengers of three-wheeler taxis. Since three-wheel motorized vehicles (Bajaj taxis) are used as a main mode of public transport in the city, the safety and security issues of those 3-wheelers should be assessed sufficiently.

When examining the public transport system from security perspective, it is possible to distinguish (at least) three possible scenarios in which a crime event can occur (Newton, 2004) (Kruger, T. P.

J., & Landman, K., 2007), Walking or transferring from one stop to another (departure point to stop or station, stop or station to destination point), waiting at boarding (at a stop, station or interchange), and on board (bus, train, tram, 3-wheeler in this case and other modes). As a result, the external environment through which a public transport vehicle travels influences the level of crime experienced by passengers, and this should be considered in the planning and construction of public transport infrastructure (Kruger, T. P. J., & Landman, K., 2007). Two distinct environments - external and internal - influence the design of public transport vehicles. The link between these two is provided at the stops, stations and interchanges, which provide the gateway between the internal and external environments. External environments will vary by crime levels, socio-economic characteristics, land use, demographics and the physical infrastructure (Newton, 2004). Public transport users are sensitive to the quality of service provided by public transport operators. Excessive waiting time, poor response rate to vehicle breakdowns, unfavorable attitude of operator and bad state of operating mode are some of the possible reasons that public transport users to be unsatisfied (Odufuwa, B. O., & Fasina, S. O., 2012). A study examined using Correlation, regression and analysis of variance techniques to understand the relationship between volume of crimes in public transport system and some socio-economic variables, and found that, public transportations perceived security performance and quality expectation fell short of passengers' expectations. This suggests that the research area's public transportation quality and security levels did not meet passengers' mobility needs. From an environmental perspective, crimes may be occurred in to different situations as the walking environment, the waiting environment and en-route environment (Newton, 2004). The environment in public transportation encompasses not only the vehicles themselves, but also the facilities where passengers board and exit, as well as the areas where they change modes of transport or travel to/from their final destination (Kruger, T. P. J., & Landman, K., 2007) (Badiora, A. I., Ojewale, O. S., & Okunola, O. H. , 2015). Fear of being raped or abused makes it difficult for many women and girls to access safe public transportation (ITF, 2018) (Kim, 2021). Public transportation is a crucial service that allows individuals to commute to work, education, and other possibilities in life (ITF, 2018). Further on this, One out of every four women in the United States has suffered sexual harassment or assault on public transportation. Additionally, study conducted on women's personal security and public transport in three Latin American cities indicates that women were more likely than men to experience both crime and harassment while accessing or using public transport (Allen, H.,

Cárdenas, G., Pereyra, L., Sagaris, L., 2019). According to this study much of the crimes related to harassment were experienced either inside the vehicles or on the journey to or from public transport, which is often given less attention by transport planners. The majority of users interviewed said they felt insecure on public transportation and were concerned about security. More than half of all public transportation riders report feeling unsafe during their commute. The majority of users have experienced or seen sexual harassment (both men and women). Crimes on public transports committed both in day and night time (Badiora, A. I., Ojewale, O. S., & Okunola, O. H. , 2015). Evidence obtained from quantitative data on public transport in Bangladesh nearly all the entire sample (100%) indicated that their ability to study or work is dependent on access to transport and female participants used adjectives like 'unsafe,' 'worried,' 'helpless,' 'vulnerable,' 'afraid,' and 'scared' while characterizing their public transportation experiences (King, J., King, M., Edwards, N., Anam, M., Bull, M., Watling, H., ... & Carroll, J. A., 2021). This shows that public transport users especially women are full of fear when using public transport and the transport sector should give emphasis for the problem. When the study come to the developing nations it is necessary to observe the country Ethiopia which has a limited number of researches on the problem, one of the researches obtained in the country on women safety and security is conducted in Hawassa University. According to the data from this research, the most common incidents of sexual violence experienced by women and girls were staring takes, obscene gestures, making noise, whistling or catcalling, sexual comments or remarks, grabbing, pinching, and sexually motivated touching, groping, or rubbing (Kacharo, D. K., Teshome, E., & Woltamo, T. , 2022). The presence of high level of violent crime makes the physical environment often contribute to an increase in levels of fear and the creation of opportunities for crime (Kruger, T. P. J., & Landman, K., 2007). The researchers divided the violence in to physical, sexual and psychological violence. From the total respondents, large numbers of respondents (86%) were experienced sexual violence, 84% psychological violence, and 75% experienced physical violence. This data obtained from three types of public transports, city bus, mini bus and 3-wheeler that takes the city public transport proportion of 18.6%, 45.7% and 35.7% respectively (Kacharo, D. K., Teshome, E., & Woltamo, T. , 2022). Unexpectedly, evidence from Debre Markos City (Ethiopia) on the impact of public transportation level of service on three-wheelers indicates that the security dimension of three-wheeler (Bajaj) service quality had the least impact or contribution on its users' satisfaction (Getachew, 2019). When considering service quality on a per-attribute

basis, it becomes clear that security is crucial, limiting the chance for theft and other criminal acts in the three-wheeler, especially at night, is one strategy to improve security in three-wheeler transportation. Evidence from (Badiora, A. I., Ojewale, O. S., & Okunola, O. H. , 2015), shows that passengers feeling of safety was affected by age, gender and passenger's perception of crime. Customers from another study (Getachew, 2019), said that robberies (violent at times) occur during night travel, and that 3-wheeler terminals are not free from criminal activity. Moreover, study in Sri Lanka shows us 3-wheeler drivers reported as they fear night times of being hired for unlawful activities and being kidnapped by gangsters (Somasundaraswaran, 2008). According to (Getachew, 2019), descriptive statistics on Security dimension, one can get evidence that there was a security problem during night travel and that 3-wheeler terminal are not safe from crime. In addition to that, commuters also think that the 3-wheeler drivers are un-professional (undisciplined), and vehicles were used for illegal activities and drivers were involved in unlawful activities (Somasundaraswaran, 2008). customers feel in secured with the three items of security (i.e., 3-wheelers are free from violent robbery during night travel, 3-wheeler terminals are safe from crime and the drivers are friendly and disciplined) (Getachew, 2019). On the other way, vehicle robberies, use the vehicle for illegal activities, killing of the driver and injured him/her were other crime types committed at night times in 3-wheelers (Somasundaraswaran, 2008).

2.2 Traffic safety

In transport terms safety can be defined as the level of vulnerability/protection to accidental injury (involving at least one vehicle causing the injury) (O'Neill, B., Mohan, D., Breen, J., Koonstra, M. J., Mackay, M., Roberts, I., & Ryan, G. A., 2002). Safety measures assess the likelihood of passengers being involved in an accident, whether it is a vehicular or non-vehicular one (Allen, H., Cárdenas, G., Pereyra, L., Sagaris, L., 2019) or it can be defined as freedom from the impacts of accidents, such as vehicle crashes, safe interchange environments, and avoiding slips and falls (Beecroft, M., & Pangbourne, K., 2015). It accounts for objective problems relating to the consequences of accidents, whether they occur to a vehicle or to a person (e.g., slipping or tripping while on a vehicle, at an interchange, or negotiating the streets between one's front door and the bus). But, in this study only vehicular involvement will be assessed under the parameter of safety and non-vehicular cases will be addressed under the parameter of security.

The dramatic problems linked to the accelerated rise in the population and motorization includes the increase in traffic accidents, which result in loss of life and property damage.

Road traffic accidents (RTAs) are a major public health issue around the world, killing 1.24 million people in 2010_(WHO, 2013) and 1.35 million in 2016_(WHO, 2018). Injury deaths are highest in Africa and Southeast Asia, with 26.6 and 20.7 per 100 000 people, respectively, whereas Europe (9.3 per 100 000) and America (15.6 per 100 000) have the lowest rates. Not only that, but the trend from 2013 to 2016 indicates an increasing rate of death in Africa, the Eastern Mediterranean, and Southeast Asia and decreasing rate in Europe, America, and the Western Pacific. Even within high-income countries, people from lower economic backgrounds are more likely to be involved in road accidents; in fact, rates in middle-income countries are three times higher than rates in high-income countries (14.4 per 100 000 population vs. 5.1 per 100 000) in European regions. In African regions, there is also a gap between low- and middle-income countries (29.3 and 23.6 fatalities per 100,000 population, respectively)_(WHO, 2018). Various studies have been conducted in relation to the problem, but it is still growing, and more research should be conducted. There have been a number of research projects related to road traffic accidents. According to Farag Hashim (Farag, S. G., Hashim, I. H., & El-Hamrawy, S. A. , 2014), "a road traffic accident is a random event involving a road user that results in property damage, death, or injury." According to the WHO Global Status Report published in December 2018, road traffic injuries are the most common cause of mortality for individuals aged 5–29 years and the eighth largest cause of death for people of all ages (WHO, 2018). According to the report, Road traffic accidents (RTAs) affect individuals worldwide; different local factors influence the causes of RTAs in specific regions. RTAs can be caused by a variety of factors, including human or driver error, vehicular characteristics, and traffic infrastructure such as engineering design, road maintenance, and traffic control. According to the study, among the proven human factors connected to RTA are driver attitude, including road etiquette and attitude, driving while under the influence of substances, notably alcohol, sex, safety belt usage, and driver age (for teenage and elderly drivers) (Bjerre, J., Kirkebjerg, P. G., & Larsen, L. B., 2006). Non-fatal injuries are estimated to affect 20 million to 50 million people worldwide. It is also predicted that road traffic injuries will be ranked to 5th leading cause of death by 2030 (WHO, 2015). Of worry, though, is that RTA related fatalities seem to increase with the gross domestic product (GDP) per capital in lower-income countries and decrease with GDP per capital in wealthy countries. For instance, increase in GDP of 10% in a

low-income country (GDP/Capita \$5,600) through a process that is independent of population size, vehicle counts, oil use, and route availability, is anticipated to increase the number of crashes by 7.9%, traffic injuries by 4.7 percent, and traffic deaths by 3.1 percent (Bishai, D., Quresh, A., James, P., & Ghaffar, A. , 2006). Traffic accidents account for about 3000 daily fatalities worldwide, and are currently becoming a major public safety issue and it becomes obstacle for development around the world. The issue is particularly dangerous for developing countries. According to World Health Organization studies about road traffic deaths, the number of road traffic deaths continues to increase and reached 1.35 million in 2016 (WHO, 2018), More than 90 percent of road fatalities occur in low- and middle-income countries, which have only 48 percent of the world's vehicles with the remaining 8% occurring in high-income countries_(WHO, 2015). Pedestrians, cyclists, and motorcyclists, particularly those in underdeveloped countries, bear a disproportionate share of the burden. In Africa 4-wheel drivers /passengers and pedestrians take the largest share (40% each) followed by motorized three and two wheelers (9%), but in south east Asian countries about 43% which is the largest share of death comes from motorized 3 & 2 wheelers. For Europe and America, the largest death was recorded to drivers/passengers of motorized 4 wheeled vehicles (WHO, 2018). Statistical forecasts show that, traffic-related fatalities in high-income countries will fall by roughly 30% between 2000 and 2020. The opposite tendency is forecast in developing countries, where traffic accidents are expected to increase rapidly in the next years. The number of people killed in traffic accidents in Ethiopia is said to be among the highest in the world. Furthermore, it is sad to observe that pedestrian fatalities in developing nations such as Ethiopia are higher than in industrialized countries. For instance, 51% of the fatalities in the United States account for car drivers and 11% for pedestrians, while in Ethiopia only about 6% account for drivers and 55% for pedestrians (WHO, 2015) (Tulu, G. S., Washington, S., King, M., & Haque, M., 2013). According to the 2018 report, pedestrians account for approximately 37% of crashes, with the remaining 63% being others (WHO, 2018). This study is consistent with a recent study (Mariam, 2014), which found that from a total of 25,110 accidents and 3415 fatalities during the period 2000–2009 in Addis Ababa, the fatality distribution was 87% pedestrians, 9% passengers, and 4% drivers. Researchers point out some reasons for the pedestrian crash to be higher than motor vehicle crashes. Among these vehicle standards and crash worthiness, insufficient provision of pedestrian facilities, like lack of crossing facilities, pedestrian walk ways and invisible road lighting were the reasons (Tulu, G. S., Washington, S., King, M., &

Haque, M., 2013). Evidence obtained from the WHO's estimate in the 2015 report (WHO, 2015), shows that the road traffic crash caused a GDP loss of 0.8–0.9%; the incidence of road traffic fatalities in the country during the time was 25.3 per 100,000 populations, and this rate is among the highest in the world. According to numerous studies, driver-related issues were the leading cause of traffic accidents in Ethiopia. Driving without a license, vehicle technical failures, pedestrian faults, and road conditions (absence of well-designed infrastructure for pedestrians and engineering quality of the road design) are among the primary causes of traffic-related accidents in Ethiopia today (Tulu, G. S., Washington, S., King, M., & Haque, M., 2013). Despite the fact that, the condition of RTAs in many developing countries is deteriorating from time to time. The incidence of RTA-related injuries and fatalities remains scarce in several countries, including Ethiopia.

RTA deaths are anticipated to increase by 83 percent in low-income nations while decreasing by 27 percent in higher-income ones. As a result, RTA injuries would place a significant financial strain on health-care resources (Gopalakrishnan, 2012). In accordance with a study of RTA vehicle occupants, 37% were on motorcycles, 28% in 3-wheelers, 13% in dual-purpose vehicles, and 11% in buses (Bandara, K. V. U. K. S., Vadysinghe, A. N., & Edussuriya, D. H., 2019). Another study done in Sri Lanka by Department of Surgery (de Silva, M., Nellihala, L. P., & Fernando, D. , 2014), indicates that 54% of 3-wheeler crashes took place during the daytime (between 07:00 to 19:00), and passengers were the most common victims (40%). In addition, 3-wheelers going at fast speeds are the leading cause of accidents on major roads. Other major cause is under steering circumstances, which can occur when the 3-wheels are overloaded (Jayatilleke, A. U., Poudel, K. C., Dharmaratne, S. D., Jayatilleke, A. C., & Jimba, M., 2016) (Peiris, W. K. R., Shantha, K. Y. H. D., & Silva, S. A. P. S., 2016). Three-wheeler topples due to a sudden turn of the vehicle have accounted for 30% of accidents (de Silva, M., Nellihala, L. P., & Fernando, D. , 2014) and these vehicles are more prone to toppling (moving out of the way) due to impacts by external bodies such as, small vehicles (bikes), animals and pedestrians. This form of accident is caused by braking of the lock given for over steering control, and practically slip-free turning conditions (Peiris, W. K. R., Shantha, K. Y. H. D., & Silva, S. A. P. S., 2016). More importantly, 3-wheelers are generally less stable than four-wheel vehicles and can roll over if driven too rapidly around sharp curves or turned when braking hard (Starkey, P., Batool, Z., & Younis, M. W, 2019). Another study in Sri

Lanka pointed out that among all three-wheeler crashes studied in the time; drivers who rent the vehicle had higher chance of involvement in traffic accidents than drivers who drive their own vehicle (Sampath, H. M. R. C., & Fonseka, P., 2012). In all those who tampered with the handle-lock, toppling due to an abrupt turn was established as the cause of the accident. During the accident, 89% of the injured drivers were driving under the influence of alcohol (de Silva, M., Nellihala, L. P., & Fernando, D., 2014). The occurrence of crash in drivers who drinks alcohol and smoke was significantly higher than those who didn't do that (Sampath, H. M. R. C., & Fonseka, P., 2012). A similar study shows that more passengers (57%) were affected than drivers (52%), where there was toppling of the vehicle, but more drivers than passengers sustained injuries due to impact with objects, and there was no significant difference in the type of incident between the driver and passenger groups (Bandara, K. V. U. K. S., Vadysinghe, A. N., & Edussuriya, D. H., 2019). Study conducted in Tamale Metropolis about those three-wheeler crashes indicates, the majority of the crashes were occurred during the day time again 60 percent of the drivers have experience between 2-4 years and 16.9% between 4-6 years. All interviewed drivers were males, in addition to that from experience point of view, 22.3% had less than one year of experience. This result shows that more than 50% of the drivers have less than 4 years' experience, and most of the crashes occurred during the day rather than night time (Wahab, L., & Salifu, M., 2017). Furthermore, a study in Sri Lanka indicates that most of the three-wheeler-crashes were discovered to have occurred during daytime hours in a heavy traffic and in clear weather. The majority of three-wheeler crashes included two vehicles. During the relevant study period, the majority of all three-wheeler-crashes occurred on weekdays. When three-wheelers were operated by male drivers in the age interval of 21 and 40, a high proportion of crashes occurred and the main crash occurring areas for three-wheeler were intersection locations (Amarasingha, 2015). Analysis of three-wheeler accidents reveals that toppling occurred in the majority of cases before the impact (hitting the other vehicle/obstacle) and it was the main constraint when attempting to avoid an obstacle by turning, braking, and accelerating (Peiris, W. K. R., Shantha, K. Y. H. D., & Silva, S. A. P. S., 2016). A study conducted in Sri Lanka concluded that males in the age interval of 21 and 40 were the most vulnerable age groups. The most prevalent type of accident was the vehicle tipping over (Bandara, K. V. U. K. S., Vadysinghe, A. N., & Edussuriya, D. H., 2019) (Amarasingha, 2015) and two vehicle crashes (three-wheeler and other vehicle) (Amarasingha, 2015). The majority of the people were injured when they collided with stuff inside the three-wheeler. The most prevalent

type of injury was abrasion, and the limbs were the most afflicted body part. Majority of the injuries were not life-threatening, and there was no significant difference in injury patterns between the driver and passengers but rear passengers were injured than the driver (Bandara, K. V. U. K. S., Vadysinghe, A. N., & Edussuriya, D. H., 2019). Moreover taking more than three passengers in the passenger seat(overloading) (Peiris, W. K. R., Shantha, K. Y. H. D., & Silva, S. A. P. S., 2016), higher age of the three-wheeler vehicle, drivers experience < 1 year and >5 year and convictions by police for traffic law violations were some variables that had significant association with three-wheeler crash (Jayatilleke, A. U., Poudel, K. C., Dharmaratne, S. D., Jayatilleke, A. C., & Jimba, M., 2016), and lack of required driving skill can also be one cause for three-wheeler crash (Wahab, L., & Salifu, M., 2017). Furthermore, 3-wheelers are intrinsically less stable than four-wheel vehicles, and can roll over if they go fast on sharp curves or turn while braking hard (Starkey, P., Batool, Z., & Younis, M. W., 2019).

Global status report 2018 shows that majority of road user deaths in Sri Lanka is taken by motorized two and three-wheeler vehicle riders (51%) followed by pedestrians (29%) and cyclists take the third (8%) position of death, by proportion the largest percentage of the countries vehicle type is also taken by these two and three-wheeler motorized vehicles (71%) followed by Cars and 4-wheeled light vehicles (11%) (WHO, 2018), but for Ghana that have the vehicle proportion of two and three-wheelers from the total vehicle (25%) that takes the second position next to Cars and 4-wheeled light vehicles (57%), the majority of road deaths is taken by pedestrians (46%) followed by motorized 2- and 3-wheeler riders (18%). Studies both in Sri Lanka and Tamale metropolis shows that most of the drivers of 3-wheelers are adult aged groups, and female drivers are small in number or has no participation in driving of 3-wheelers. Global status report in 2018 also indicates that riders of two and three-wheeler vehicles take the first position of death in India (WHO, 2018). In Sri Lanka the largest proportion of the vehicle is taken by these two and 3-wheelers and the number of deaths also high for the drivers of these two and three-wheeler vehicles. This result shows that the death of drivers is proportional to the number and type of total registered vehicles in the country. For Ethiopia there is no available data in WHO 2018 report. But a health study conducted in Wolaita Zone indicated that 14.2% of the hospital reported cases were due to three-wheeler related injury crash (Hailemichael, F., Suleiman, M., & Paulos, W., 2015). When it comes to the scenario in the study area (Ethiopia), it can be seen that there is property loss as a result of traffic accidents. In terms of a percentage of GDP, it dropped from 0.09 percent in

2001/02 to 0.03 percent in 2007/08, and then recovered to 0.09 percent in 2009/10 before dropping to 0.02 percent in 2010. This is owing to the fact that nominal GDP has grown faster than the value of damaged property (Ethiopian Economics Association, 2012). Again, narrowing the situation to the study area, it can be seen that regional traffic accident data to arrive to the research area. As it stated before the research area which is Kombolcha city is belongs to the Amhara regional state.

Amhara region is among the regional states of Ethiopia and accounted for 27.3% of the total road traffic accident-related deaths in the country during the year 2008/9, which is the highest share among the other regions like Oromia (22.7%) and Addis Ababa (21.2%) of the country (Ethiopian Economics Association, 2012). This entails the need to study the overall condition and trend of road traffic crashes in the region. Evidence from another study about road traffic incidents in the regional state provides that crashes involving vehicle-pedestrian interaction account for the largest share (54.5%), vehicle-vehicle collision (10%), and vehicle-road-structure crashes account for 35.5%, and the highest number of deaths were recorded from fright vehicles followed by passenger transport vehicles (Mekonnen, F. H., & Teshager, S., 2014). From the 11 zones of the regional state, North Gondar, South Gondar, and South Wollo zones recorded the highest absolute number of deaths in 2011. The region's urban areas have the highest proportion of accidents, with Dessie accounting for 48.5%, followed by Gondar (86.3%) and Bahir Dar (54.8%). Finally, at the regional level, 56 percent of those killed were commuters in vehicles, while 35.7 percent were pedestrians (Mekonnen, F. H., & Teshager, S., 2014). Related to 3-wheelers, customers disagree with the items (3-wheeler drivers follow traffic rules, drive at a safe speed, and drive without the influence of any other drugs (alcohol, chat) according to research conducted in Debre Markos City on 3-wheeler taxis and resulting from descriptive statistics on safety dimensions) (Getachew, 2019). There have been a few types of research on road traffic accidents separated by vehicle types, especially public transportation vehicles in the Regional State (ANRS). Therefore, the current study aims to investigate the traffic safety, specifically three-wheeler taxi accidents, in one of the regional state cities of Kombolcha, which is under the south Wollo zone.

2.3 Summary and Gaps of the Literatures

The literature review establishes the prerequisite for the work's necessity in order to make comparisons and references with the aspect of current transportation problems around the world. Currently, the transport demands of society increase in parallel with the increase in human activities and globalization. The transportation sector may have problems like safety, security, accessibility, reliability, comfort, mobility, and others that oppose the environmental and transportation rules. Different scholars studied these problems in different countries in order to satisfy the mobility needs of passengers. One of the most serious issues concerning public transportation is safety, which is the eighth leading cause of death for people of all ages and the number one cause of death for people aged 5 to 29 (WHO, 2018). In most of the published papers, safety is analyzed from secondary data in traffic police crash report centers (Mekonnen, F. H., & Teshager, S., 2014), (WHO, 2015), (WHO, 2013), (WHO, 2018), (Ethiopian Economics Association, 2012) and health centers (de Silva, M., Nellihala, L. P., & Fernando, D., 2014). There are few studies that try to address the safety issues of 3-wheelers in some Southeast Asian countries (Amarasingha, 2015), (Bandara, K. V. U. K. S., Vadysinghe, A. N., & Edussuriya, D. H., 2019) and some African countries (Getachew, 2019) (Wahab, L., & Salifu, M., 2017). Those studies, conducted in some Southeast Asian countries, analyzed secondary data collected from hospitals and police-recorded crashes. However, there is a lack of studies concerning the safety of 3-wheelers in African regions, especially in Ethiopia. Although there are very limited studies in the country concerning the problem, these studies are not done from secondary data sources and are based on primary sources (questionnaires), which are perceptions from users and express their feelings only, but may not include the actual condition, including the types of accidents that involved 3-wheelers, severity levels, causes of accidents, and other related safety issues concerning 3-wheelers. Therefore, it is important to address these questions, and this research tries to fill this gap by adopting data from secondary (police-reported crash) sources and from primary sources (questionnaires) to support the secondary data. The other issue concerning 3-wheelers as public transport is the security problem. Scholars studied the security problem related to crimes in different areas for different types of public transportation (Newton, 2004), (Odufuwa, B. O., & Fasina, S. O., 2012), (Kruger, T. P. J., & Landman, K., 2007), (Allen, H., Cárdenas, G., Pereyra, L., Sagaris, L., 2019), (ITF, 2018) by collecting primary data through questioning and interviews. To investigate the security problems of public transportation, most scholars mainly use primary

data from individuals that are victims of the problem. As stated before, primary data alone may not express the existing condition, and it gives limited information regarding the problem. On the contrary, past recorded data gives the actual (real) condition that happened before, and it gives more information regarding the problem. Furthermore, in the majority of public transport security studies, 3-wheelers have not been studied as a mode of public transportation, despite the fact that they are now the most widely used mode of public transportation in towns, secondary cities, and the city sides of large cities. Particularly in Ethiopia, there is a lack of study regarding 3-wheeler security as a public transport mode. Here on, there is a study conducted in Ethiopia on customer satisfaction through a questionnaire (Getachew, 2019). However, as stated before, this study (Getachew, 2019) and others done on public transport security use questionnaire data only, and they lack evidence on the crime types by place of crime, the association of crime types and crime place, victims by demographic characteristics, three-wheeler driver characteristics (their involvement in criminal activities), and the volume of crime related to social activity. Moreover, regarding security, previous studies have focused on gender-based violations and other criminal activities, some of which undermine theft, which has become a big problem in recent days in all types of public transport systems. This study aims to address the above-mentioned gaps, which are not adequately addressed by scholars in terms of the mode and geographical area of the study, and give emphasis to other studies that will focus on the problem.

In general, the literatures add value to the world through their respective study areas and topics. All of the listed literatures are valuable for this study by contributing their methodologies and identifying areas that need to be studied by other researchers. The researcher uses some of the methodologies from these previous works that are applicable to the study area and the research topic. For instance, the researcher used a method of logistic regression analysis (Kadilar, 2016) (Rezapour, M. and Ksaibati, K., 2018) to predict the relation between dependent and independent variables mentioned in this study for both crime and crash data analysis.

CHAPTER THREE

3. RESEARCH METHODOLOGY

Under this section, the study area, type of research, sample size determination, sampling technique, source of data, methods of data collection, and analysis techniques were elaborated.

3.1 Description of the study area

Ethiopia is a landlocked country in the Horn of Africa that covers a total area of 1,126,829 km² and has over 118 million inhabitants (Central Statistical Agency, 2013). Amhara regional state is one of the ten regional states of the country and contains 18% of the country's population (Teshale, B., Lee, R., & Zawdie, G, 2002). Further on that, Kombolcha city is located in the north-central part of Ethiopia and is found in the Amhara Regional State's south Wollo Zone, with a latitude and longitude of 11°5'N 39°44'E and an elevation of between 1842 and 1915 meters above sea level. According to the central statistics data for 2007, the city has a total population of 85,337(41,947 (49.2%) men and 43,390 (50.8%)) women (Ethiopia, C. C. S. A, 2008), and a predicted population of 93,936 in 2016. The main economic activities of the city are trade, public services, and transport. The city is home to different industries like Kombolcha Steel Products, a metalworking factory, and Kombolcha Textile Factory (KTF); it shares Kombolcha Airport with neighboring Dessie; and the city is also served by a station on the Awash-Woldia standard gauge railway under construction that will serve as a northward extension of the new Ethiopian National Railway Network (Ethiopian Railways Corporation, 2023).

As stated before, the city is one of the industrial villages and a center for connecting the northern part of the country to the central part of the country. Different types of freight and passenger vehicles enter and pass through the city. Besides this, the main public transport mode in the city is three-wheeler taxis, and serves in a mixed traffic system.



Figure3. 1 Relative location of Kombolcha city from Addis Ababa and BahirDar

The main public transport mode of the city is three-wheeler taxis, but there are some four-wheeler public transport vehicles, locally known as minibus taxis, Damas and Suzuki (having a loading capacity of up to six passengers at once), and four-wheel Bajaj loading four passengers during a single trip. The data obtained from Kombolcha city transport bureau and 3-wheelers association indicates that the largest share (98%) of the city’s public transport service is provided by three-wheeler (Bajaj) taxis, and the remaining 2% provided by four-wheel public transport vehicles having a loading capacity of four to twelve passengers.





Figure3. 2 Types of four-wheel public transport vehicles in Kombolcha city



Figure3. 3 Three- wheeler (Bajaj) taxis in Kombolcha city

NB: Throughout this study Bajaj and three-wheelers are used interchangeably.

3.2 Research Type

This study is mainly quantitative research. A quantitative investigation is all about objectivity and collective behavior, with no regard for individual participant thoughts; it looks for strength in numbers and analyzes trends in user behavior based on numerical data, statistics, and percentages. Moreover, it focuses on the big picture from groups with a significant sample using questioners, surveys, and counts. In addition, there is also a qualitative explanation of some variables that need justification.

3.3 Sample Size Determination

Sample size refers to the number of observations used for determining the estimations of a given population. Sampling is the process of selecting a subset of individuals from a population to estimate the characteristics of the whole study population. In order to calculate sample size, variables such as population size (known or unknown), margin of error to account for uncertainty, confidence level, and standard deviation should be known. The size of the sample has been drawn from the population. Sample size can be calculated using different formulas, but for this study, **Cochran's formula** was used.

The sample size for an infinite population is calculated by taking the population size unknown, 95% confidence level with Z-score ($z=1.96$), degree of variability or population proportion ($p = 0.5$). Here, the population of the study does not have significant variation in transport usage, but to be conservative, the proportion is taken as 0.5, and margin of error (level of precision) is taken as $\pm 5\%$ ($e = 0.05$). Then by applying Cochran's (1977) correction formula;

$$\text{Necessary Sample Size } (S_i) = \frac{(Z\text{-score})^2(p)(1-p)}{(\text{margin of error})^2} = \frac{(1.96)^2(0.5)(1-0.5)}{(0.05)^2} = 384.16 = 384$$

Adding 10 percent to account for possible non-responding questions, the total sample size for the questionnaire is calculated as $(384 + 384 * 10\%) = 384 + 39 = 423 = 430$.

3.4 Sampling Technique

The main objective of the research is evaluation of the variables affecting the safety and security of 3-wheeled motorized vehicles, which are called Bajaj taxis in Kombolcha city. As it is obtained from the city's public transport authority office, there are around sixteen (16) 3-wheeler distribution routes, and there are a total of 2412 public transport vehicles from seven 3-wheeler associations. The number of 3-wheelers assigned per distribution route varies based on the social

and economic activities of the society. Considering that, a probability sampling technique called stratified sampling, followed by simple random sampling techniques, is adopted. This is done for each distribution route based on the number of 3-wheelers assigned to that specific route in the city. The stratified sampling technique was applied in such a way that the total sample size (for both drivers and passengers) is proportionally divided according to the relevant variable called distribution route (see *Table 3. 1* below). After getting the number of sample respondents for each stratum (distribution route), the target respondent from each stratum was selected by a simple random sampling technique, and this was done to give an equal and non-zero chance of selection for each element in the sampling strata.

The primary data obtained from the questioner assists the researcher in obtaining evidence on the variables of passenger safety and security that are not available as secondary data in the study area's police office.

3.5 Source of Data

Data collection refers to gathering specific information required to provide relevant information needed for a particular study. This study has both primary and secondary sources of data.

3.5.1 Primary Data (Questionnaire)

The primary data for the study are collected in the field via questionnaires.

A questionnaire is a type of research tool that consists of a series of questions meant for collecting information from the intended respondents. It is beneficial due to the uniformity of the questions for the respondents, which means all respondents can receive the same questions. Questioners can be structured or unstructured. For this particular study, structured questionnaires are designed to gather information from drivers and passengers of 3-wheeled auto rickshaws (Bajajs) in the city.

The questionnaires are designed and prepared separately for two types of participants (3-wheeler drivers and passengers). For the drivers, the questionnaire contains their demographic characteristics (sex, age, and marital status), license status (experience), driver and vehicle relationship (employee or owner of the vehicle), typical working conditions (working hours per day for weekdays and weekend days), problems faced, educational level, age of the vehicle, number of crashes they have been involved in and time of crash, and similar issues. Similarly,

questionnaires for 3-wheeler users have three parts. The first part is the basic information part and contains questions about demographic information, mode of transport used, reasons for choosing a particular transport mode, frequency of three-wheeler usage in a week, and purpose of trip.

The second part concerns safety issues and contains questions about passengers' feelings of safety while travelling by three-wheeler, indirect experience of three-wheeler accidents (frequency of hearing or seeing three-wheeler accidents in the city), the drivers' behavior whether they are exposed to accidents or not, the discipline of drivers in a mixed traffic system, distractions to the driver such as using mobile phones and eating chat while driving, which are considered as the driver factors for the occurrence of RTAs, the city's traffic police controlling level of the traffic activity, and contributory factors for 3-wheeler accidents in Kombolcha city. The final section of the questionnaire is about security against crime for three-wheeler users and includes questions about their feelings of safety while traveling or considering traveling by 3-wheeler, whether they have been convicted of a crime before or not, the type of crime committed, the number of crimes committed against them, the location where the crime was committed, the condition of reporting the crime to the police, and the police response. And finally, there is a question that the respondents asked: whether there is a need for an alternative or additional public transport mode in the city or not, and what type of transport mode should be provided.

For the study, multiple-choice questions were chosen to ensure that none of the participants was disadvantaged due to writing limitations.

The questionnaire was constructed in English first, then translated into Amharic. The translation of the schedule familiarizes the respondent with the subject and makes the question understandable to the respondents.

The breakdown of the questionnaire for each distribution route is made by proportioning the number of respondents to the number of 3-wheelers assigned for each distribution routes (*Table 3. 1* above)

Table 3. 1 Break down of questionnaire per distribution route

Location of distribution routes	Share from one association	Vehicles Assigned /trip line	No of sample drivers to be questioned	No of sample Passengers to be questioned
Commercial Bank - University Kombolcha	68	544	32	65
Commercial Bank- OIC	7	56	3	6
Commercial Bank- Kebele 01	20	160	10	19
Kaleb building- addis sefer menafesha	35	280	17	33
Dashen -kebele 01	6	48	2	5
Dashen Bank-Piassa	5	40	2	5
Dashen Bank-Asseb gate	5	40	2	5
Dashen Bnk -Mitikolo Kombolcha Gate	10	80	5	10
Fun Caffee-Megenteya Metrology	60	480	29	57
Weyraw-kebele 01	10	80	5	9
kalu bank-Megenteya Kospi	30	240	14	29
Kalu bank-Tebisa	10	80	5	10
Kospi-Old airport	10	80	5	10
Kospi-Trinity	10	80	5	10
Borkena-E/PO/BA Tenkaka	10	80	5	10
Borkena-E/PO/BA Qurangoye	5	40	2	4
Total		2408	143	287

Source: Kombolcha city transport bureau and researcher own

In the study, a pilot survey test was applied to predict the response patterns of participants, the inclusiveness of the questions, and to apply any modifications to the research process (questionnaire). Pilot survey gives the researcher ideas, approaches, and clues that they may not have considered previously. Generally, it is an opportunity to get valid feedback from target groups of the convenience sample that helps the researcher improve the data collection process.

The survey instrument of this study was pre-tested on some three-wheeler transport users and drivers for clarity, inclusiveness, and practicality. Thirty (30) questions for passengers and fifteen (15) questions for drivers were distributed, and out of them, fifteen (15) questions from passengers and five (5) questions from drivers were filled out and returned; the remaining were not filled; some were returned as distributed, some were filled out partially, and some were not returned at all. The pilot test was done between August 26, 2022, and September 5, 2022, for ten consecutive days. During the pilot test, it was observed that respondents were bored with filling out the questions due to the large number of questions and some clarity problems that made them tired and careless with the responses they gave. Additionally, because of their boredom, they took the papers and disappeared, and when asked to return them, they led to insults and fights (this problem was mainly observed on drivers). Based on that result modifications like reducing the number of

questions (the number of pages of the question paper) and increasing the clarity of the questions were made from September 9, 2022, to September 14, 2022.

The data collection looked that, questions were distributed to passengers and drivers around the three-wheeler taxi terminals during the working days of the week and filled out collected by data collectors under the supervision of the researcher. At the beginning, respondents were informed that the present research aimed to determine the service level of three-wheeler taxis with respect to safety and security in Kombolcha city. In addition to that, they were also informed that their participation was voluntary, their identity would remain anonymous, and they would receive no compensation for participating in the questionnaire. Participants/3-wheeler users were asked to complete a questionnaire while waiting for, coming from, or sitting inside 3-wheelers.

Questions for drivers are filled in around three-wheeler terminals while the drivers wait for passengers. By the time, there was a war (between TPLF and the federal government of Ethiopia) 150 kilometers from the study area, and due to that, the main roads were cleared of those 3-wheelers (Bajajs) to allow easy circulation of military vehicles. As a result, 3-wheelers were ordered to work on internal roads segregated through villages, this caused them to wait longer for passengers, and the researcher took advantage of this opportunity to collect data from three-wheeler drivers easily. It was the passenger's questionnaires that were difficult. The questions were not answered and did not end with a trip for short-distance routes. To solve this problem, the researcher fixes a place (a shop) by negotiating with shoppers near 3-wheeler terminals and tells the respondents to put the paper in that place after filling it. The shoppers receive and carefully hold the paper until the data collector takes it. This method solved the problem for short-distance routes and also for the passengers that come to the station and board the 3-wheeler without waiting at the station. As passengers waiting for a three-wheeler, the remaining questionnaires were filled out and collected from the respective 3-wheeler terminals along each distribution route.

3.5.2 Secondary Data

Secondary data used for the research was collected from a different source at different times of the study period. The secondary data sources are the Kombolcha city transport bureau, the city three-wheeler and taxi owners' association, the city police departments (Berbere Wenz and Shisha Ber police stations), and relevant published and unpublished documents. The city's police department

serves as a secondary source for both crime and crash data, while the city's transport bureau provides the number of distribution routes, their locations, and the respective number of 3-wheelers assigned per distribution route. From the three-wheeler and taxi owners' association, the researcher obtains yearly registered three-wheeled public transport vehicles.

For crash data, a ten-year evaluation period was chosen, from September 2011/12 to September 2020/21, and for crime data, a three-year evaluation period (2016/17 to 2018/19) was chosen because it was available at the city police department. According to the United States Census Bureau 2019, sample sizes of 1 year, 3 years, 5 years, and more can be used. Five-year or more data is beneficial in terms of getting a large data sample and the most reliable data to identify trends, and a 5-year or more data set is best used when accuracy is required (US Government, 2019).

Data collected from the city's transport bureau (office) and from the three-wheeler owner's association contains the number of registered vehicles in the city standing from some years back up to the study year (2021/22). The data that was collected from the three-wheeler taxi owner's association and from transport offices was used to get the vehicle proportion in the city, specifically the service share of different public transport modes, and the data obtained from the city's 3-wheeler and taxi owners associations indicates that there were around seven (7) three-wheeler taxi owners associations and one (1) four-wheel (taxi) owners association. From all associations, 4 years (from 2018/19 to 2021/22) of data were collected to understand the trend of vehicle growth in the city.

Table 3. 2 Number of public transport vehicles in four consecutive years per association

Name of association	Year(G.C)	Total number of registered vehicles in the association	Name of association	Year(G.C)	Total number of registered vehicles in the association
Andnet	2018/19	300	Zenbaba(4-wheeled vehicles)	2018/19	130
	2019/20	296		2019/20	79
	2020/21	299		2020/21	57
	2021/22	289		2021/22	55
Fetan	2018/19	302	Yegof	2018/19	0
	2019/20	270		2019/20	265
	2020/21	265		2020/21	272
	2021/22	300		2021/22	296
Selam	2018/19	0	Borkena	2018/19	0
	2019/20	298		2019/20	0
	2020/21	283		2020/21	286
	2021/22	272		2021/22	303
Bikat	2018/19	295	Tiret	2018/19	270
	2019/20	289		2019/20	298
	2020/21	284		2020/21	300
	2021/22	300		2021/22	302

Source: Kombolcha city public transport owners' association

Out of the total number of 2412 registered public transport vehicles in the year 2021/22, **98%** (2357) were three-wheeler public transport vehicles with a legal loading capacity of three passengers, and the remaining **2%** (55) were four-wheel public transport vehicles, including minibus taxis and others, that have the capacity to load from 6 to 12 passengers.

The number of four-wheel public transportation vehicles decreases year after year, while the opposite was true for 3-wheeled vehicles. This shows that, mainly, the city's public transport is provided by three-wheeler vehicles.

Table 3. 3 Number of registered public transport vehicles and their percentage change

Study year	Total registered vehicles		percentage change(%)	
	Bajajs	4-wheel P.T vehicles	Bajajs	4-wheel P.T vehicles
2018/19	1217	130		
2019/20	2006	79	64.83	-39.23
2020/21	2274	57	13.36	-27.85
2021/22	2357	55	3.65	-3.51

Source: Kombolcha city P.T vehicle owners association

Registered crime cases involving three-wheeler taxis and details of police-reported crashes were another type of secondary data collected from the city's regular police offices and traffic police offices respectively. The dataset contained information related to every police-reported three-

wheeler (Bajaj) and other vehicle crash in the city, integrating various driver, vehicle, environment, and road-related characteristics that prevailed at the time of the crash. This secondary data is used to determine the number of accidents involving three-wheeler taxis in the city, as well as the pattern and type of crime committed against passengers and drivers of those three-wheeler taxis.

3.6 Reliability and Validity Test

The internal consistency of the constructs in the study is measured by reliability. Internal consistency assesses data reliability by determining how closely linked a group of variables are. Cronbach's alpha is used to examine this assumption and to test whether the interrelated items have high communalities and low uniqueness. Higher Cronbach's alpha scores demonstrate higher interrelated reliability. Based on the rule of thumb about Cronbach's alpha coefficient size (Hair, J. F., Money, A. H., Samouel, P., & Page, M, 2007) alpha scores of 0.7 to 0.8 are considered to be good, and higher values are considered to be better than this.

For this particular study, construct reliability was assessed using Cronbach's alpha and the results are indicated below (Table 3. 4 and Table 3. 5) Both alpha values fall within an acceptable range, and as a result, the questionnaire is reliable. Furthermore, the researcher also avoids variations from group to group by designing and asking similar questions for each sample respondent.

Table 3. 4 Cronbach's alpha value of questionnaire for drivers

Reliability Statistics	
Cronbach's Alpha	N of Items
.743	53

Table 3. 5 Cronbach's alpha value of questionnaire for passengers

Reliability Statistics	
Cronbach's Alpha	N of Items
.707	59

In order to ensure the validity of the study different steps were taken: Data was collected from reliable sources, including a respondent who has experience using three-wheeler taxi transportation. Questionnaires were developed based on a literature review and frame of reference, and they were translated into the respondents' native language to ensure clear comprehension and result validity. To minimize the change of major events related to the topic, data was collected in

less than a month. Moreover, the survey questions were administered and collected under the serious supervision of the researcher to arrive at a reliable result.

3.7 Analysis Methods and Tools

Primarily, the collected data from both primary and secondary sources was coded, cleaned in Microsoft Excel, and entered into Statistical Analysis Software (SPSS.v26). SPSS was used to generate both descriptive and inferential statistics from quantitative data. After doing that, the data obtained from both primary and secondary sources were quantitatively summarized and interpreted using tables and graphs.

3.8 Data description

Because regression is a necessary component of any data study that seeks to describe the relationship between an outcome variable and one or more explanatory factors (Hosmer Jr, D. W., Lemeshow, S., & Sturdivant, R. X., 2013), this research adopted logistic regression (Binomial logistic regression, ordinal logistic regression and multinomial logistic regression) to predict the dependent variable from the explanatory variables.

One application of logistic regression is estimating the likelihood of an event occurring, and it is used when the dependent variable is anticipated to be nonlinear with one or more of the independent variables. Logistic regression can demonstrate which of the different factors under consideration has the strongest relationship with an outcome and provide a measure of the degree of the potential influence (Tolles, J., & Meurer, W. J. , 2016) (Warner, 2008).

The logarithm of the probability of that response value is modeled for each combination of explanatory variables (which is termed a logistic transformation). Each association in the model is summarized or estimated using an odds ratio (OR). In Logistic regression, when the response variable is polychotomous (multi-variable), there are two types of outcome variables: multinomial and ordinal. When the dependent variable is classified according to its order of magnitude, a multinomial logistic regression model cannot be employed; instead, ordinal logistic regression should be used. However, if the dependent variable is binary, binomial logistic regression should be utilized.

3.8.1 Binomial Logistic Regression

Based on one or more continuous or categorical independent variables, a binomial logistic regression (commonly referred to as just "logistic regression") estimates the likelihood that an observation would fall into one of two categories for a dichotomous dependent variable.

Binomial logistic regression model can be represented by the equation: -

$$\text{Log(odds)}=\text{logit}(P) = \ln \left(\frac{p}{1-p} \right), \quad P = \frac{\exp(a+b_1 x_1+b_2 x_2+b_3 x_3 \dots b_n x_n)}{1 + \exp(a+b_1 x_1+b_2 x_2+b_3 x_3 \dots b_n x_n)}$$

Where: -

P = the probability that a case falls in a particular category,

exp = the exponential function (approx. 2.72),

a = the constant (or intercept) of the equation

b = the coefficient (or slope) of the predictor variables.

X= predictor variables

Assumptions of binomial logistic regression

1. Response variable should be dichotomous but may have one or more independent variables either continuous (interval or ratio) or categorical (nominal or ordinal)
2. The observations are independent
3. Little or no multicollinearity between the predictor/explanatory variables
4. There should no extreme outliers

In this particular study, binary logistic regression analysis was applied to crime places (inside the three-wheeler or outside it) with predictors of crime types, victims' types in terms of driver or passenger, and the drivers' involvements in the crime.

3.8.2 Ordinal logistic regression

Ordinal regression models are statistical models that describe the dependency of an ordinal variable on one or more explanatory factors (Armstrong, B. G., & Sloan, M. , 1989) (O'Connell, A. A., 2006). When the responses have a natural ordering, the model specification should take that into account in order to handle the extra information in the model (Das, S., & Rahman, R. M., 2011). Ordinal response variables are common when a researcher wants to evaluate the satisfaction and feelings of customers (in this case, passengers). In OLR, the dependent variable is the ordered

response category variable, while the independent variables might be categorical, interval, or ratio scale variables. The general formula for ordinal logistic regression is: -

$$\text{Logit (P (Y ≤ j))} = \log \left(\frac{P(Y \leq j)}{1 - P(Y \leq j)} \right) = \alpha_j + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p$$

Where: P (Y ≤ j) is denoted as the cumulative probability of an event

J= 1, ..., J-1 are the levels of the ordinal outcome variable Y

X₁, X₂, ..., X_p are the predictor variables

If we have j categories, then we will have j-1 simultaneous equations and each equation has α different intercept α^j (threshold) but a common slope β.

Important assumptions of ordinal logistic regression are:

1. The dependent variable should be ordinal.
2. One or more of the independent variables can be continuous, categorical, or ordinal.
3. The assumption of proportional odds should be satisfied (test of parallel lines).
4. There is no important multicollinearity (the independent variables are not strongly correlated with each other).

In ordinal logistic regression a positive logit coefficient indicates that a person is more likely to fall into a higher category of the outcome variable than a lower category.

In this study ordinal logistic regression analysis was applied to questionnaire data of 3-wheeler passengers' safety and security feelings and their satisfaction level as dependent variables.

Table 3. 6 Dependent and independent variables for OLR

Response Variable	Explanatory variables
Passengers' safety feelings when travelling by 3-wheelers	Sex, Age, Passenger's occupation and 3-wheeler usage frequency in a week
Passengers' security feelings when travelling by 3-wheelers	Sex, Age, Passenger's occupation and Travel frequency in a week
Passengers' general satisfaction level with 3-wheelers service	Sex, Age, Marital status, educational level, Occupation, Travel purpose and 3-wheeler usage frequency in a week,

3.8.3 Multinomial logistic regression

On the other hand, multinomial logistic regression was applied to both crash data (accident type and severity level) and criminal data (type of crime) as dependent variables. Generally, MLR model is used when the dependent variable has more than two nominal or unordered categories and the independent variables can be any type (continuous or categorical).

Multinomial logistic regression model can be represented by the equation: -

$$\text{Logit}(P) = \ln \left(\frac{p}{1-p} \right) = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \dots$$

Where: p is the probability of an event happening, which we are trying to predict in the study (logit response)

- a is the constant term, which will be the probability of the event happening when no other factors are considered, and β’s are regression coefficients
- X₁, X₂, and X₃ are the explanatory variables that determine the occurrence of an event

Important assumptions of multinomial logistic regression are

1. The response variable should be categorical with three or more categories
2. There should no significant outliers in the data
3. Independence (each value of the variables doesn’t “depend” on any of the others)
4. There should no important multicollinearity between independent variables

Table 3. 7 Variables analyzed using multinomial logistic regression

Dependent variables	Predictor variables
Variables related to crime	
Crime types (the type of crime committed related to 3- wheelers)	Gender, shift of the day and driver involvement
Crash variables	
Type of accident	Road geometry, causes of accident and vehicle type involved in the crash
Crash severity level	Vehicle type involved in the crash, type of crash and causes of accident

In addition to logistic regression, Mann-Whitney u test and Kruskal-Wallis were utilized to identify the existence of differences in passengers’ attitudes towards the city’s three-wheeler driver’s behavior and their indirect experience of three-wheeler related crashes and crimes across

users' gender and travel frequency. The reason behind using the Mann-Whitney u test instead of the t-test and ANOVA is that the Mann-Whitney u test is used when the variable of interest is not normally distributed and if the dependent variable is ordinal. Particularly, the two tests (the nonparametric Mann-Whitney U-Test and the parametric t-Test for Independent Samples) may serve comparable functions in that they both look for statistically significant differences between two groups. However, the Mann-Whitney U-Test, is used with nonparametric data (typically ordinal data), whereas the t-Test for Independent Samples is used with data that meets the assumptions of parametric distributions (typically interval data that approximates an acceptable level of normal distribution)_(MacFarland, T.W. and Yates, J.M., 2016). Moreover, the Mann-Whitney U and the Kruskal-Wallis H vary primarily in that the latter can accommodate more than two groups. Both tests require independent (between-subjects) designs and rely on summed rank scores to provide results_(Moro, D., Villemain, D., Vuillez, J.P., Delord, C.A. and Brambilla, C., 1995). Besides these quantitative tests, qualitatively, some questions, like the reason for the underreporting of both crash and crime incidents, three-wheeler-related crimes not going through investigation, and the police's response to crimes, were informally justified.

CHAPTER FOUR

4. Analysis and Discussion

This chapter presents the findings of the study as part I secondary data and part II primary data

4.1 Crash Data (Secondary data)

4.1.1 Demographic information of drivers involved in crash

Demographic information contains gender, level of education and age of drivers.

4.1.1.1 Gender and age of drivers

According to Kombolcha traffic police data (2011/12 to 2020/21) the majority of drivers were males. As shown in *Table4. 1*, the majority of all other vehicle drivers (99.7%, or 305) were also males, with the remaining 0.3% (1 driver) being female. The sex distribution of three-wheeler drivers was also similar, meaning that about 99 percent (212) of drivers of 3-wheelers were males, and the remaining 1% (2) was females, this is consistent with earlier similar studies in south-east Asian countries and others, indicating that crash involvement of male three-wheeler drivers outnumber female three-wheeler drivers (Amarasingha, 2015) (Wahab, L., & Salifu, M., 2017), and the reason for this was stated as the presence of more male drivers in the field than female drivers.

Table4. 1 reveals that, 65% of three-wheeler drivers were in the age group of 18-26 followed by 27-31 (20%), and the age group 32-40 covers 9% of the drivers. The others 41-50, ≥ 51 and < 18 covers 3, 2 and 1 % respectively. This result shows that the majority of three-wheeler drivers fall under the age group of 18-31 and there are very few drivers in the age < 18 and ≥ 41 . An earlier study found approximately the same result: that the majority of three-wheeler drivers involved in accidents were between the ages of 21 and 30 (Amarasingha, 2015). Similarly, 35% (108) of all other vehicle drivers involved in an accident fall under the age group of 18-26 and 25% (78) were in the age group of 27-32 followed by the age group of 32-40 which covers 24% (73) of the drivers involved in the accident. The remaining age intervals 41-50(30), ≥ 51 (14) and < 18 (3) covers 10 %, 5 % and 1 % respectively.

Again, regarding educational qualification of drivers, the data indicates that majorities 64 % (138) of three-wheeler drivers have an academic qualification of secondary school education (9-12 grade) and 19 % (41) were college graduates. The remaining 15 % (32) were completed primary

school education. The result shows that in both cases (3-wheelers and all other vehicles) majority of the drivers had an academic qualification of secondary school (9-12 grades) (see *Table4. 1* below).

Table4. 1 Basic informations of drivers involved in crash

Variables		All other vehicles		Three-wheelers	
		Number	%	Number	%
Gender	Male	305	100%	212	99%
	Female	1	0%	2	1%
Total		306	100%	214	100%
Age	<18	3	1%	2	1%
	18-26	108	35%	139	65%
	27-31	78	25%	43	20%
	32-40	73	24%	19	9%
	41-50	30	10%	7	3%
	≥51	14	5%	4	2%
Educational level	Un-educated	9	3%	1	0%
	Basic education	1	0%	0	0%
	Primary school (1-8)	59	19%	32	15%
	Secondary school (9-12)	193	63%	138	64%
	College Graduate	34	11%	41	19%
	degree and above	10	3%	2	1%
owner ship	Owner	39	13%	56	26%
	Employe	257	84%	153	71%
	Others	10	3%	5	2%

According to the data obtained from Kombolcha City's police department, the majority of the drivers (excluding three-wheeler drivers) involved in an accident were employees (84%), and vehicle owners account for about 13% of crash frequencies. Garage workers, learners (training for driving licenses), and drivers who use a vehicle as a contract were grouped under other categories and accounted for 3% of the accident shares in the city (see *Table4. 1*). The trend is similar for three-wheeler drivers. Meaning that drivers of 3-wheelers who drive the three-wheeler as employees account for about 72% of the accidents, owners account for about 26 % and the remaining 2% are others (*Table4. 1*). The fact that the majority of the drivers involved in crashes are employees is due to the fact that the number of employee drivers in the field is higher than the number of owner drivers.

4.1.2 Vehicle types involved in crashes

Vehicle type has its own impact on crash frequency and severity level. The study site had nine categories of vehicles (as per the researcher). Crash data collected in the study area indicated that vehicles most frequently involved in accidents were motorized 3-wheelers (41%). The figure below shows the types of vehicles concerning accident frequency. The second most frequently involved vehicle in an accident was large and medium trucks accounting for about 23% and

followed by minibuses having a loading capacity of ≤ 15 passengers (13%). Small trucks containing vehicles like pickups, land cruisers, and Toyotas had significant involvement in accidents (12%), while the remaining small percentages were covered by other vehicle types. Large and medium buses, Cycle and Motorcycles, cars, and animal-drawn carts cover the accident share of 4%, 3%, 2%, and 1% respectively (See *Figure4. 1*)

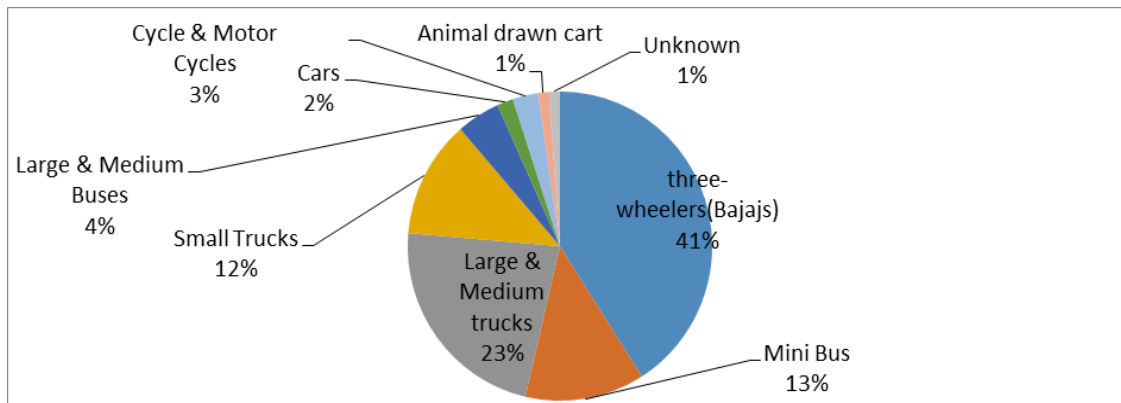


Figure4. 1 Crash distribution by vehicle types in Kombolcha city

4.1.3 Crash distribution over ten years period (2011/12 to 2020/21)

Crash data obtained from Kombolcha city police departments show that the highest number of accidents (71 incidents) was recorded in the year 2016/17 that shares 14% of the total ten-year accidents and 2017/18 was the year next to 2016/17 that the highest number (65 accidents, 13%) of crashes happened in the city. The lowest number of incidents were recorded in 2018/19 and 2020/21 with percentages of 7% and 5% respectively. The number of crashes increases slightly from the year 2011/12 to 2016/17. From the year 2016/17 to 2020/21 its trend indicates the number of accidents decrease in consecutive years (*Figure4. 2*). The highest number of crashes due to 3-wheelers occurred in 2012/13 accounting for 16% (34 incidents) of the total three-wheeler (Bajaj) crashes and followed by 14% (30 incidents) in the year 2016/17. From the year 2016/17 the number of three-wheeler accidents decrease yearly and the last study year (2020/21) accounts for the lowest percentage of crashes. As the data obtained from the city's vehicle association indicates, the number of vehicles increases year after year, and the socioeconomic activities of the city's residents also follow a similar trend. However, in the absence of newly provided infrastructure for the transport sector, the crash data indicates a decreasing trend, and these two ideas are contradictory. Here, the researchers fear for the decreasing trend of crashes is the underreporting of incidents in the city due to different reasons. Informally, one of the city's traffic police members was asked

about this case, and he said that "not all accidents that occur in the city may go to investigation, especially if it is a minor collision, and there will be a situation where it will be settled in the field. This happens through the agreement of the parties involved in the crash that they will not waste time acting on behalf of the plaintiff and the defendant."

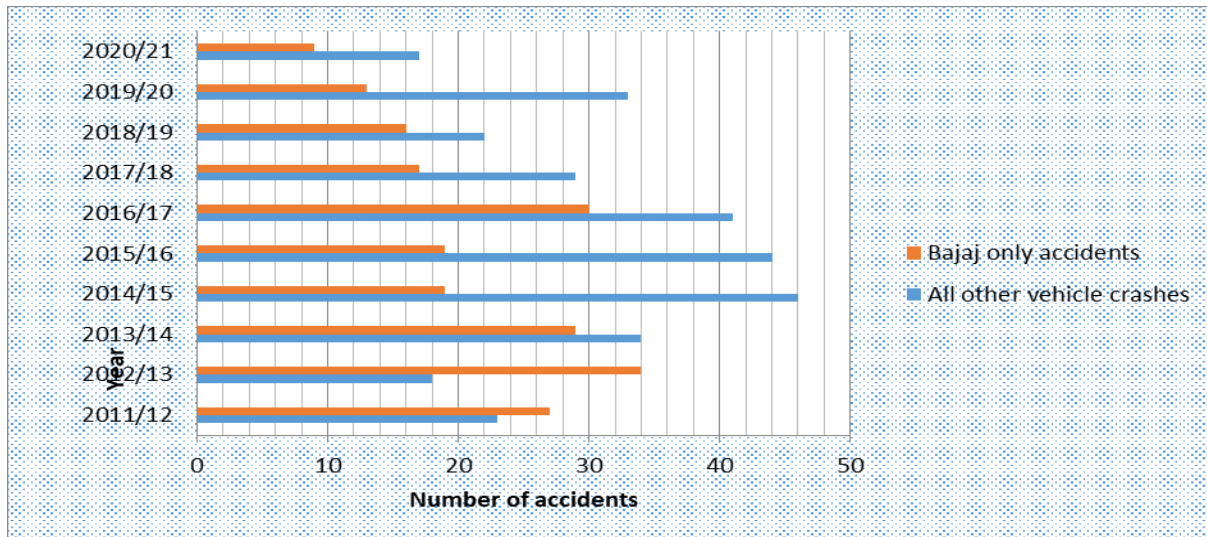


Figure4. 2 Yearly numbers of crashes over ten-year period (2011/12-2020/21)

4.1.4 Crash distribution by shift of the day

As it is shown in Table4. 2 below, the majority of crashes (for both all other vehicles and 3-wheelers) occurred during the daytime, and nighttime accounted for a small percentage of the total accidents. This is very much linked to the socio-economic activity of the societies. Most socio-economic activities are performed during day time because of that, vehicle and pedestrian activities become high in the daytime than at night time. This results in higher interaction of the road users in day times. Moreover, in three-wheeler accidents, the percentage of nighttime crashes was higher at high severity levels than at lower severity levels. For instance, out of the total deaths, three-wheeler crashes at night accounted for 26%, whereas out of the total slight injuries, three-wheeler crashes at night accounted for 13%. However, the opposite situation was observed in daytime accidents. Meaning that the percentage of daytime accidents was higher in low severity levels than in higher severity levels (see Table4. 2 below). Generally, the result shows us that nighttime crashes were more severe than daytime accidents; specifically, in three-wheeler crashes, nighttime crashes were more severe than daytime crashes.

Table4. 2 Crash distribution by shift of the day

Shift of the day	Deaths				Serious injuries				Slight injuries				Property damage			
	3-wheelers		All others		3-wheelers		All others		3-wheelers		All others		3-wheelers		All others	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Day	35	74%	64	85%	39	81%	37	86%	91	87%	64	93%	37	90%	125	81%
Night	12	26%	11	15%	9	19%	6	14%	14	13%	5	7%	4	10%	29	19%
Total	47	100%	75	100%	48	100%	43	100%	105	100%	69	100%	41	100%	154	100%

4.1.5 Crashes per days of the week and regions of the city

A total of 520 incidents were recorded in ten years, with the highest number of crashes observed on Wednesday (108 incidents), which accounted for 21% of the total incidents in the area, and the next worst day was Saturday (94 incidents) that accounted about 18% of the incidents that happened in the city. For all vehicles other than 3-wheelers, the number of crashes was larger on these two days (Wednesday and Saturday) accounting for 20 % (60 incidents) and 19 % (57 incidents) respectively. As these two days are market days in the city, they involve more socio-economic activities and traffic interaction than other days that result in more accidents. Similarly, for three-wheeler accidents the worst days were Wednesday and Saturday which accounted for 23% and 17% of the total accidents (213 incidents).

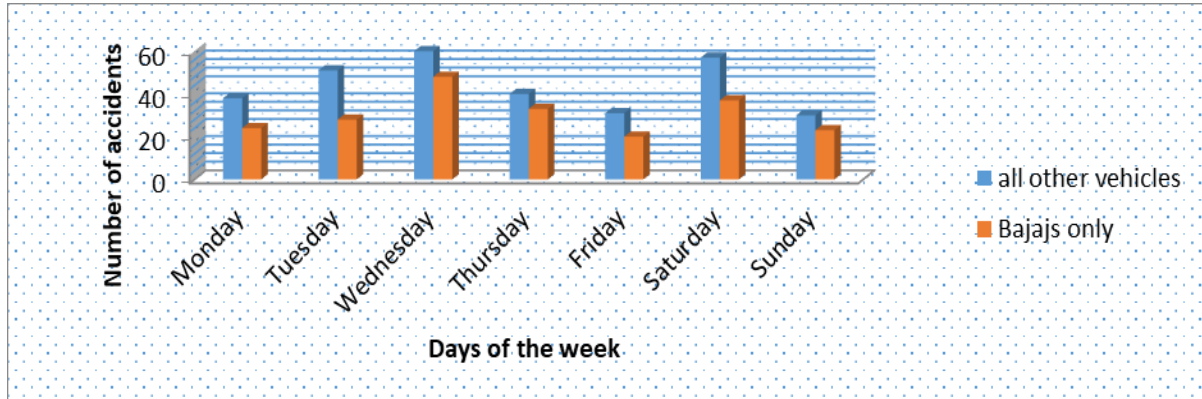


Figure4. 3 Number of crashes over days of the week

In both cases (all other vehicle crashes and three-wheeler crashes) the lowest number of crash records was observed on Friday accounting 10% for all other vehicle crashes and 9% for three-wheeler crashes. Additionally, as the region is center for the city, and activities are higher in this region than in others, the highest numbers (26%, 136 incidents) occurred in kebele 03. In both cases (all other vehicle crashes and three-wheeler accidents) this region took the largest share of accidents and kebele 04 shared the next highest number of accidents 21%, and 17% for 3-wheelers and all other vehicle crashes respectively.

4.1.6 Hourly distribution of crashes

The travel pattern of road users differs from time to time during a single day. Due to that different hour of the day handles different roadway incidents. As can be seen in *Figure4. 4*, the highest number (63 incidents, 12%) of traffic accidents in Kombolcha city occurred in the time interval of 11:00-11:59 AM and the next highest number of accidents (53 accidents, 10%) occurred in the time interval of from 12:00 PM to 1:00 PM. At midday, traffic activity increases as workers go back home for lunch, and vehicular activity, especially three-wheeler activity (as they are the main public transport modes in the city), increases with the movement of users. This situation increases the level of interaction among road users, which leads to an increase in the number of crash incidents. According to the data from midnight (0:01 AM) to morning (7:00 AM), there are no/fewer accidents and the number of crashes began to increase after 7:00 AM. It has been expected that in rush hours also a higher number of accidents. Generally, the number of crashes was higher (153, 29%) in the time interval of 9:00AM to 11:59PM and from 12:00PM to 3:00PM there are 118 incidents which cover 23% of the total crash.

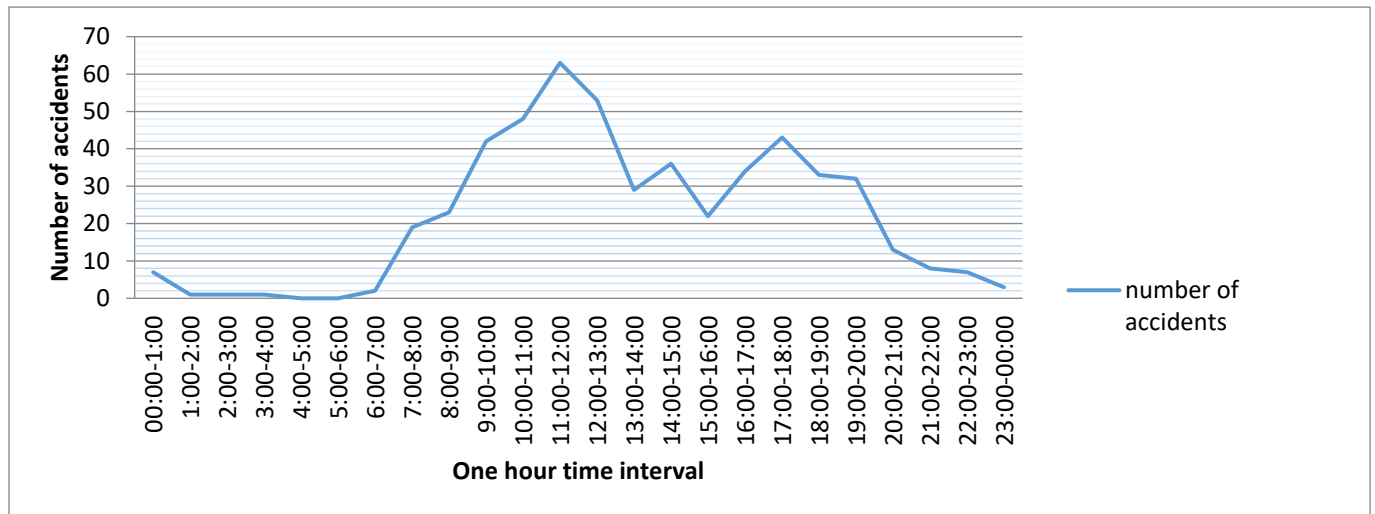


Figure4. 4 Hourly distributions of accidents within one hour interval

Table4. 3 Hourly distribution of accidents with in three-hour interval

Time interval	No of crashes	%	Time interval	No	%	Time interval	No	%
00:00-3:00	9	2%	9:00-12:00	153	29%	18:00-21:00	78	15%
3:00-6:00	1	0%	12:00-15:00	118	23%	21:00-23:59	18	3%
6:00-9:00	44	8%	15:00-18:00	99	19%	Total	520	100%

Source; - Kombolcha city police office

4.1.7 Crash distribution by collision type

In terms of collision types, the majority of accidents that were registered among road users resulted from pedestrian collisions; of total three-wheeler accidents, pedestrian collisions accounted for about 56 %. According to the data, pedestrian collisions were more common in 3-wheelers than in other vehicle types. The reason for this is that the three-wheelers serve in a mixed traffic system, and due to the lack of separate roadways for both vehicles and pedestrians, there is a higher level of interaction between vehicles and pedestrians. As a result, pedestrian collisions will happen. Following pedestrian collisions, overturning (toppling) was the most common accident type observed in three-wheeler accidents. It accounted for about 21 percent of the total three-wheeler crashes in the city. On the other hand, previous studies on three-wheeler accidents showed that toppling was the leading type of accident among 3-wheelers (de Silva, M., Nellihala, L. P., & Fernando, D. , 2014). In terms of all other vehicle crashes, vehicle-to-vehicle collisions were the first most common accident type, followed by pedestrian collisions. It shares 46 % of the total (all other vehicle) crashes registered in the city. As indicated in the figure below, collisions with static objects were the smallest type of collision, and they were observed mostly in large vehicles like Sino track and track without trailers (see [Appendix 1, Table 2](#), for each vehicle category). However, this type of collision was not common among 3-wheelers.

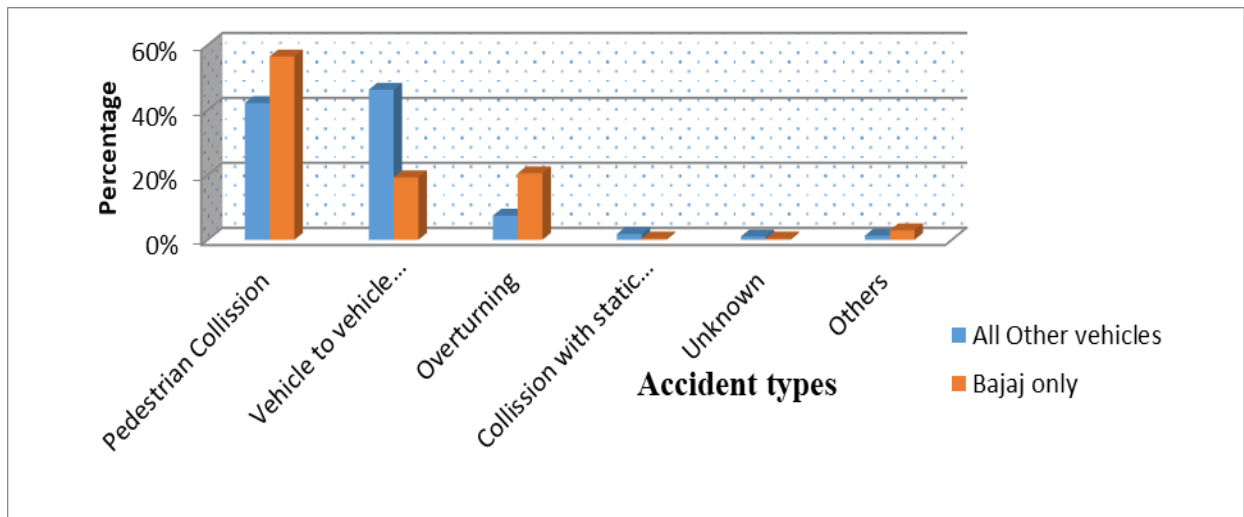


Figure4. 5 Percentage distributions of crashes by collision type

Collisions such as passengers falling from the vehicle, passengers jumping and falling from the vehicle, cars sliding, and loads falling from the vehicle comprised the remaining group. All these types of incidents were grouped under the category of "other collision types" and accounted for

one percent of all other vehicle crashes and three percent of three-wheeler accidents. Importantly, the accident types involving the falling of passengers from the vehicle and passengers jumping and falling from the vehicle while the vehicle is in motion were observed mainly in three-wheelers. This type of accident occurred due to the open structure of the three-wheeler and a lack of caution for passengers.

4.1.8 Prediction of accident type as a dependent variable

Multinomial logistic regression analysis was performed primarily to comprehend the relationship between the type of accident involved and the vehicle type, cause of the accident, and road geometry. Important assumptions of MLR were checked before going to the analysis by recoding the variables into K-1 dummy variables. Actually, SPSS v26 gives an output for each of the K-1 dummy variables of the dependent variable to check for an outlier, and the result shows that there is no outlier for the given data. Multicollinearity assumptions were also checked, and as can be seen from the result, all multicollinearity checking parameters fell within the permissible range (VIF<2.5, tolerance > 0.2, Eigen values far from zero, condition index <15, and proportions of variance <0.9). This was done after the elimination of other variables that were not significant and then continuing testing of interaction effects with only significant variables. As it is seen in the table below, the full model shows a significant improvement in fit over a null model ($\chi^2 (10) = 153.335, p<.001$), and Pearson’s and Deviance’s chi-square both indicate a good fit of the model to the data ($p > 0.05$).

Table 4.1.8. 1 Goodness of fit and model fitting information statistics

Model Fitting Information					Goodness-of-Fit			
Model	Model Fitting Criteria	Likelihood Ratio Tests				Chi-Square	df	Sig.
	-2 Log Likelihood	Chi-Square	df	Sig.	Pearson	21.736	20	0.355
Intercept Only	266.088				Deviance	23.036	20	0.287
Final	112.754	153.335	10	0.000				

The likelihood ratio test indicates that all three predictor variables (vehicle types involved in an accident, road geometry, and causes of the crash) were significant predictors of accident type.

Table 4. 4 presents odds ratio values, and it appears from this table that road geometry had an influence on accident type. As seen in the table, the chance of occurrence of overturning/toppling on straight portions of the road was 73.3% (2.8 times) less than the chance of occurrence of pedestrian collisions, this indicates that there was a high probability of pedestrian collisions to be happened on straight portions of the road than in curved sections. Similarly, pedestrian collisions were found to be higher than that of vehicle-to-vehicle collisions in straight portions of the road (for this particular study, the odds for the occurrence of vehicle-to-vehicle collisions in straight roads were 2.2 times lower than pedestrian collisions). The result indicates that on curved portions of the road, vehicle-to-vehicle collisions have a greater chance of occurring than pedestrian collisions, however, overturning/toppling has a greater chance of occurrence in curved sections than vehicle-to-vehicle collisions. Another interesting point that can be drawn from the result in *Table 4. 4* below are that 3-wheelers were more responsible for pedestrian collisions than vehicle-to-vehicle collisions. As indicated by the descriptive statistics, the main accident types due to 3-wheelers were pedestrian collisions, and a similar result was obtained here from LR analysis. According to the logistic regression result, 3-wheelers were responsible for vehicle-to-vehicle collisions at a rate 2.5 times lower than for pedestrian collisions. Which means that 3-wheeled vehicles were 71% less likely to account for vehicle-to-vehicle collisions than pedestrian collisions. As it was discussed in the descriptive section of this study, the 3-wheeled vehicles in Kombolcha city serve in a mixed traffic system, and there is also an inadequacy of the road to accommodate the existing traffic. Due to that, these public transport vehicles highly interact with pedestrians either during loading and unloading or during their travel to one of their destinations, as a result, these reasons increase the probability of 3-wheeler crashes being pedestrian collisions rather than vehicle-to-vehicle collisions.

Additionally, another accident type that was largely experienced by those 3-wheelers was overturning/toppling. In comparison with other accident types, overturning is more commonly experienced by 3-wheelers than other vehicles. Previous studies on three-wheeler accidents also indicated that toppling was the major type of accident among 3-wheelers (Bandara, K. V. U. K. S., Vadysinghe, A. N., & Edussuriya, D. H., 2019) (de Silva, M., Nellihala, L. P., & Fernando, D., 2014). According to the MLR results of this study, the likelihood of overturning accidents occurring in 3-wheelers was 9.4 (95% CI: 4.948, 17.76) and 3.8 (95% CI: 2.096, 7.023) times higher than the likelihood of vehicle-to-vehicle and pedestrian collisions occurring due to 3-

wheelers, respectively. Here it can be seen that overturning/toppling was more commonly experienced by 3-wheelers than it was experienced by other vehicle types, and pedestrian collisions were the second accident type for which the likelihood of its occurrence on three-wheelers was higher than other vehicle types.

The third predictor variable for crash types was accident cause. In this case, the causes of accidents included in the analysis were failure to give way for vehicles and pedestrians (FTW), over speeding (S), technical problems and lack of experience (TP & LE), and lack of caution (LC), and all of them were found to be significant predictors of the dependent variable (collision type). One cause of an accident can be responsible for the occurrence of one or more crash types. For instance, lack of caution was the leading cause of all crash types, and speeding was the second leading cause of accidents for all crash types; however, their effect on each accident type was different. For example, Failure to give way for vehicles and pedestrians causes overturning/toppling 7 times less likely than it causes vehicle to vehicle collisions. It also causes pedestrian collision 19.7 times less likely than it causes pedestrian collisions. The result indicated that the chance that failure to give way causes pedestrian collisions and vehicle to vehicle collision was higher than the chance that it causes overturning. When we compare only pedestrian collisions and over turning by keeping the other variables constant, the probability that failure to give way causes overturning was 5% ($\frac{0.051}{1+0.051}$) and the probability that it causes pedestrian collision was 95% (100%-5%). As it was indicated before, speeding was the other cause of accidents, and it was also a significant predictor. For this particular study, the likelihood that speeding causes overturning crashes was 5.3 ($\frac{1.478}{0.277}$) times higher than the likelihood that it causes a vehicle-to-vehicle collision, meaning that there is a higher chance for the occurrence of overturning or toppling than a vehicle-to-vehicle crash due to over speeding of the vehicles compared to a lack of caution causing toppling rather than vehicle-to-vehicle collisions. In addition, due to over speeding of the vehicles there is also a higher chance to the occurrence of pedestrian collisions than vehicle-to-vehicle collisions and lesser chance to the occurrence of pedestrian collisions than overturning. Specifically saying, the odds of speeding causing pedestrian collisions rather than vehicle-to-vehicle collisions was 3.6 ($\frac{1}{0.277}$) times higher than the odds of lack of cation (reference) causing pedestrian collision than vehicle-to-vehicle collisions. This shows us that although speeding is the cause of both pedestrian and vehicle-to-vehicle collisions, its contribution is higher for the occurrence of pedestrian collisions compared

to vehicle-to-vehicle collisions. On the contrary, the likelihood that overturning caused as a result of over speeding is 1.5 times greater than the likelihood that pedestrian collisions caused due to speeding of the vehicles. Regarding this, previous studies also proved that, due to their lower stability than four-wheel vehicles, three-wheelers roll over if driven fast on sharp turns or turned while breaking hard (Starkey, P., Batool, Z., & Younis, M. W, 2019). Moreover, as it can be seen in the *Table 4. 4* below there is no significant difference between speeding and lack of caution in causing over turning and pedestrian collisions. Which mean that the two causes of accidents nearly equally contributed for the occurrence of both types of accidents (pedestrian collisions and overturning).

The last category of the predictor variable (accident cause) was lack of experience and technical problems of the vehicle. These problems were also highly accounted for the occurrence of overturning than both pedestrian and vehicle-to-vehicle collisions. The analysis result of multinomial logistic regression indicated that the chance that technical problem and lack of experience causes toppling was 2.2 times higher than the chance that they cause pedestrian collisions. This means when we keep other variables constant and compare the pedestrian collisions and toppling, the probability of technical problems and lack of experience causing toppling is 68% and the probability that they cause pedestrian collision is 32%. As it was said before, technical problem and lack of experience less likely cause vehicle-to-vehicle collisions than pedestrian collisions and more likely cause over turning than pedestrian collisions. To show this numerically, the chance that lack of experience and technical problems being cause for vehicle-to-vehicle collisions was 1.9 times lesser than their chance of being cause for pedestrian collision (OR=0.524, 95% CI (0.306, 0.898). Further, the likelihood that vehicle-to-vehicle collisions caused due to lack of experience and technical problems was 4.1 times lower than the likelihood that overturning caused due to these causes of accident.

Table 4. 4 SPSS output of parameter estimates for accident type as a dependent variable

Crash Type	Predictors	B	Std. Error	Wald	df	Sig.	Exp(B)	95% CI for Exp(B)	
								Lower Bound	Upper Bound
Over turning/Topping	Intercept	-1.434	0.379	14.296	1	0.000			
	vehicle types involved in an accident (3-wheelers=1)	1.345	0.308	19.007	1	0.000	3.837	2.096	7.023
	vehicle types involved in an accident(others=2)	0 ^b			0				
	Road geometry [Straight =1]	-1.009	0.343	8.66	1	0.003	0.364	0.186	0.714
	Road geometry [Curved =2]	0 ^b			0				
	Cause of accident (FTW=1)	-2.982	1.036	8.291	1	0.004	0.051	0.007	0.386
	Cause of accident(S=2)	0.391	0.338	1.336	1	0.248	1.478	0.762	2.868
	Cause of accident (TP & LE=3)	0.77	0.368	4.374	1	0.036	2.159	1.05	4.442
	Cause of accident (LC=4)	0 ^b			0				
Vehicle to vehicle collision	Intercept	1.198	0.231	27.001	1	0.000			
	vehicle types involved in an accident (3-wheelers=1)	-0.893	0.207	18.62	1	0.000	0.409	0.273	0.614
	vehicle types involved in an accident(others=2)	0 ^b			0				
	Road geometry [Straight =1]	-0.766	0.235	10.611	1	0.001	0.465	0.293	0.737
	Road geometry [Curved =2]	0 ^b			0				
	Cause of accident (FTW=1)	-1.014	0.265	14.691	1	0.000	0.363	0.216	0.609
	Cause of accident(S=2)	-1.284	0.274	22.007	1	0.000	0.277	0.162	0.473
	Cause of accident (TP & LE=3)	-0.647	0.275	5.529	1	0.019	0.524	0.306	0.898
	Cause of accident (LC=4)	0 ^b			0				

a. The reference category is: Pedestrian Collision.

b. This parameter is set to zero because it is redundant.

Source: -SPSS output for the given data

4.1.9 Vehicle type and crash severity level

From the *Figure 4. 6* below, it can be observed that property damage (161 incidents, 45%) was the major severity type in all other vehicle crashes and slight injuries (104 incidents, 44%) were the major accident severity level in three-wheeler accidents. There were 46 incidents (19%) from three-wheeler-only and 78 (22%) fatal accidents from all other vehicle crashes. Frequent collisions were observed three-wheeler with pedestrians and that results more slight injuries. In three-wheeler accidents, overturning was the next leading accident type, and it also resulted in more slight injuries than serious injuries (*Table 4. 5*). A study conducted in Sri Lanka also obtained the same result as this study on the severity level of three-wheeler accidents, showing that the majority of crash severity results from three-wheeler crashes were non-grievous injuries ([Amarasingha, 2015](#)).

Figure 4. 6 shows that there was minor property damage caused by three-wheeler accidents rather than large-fright vehicle collisions that cause more property damage, but slight injuries were caused by three-wheeler accidents and all other vehicle crashes. From the total vehicle crashes, 3-wheelers account for about 59% (104 incidents) of slight injuries and 53% (47 incidents) of serious injuries. Small trucks were the first leading vehicle types for property damage, accounting for approximately 20% (45 incidents). This comparison was made between individual vehicle types (see Table 1 of Appendix 1).

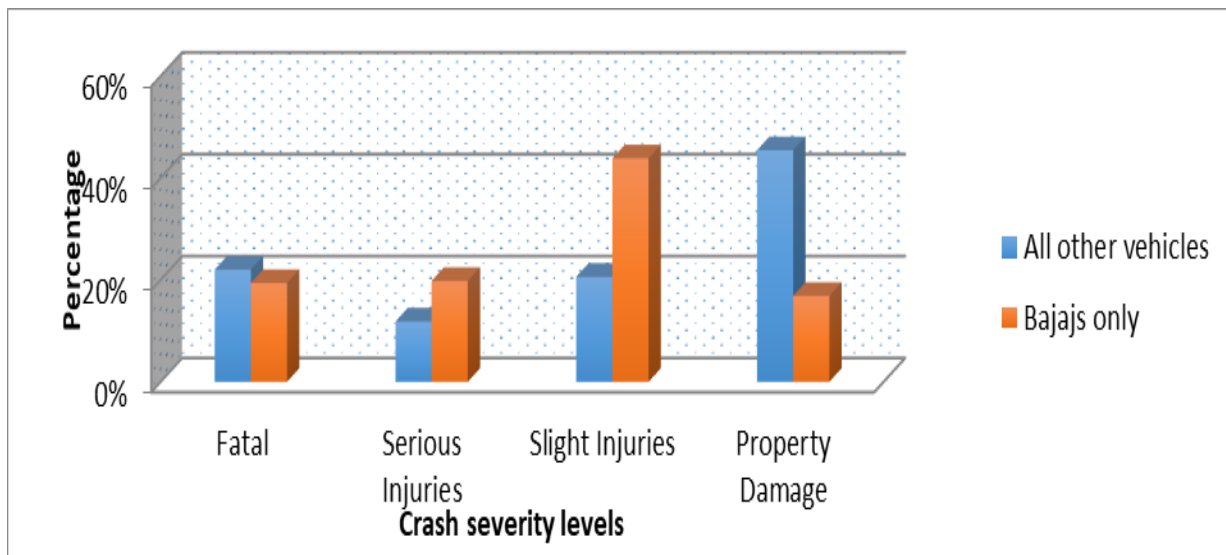


Figure 4. 6 Accident severity level by Vehicle types

4.1.10 Relation of accident type and severity level

The table below indicates that the majority (75 percent) of fatal incidents were caused from pedestrian collisions. Vehicle-to-vehicle collisions accounted for approximately 13% of fatal crashes, but they accounted for approximately 70% of property damage. Serious injuries were also primarily caused by pedestrian collisions, accounting for approximately 56 percent of all pedestrian collisions. Pedestrian collision was the leading type of collision for the three severity levels (fatal, slight, and serious injuries), whereas vehicle-to-vehicle collision was the leading type of collision for property damage only (see Table 4. 5 for total vehicle). Vehicle overturning causes approximately 18% of serious injuries and 9% of fatalities. In three-wheeler accidents, 80 % of fatal accidents came from pedestrian collisions, and overturning or vehicle overthrowing (9%) was the next accident type responsible for death, but for all other vehicles other than 3-wheelers, the second collision type that results in death next to pedestrian collisions (72%) was vehicle-to-

vehicle collision (17%). In both cases (three-wheeler and all other vehicles), serious injuries and slight injuries mostly came from pedestrian collisions. The second rank for both serious and slight injuries was taken by vehicle-to-vehicle collisions for all other vehicles and overturning for three-wheeler accidents (See *Table 4. 5* for details). Out of the total three-wheeler serious injuries, 60% were caused by pedestrian collisions, and the next higher percentage (25%) was caused by overturning. Other than three-wheelers, the first responsible collision type for all severity levels was vehicle-to-vehicle collision (46%), but for three-wheeler accidents, pedestrian collision accounts for approximately 56% and ranks first among all collision types, followed by overturning (21%).

Table 4. 5 Relation between collision type and severity level

Collision type	Fatal/Death				Serious injuries				Slight Injuries				Property Damage				Total	
	All others		3-wheelers		All others		3-wheelers		All others		3-wheelers		All others		3-wheelers			
	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Pedestrian Collision	58	72%	37	80%	25	52%	29	60%	49	67%	66	63%	32	17%	3	7%	299	48%
Vehicle to vehicle	14	17%	3	7%	17	35%	6	13%	15	21%	12	12%	134	72%	25	61%	226	36%
Overturning	7	9%	4	9%	5	10%	12	25%	6	8%	21	20%	11	6%	12	29%	78	12%
Collision with static object	0	0%	0	0%	0	0%	0	0%	1	1%	0	0%	6	3%	1	2%	8	1%
Unknown	2	2%	1	2%	0	0%	0	0%	0	0%	0	0%	2	1%	0	0%	5	1%
Others	0	0%	1	2%	1	2%	1	2%	2	3%	5	5%	2	1%	0	0%	12	2%
Total	81	100%	46	100%	48	100%	48	100%	73	100%	104	100%	187	100%	41	100%	628	100%

Source: -Kombolcha city police department

4.1.11 Severity level by causes of accident

Factors that cause traffic accidents can be internal or external in nature. Technical faults of the vehicles and drivers' behavior are internal factors, but road conditions and other road users' behavior are external factors. These are the causes of accident and can be summarized as vehicle factors, road factors and road user factors. In line with these facts, the analysis results of the study indicated that the major causes of traffic accidents in Kombolcha city were associated with road user behaviors' that includes a lack of caution (unethical driving and underestimating of things), accounted for 35% of the total accident causes. It was the major accident cause for three-wheeler accidents as well, and it accounted for 37% of the total three-wheeler accident causes registered in the city. This result shows that drivers were the major cause of traffic accidents. The next leading cause of accident in the study area was speeding or over speeding, which accounted for 22% of total accident causes. Failure to give way for pedestrians was the third-ranked cause of accidents

in the city, accounting for 20 % of the total accident causes for all other vehicle crashes, whereas, the third cause of accidents for three-wheeler accidents was other causes, which included passengers falling from the vehicle and passengers jumping from the vehicle, accounting for 15% of total three-wheeler accidents (see *Figure 4.7* below). All the above causes of accidents fall under the category of road user behaviors. On the other hand, the second factor observed in the analysis were road factors. As the majority of road types in the city are two-way roads, 80% of three-wheeler crashes happened on two-way, and the remaining 20% were on one-way roads. The primary data obtained from the questionnaire also supports that the narrowness of the road (inadequate capacity to accommodate the present traffic) was the major cause of crashes in the city. However, the data obtained from police officers didn't provide information about vehicle-related factors, which indicates vehicle factors. Furthermore, in Kombolcha city, 3-wheelers operate in a mixed traffic system and due to the fact that the majority (89%) of the accidents occurred on asphalt and 7% on cobblestones. On gravel roads, there were few accidents related to 3-wheelers (2%). Three-wheeler incidents also occur in areas like fuel stations, garages, market areas, and villages that can't be considered crashes by definition.

In examining the relationship between accident causes and severity levels, three-wheeler-related crashes indicated that over speeding (29%) was the leading cause of fatal and serious injury crashes, with lack of caution (27%) coming in second for both severity levels. In terms of all other vehicle crashes, excluding three-wheeler accidents, lack of caution was the leading cause for all severity levels, followed by over speeding (see [Appendix 1 table 3](#)). In both cases (all other vehicles and 3-wheelers only), minor injuries were mostly caused by careless driving (lack of caution) by drivers, which accounted for approximately 42 % of other vehicle accidents and 41% of three-wheeler only accidents. Failure to give way for pedestrians (21%) was the next cause of accidents that resulted in slight injuries from three-wheeler accidents, but for other vehicle crashes, speed (18%) took the second rank for causing slight injuries (see [Appendix 1 table 3](#)).

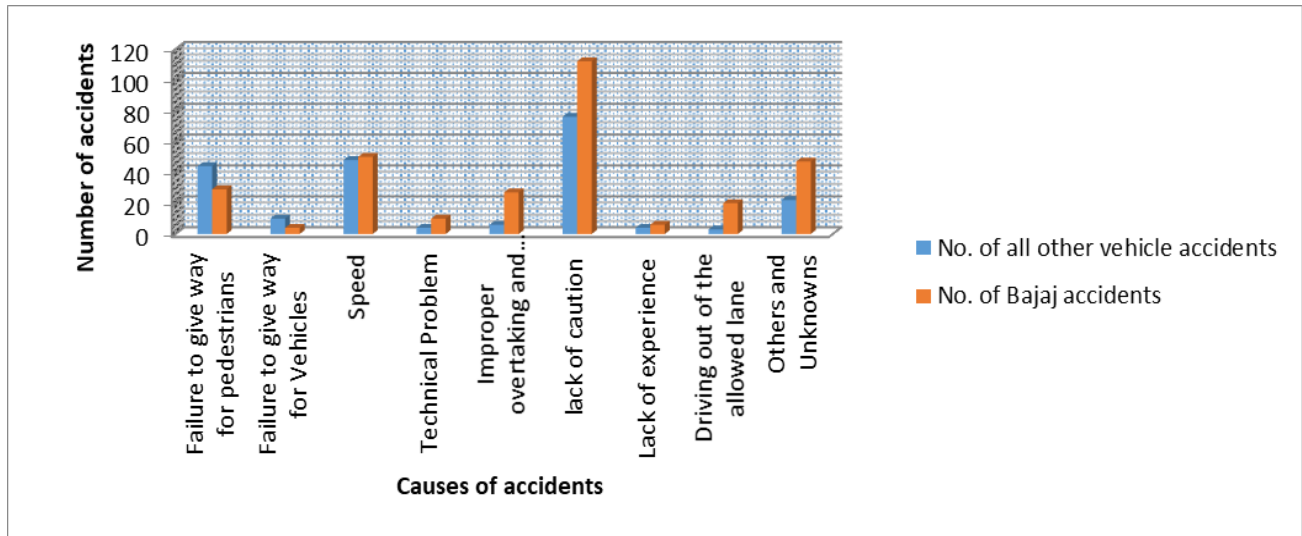


Figure4. 7 Causes of accidents in the study area

4.1.12 Prediction of crash severity level as a dependent variable

The other variable chosen for analysis in this study was crash severity levels. For this analysis, crash severity levels are classified into three categories (fatal/death, injuries, and property damage), and multinomial logistic regression was used to estimate its relationship with the selected independent variables (vehicle type involved in an accident, type of crash and accident causes) after the exclusion of non-significant independent variables that cause multicollinearity problems in the model. The assumptions were checked, and they all fall within and above the model's cut values, i.e., for the multicollinearity problem, all VIF values were less than 5 and tolerance values were greater than 0.1, condition index values were also less than the cut value of 15, and Eigen values were far from zero. The existence of outliers was also checked, and there were no outliers in the data.

The model's fitness was assessed using Chi-square test statistics. The chi-square value was 317.937 and the p value was less than 0.001. This indicates that there is a significant relationship between the dependent variable and the independent variables in the model. This means that the final model fits over the baseline model. Therefore, the null hypothesis is rejected (adding the independent variables of vehicle types involved in an accident, accident types, and causes of accidents significantly predicts the dependent variable better than the base line model).

In goodness-of fit statistics, both the Pearson ($\chi^2 (32) = 30.267, p = 0.554$) and deviance ($\chi^2 (32) = 35.26, p = 0.317$) statistics tests were not statistically significant and provide that the model was fit with the data. Additionally, from pseudo-R-square (Nagelkerke R-square) results, it can be observed that 47.5% of the variation in the dependent variable was explained by the independent variables in the model. And the likelihood ratio test provided that the predictor variables like accident causes, vehicle type, and type of accident were all significant, and it proves that those predictor variables have a significant contribution to the final model. After testing and fulfilling the above assumptions, one can proceed to the interpretation of the regression results for this particular model.

To see the relationship between crash severity level and vehicle types involved in an accident, 3-wheeler accidents were about 41% (1.7 times) less likely to cause property damage than fatal accidents, meaning that the chance that a three-wheeler crash results in fatalities or death is greater than the chance that the same accident causes property damage. Since 3-wheelers are public transport vehicles and are also small in size compared to other vehicles, their effect on property damage is smaller than that of other large vehicles. If there is a severe crash related to 3-wheelers, the result is for passengers and drivers to be injured or die, and as a property the vehicle itself may be damaged. This study indicated that three-wheeler crashes less likely cause property damage than it causes injury crashes and fatal crashes. Besides this, when the 3-wheeler crashes were examined in terms of their effect to fatal and injury severity levels, 3-wheeler crashes were more likely to cause injury crashes than fatal crashes. Based on the result obtained from multinomial logistic regression, the chance that 3-wheeler crashes cause injuries (slight and serious) more than fatal crashes were 1.98 times greater than the chance that other vehicles crash causing more injury crashes than fatal crashes. As it was indicated in the descriptive statistics part (*Figure 4. 6*) the majority of the three-wheeler crashes resulted in slight injuries compared to other severity levels, and the same result was obtained from previously conducted research ([Amarasingha, 2015](#)). Generally, the result tells us three-wheeler accidents cause more injuries than deaths and property damage.

Collision type was the second predictor variable, and it was found to significantly affect the severity level of crashes. For this particular study, pedestrian collision, vehicle-to-vehicle collision, and overturning/toppling were the crash types included in the analysis, and all of them significantly

affected the severity level of crashes. For instance, when we compare overturning and pedestrian collisions in terms of their contribution to property damage and fatal crashes, it can be concluded that there was a higher probability of overturning accidents causing property damage than fatal crashes. As it can be seen from *Table 4. 6* the likelihood that overturning accidents resulted to property damage is 16 times higher than the chance that it causes fatal crashes. More than that, vehicle-to-vehicle collision resulted more to property damage than fatal crashes. The odds of vehicle-to-vehicle collisions resulted to property damage rather than fatal crashes was 59.3 times higher than the same odds of pedestrian collisions resulted to property damage. In the second case, a comparison was made between injury severity level and death. Here also, the vehicle type involved in the accident, the accident type, and the cause of the accident were found to be significant, and the result indicates that the likelihood of overturning causing injury crashes was approximately two times greater than the likelihood of the same accident resulting in fatal crashes. That is, according to the analysis results from this study, injury crashes resulting from overturning accidents were 2.4 times higher than fatal crashes caused by the same type of accident. Similarly, vehicle-to-vehicle collisions also contributed to injury crashes nearly two times higher than it contributes to fatal crashes. Whereas, vehicle-to-vehicle collisions caused more property damage than injury crashes. For instance, when we compare the effect of vehicle-to-vehicle collisions on property damage and injury crashes, the probability that this accident type resulted in property damage was 96.5%, but the probability that it caused injury crashes was only 3.5%. Likewise, in comparison to injury crashes and fatal crashes due to overturning of vehicles, there was a 70% probability that overturning crashes cause injury crashes, and only 30% of overturning crashes result in fatal crashes. Along with this, accident cause was the third variable significantly affecting the severity level of crashes. The major causes of accidents included in this analysis were failure to give way for vehicles and pedestrians, speeding, lack of caution, technical problem and lack of experience. From these causes of accidents, failure to give way was not a significant predictor of crash severity levels. Which means that there is no significant difference between failure to give way and lack of caution (base line category) accidents that result in the three severity levels (fatal, injury, and property damage). However, speeding, technical problems, and lack of experience significantly differ in predicting crash severity levels. For instance, the logistic regression analysis result indicated in the table below (*Table 4. 6*) shows that the odds of accidents caused by speeding resulting in fatal crashes rather than property damage was 3.4 ($\frac{1}{0.298}$) times higher than the lack of

caution causing fatal crashes than property damage. This also indicates that the probability of accidents caused by speeding resulting in fatal crashes was 77.3%, and the chance that the same accident resulted in property damage was only 22.7% (when the comparison was made only between the two severity levels). From these results, it can be understood that accidents caused by over speeding resulted to fatal crashes. Additionally, vehicle speed also contributed more to injury crashes than property damage. Numerically, the chance that the accidents caused by overspending of the vehicles resulted in injury crashes was 1.8 times greater than the chance that the same accident resulted in property damage. While comparing injuries and deaths in terms of the causes of accidents, speed causes injury crashes (serious and slight) 1.8 times less than it causes death or a fatal crash (see *Table4. 6* below). Keeping the other predictors constant when we compare injury crashes and deaths caused by speeding, the probability that the accidents caused by over speeding changed to fatal crashes was 65%, and the chance that the same accident resulted in injury crashes was 35%. Generally, the data shows that there was a significant increase in the likelihood that speeding would result in fatalities as well as injury crashes and property damage. It also shows that the likelihood that speeding would cause fatal crashes or deaths was about 3.4 and 1.8 times higher than the likelihood that it would cause property damage and injury crashes, respectively. In the analysis, another cause of accidents that was significantly related to crash severity levels was a lack of experience and technical problems. These accident causes were highly related to crash severity levels, and they showed a higher difference as the severity level increased from property damage to fatal injuries. The chance that accidents caused by a lack of experience and technical problems resulted in property damages was 1.9 times less than the chance that an accident caused by the same cause resulted in death, meaning that there was a higher probability of these accident causes resulting in fatal crashes than property damage. Besides this, when the comparison was made about the effect of technical problems and lack of experience on fatal crashes and injury crashes, the probability that the accident happened due to these causes was higher for fatal crashes than for injury crashes. From the result indicated in the table below (*Table4. 6*), the likelihood that crashes caused by technical problems and a lack of experience would result in fatal crashes was 2.13 times higher than the likelihood that accidents caused by the same causes would result in injury crashes. Overall, pedestrian collisions cause more fatal crashes and injury crashes than property damage, and the likelihood that they cause fatal crashes was higher than the likelihood that the same accident causes injury crashes. Whereas when we consider the causes of accidents,

there was a higher probability that lack of caution causes injury crashes and property damage than it causes fatal crashes. In the comparison of only fatal crashes and injury crashes related to lack of caution as a cause of accident, the probability that the crash caused by lack of caution resulted in fatal crashes was 19%, while the probability that the same accident caused by lack of caution resulted in injury crashes was 81%, which indicates that there was a higher chance for the crashes caused by lack of caution to become injury crashes than fatal crashes as well.

Table 4. 6 Parameter estimates of MLR for crash severity level

Crash severity levels	predictors	B	Std. Error	Wald	df	Sig.	Exp(B)	95% CI for Exp(B)	
								Lower Bound	Upper Bound
Property Damage	Intercept	-1.255	0.34	1.377	1	0			
	vehicle types involved in an accident (3-wheelers=1)	-0.531	0.32	2.766	1	0.096	0.588	0.314	1.099
	vehicle types involved in an accident(others=2)	0 ^b			0				
	Accident type (overturning =1)	2.774	0.51	29.202	1	0	16.021	5.858	43.816
	Accident type (vehicle-to-vehicle =2)	4.082	0.39	108.049	1	0	59.277	27.453	127.988
	Accident type (pedestrian collision =3)	0 ^b			0				
	Cause of accident (FTW=1)	-0.361	0.44	0.662	1	0.416	0.697	0.292	1.663
	Cause of accident(S=2)	-1.212	0.41	8.851	1	0.003	0.298	0.134	0.661
	Cause of accident (TP & LE=3)	-0.648	0.4	2.652	1	0.013	0.523	0.24	1.141
	Cause of accident (LC=4)	0 ^b			0				
Injury	Intercept	0.551	0.23	5.946	1	0.015			
	vehicle types involved in an accident (3-wheelers=1)	0.681	0.23	8.492	1	0.004	1.977	1.25	3.126
	vehicle types involved in an accident(others=2)	0 ^b			0				
	Accident type (overturning =1)	0.862	0.39	4.794	1	0.029	2.369	1.095	5.126
	Accident type (vehicle-to-vehicle =2)	0.766	0.33	5.499	1	0.019	2.152	1.134	4.082
	Accident type (pedestrian collision =3)	0 ^b			0				
	Cause of accident (FTW=1)	-0.083	0.32	0.068	1	0.795	0.92	0.493	1.72
	Cause of accident(S=2)	-0.6	0.29	4.231	1	0.04	0.549	0.31	0.972
	Cause of accident (TP & LE=3)	-0.755	0.33	5.242	1	0.022	0.47	0.246	0.897
	Cause of accident (LC=4)	0 ^b			0				

a. The reference category is: Fatal/death.

b. This parameter is set to zero because it is redundant.

Abbreviations of variable names in the accident cause are FTW = failure to give way for pedestrians and vehicles, TP = technical problem, S = speed, LC = lack of caution, LE = lack of experience

4.2 Three- wheeler Related Criminal Data

All forms of illegal action are regarded as crimes, and they are subject to legal sanctions. Crimes affect the standard of living and the economic growth of a society. In order to reduce the rate of crime, which has increased significantly worldwide, it is necessary to evaluate crime statistics. This motivates the public and law enforcement to take the necessary actions, thereby reducing the number of crimes [\(Hussain, F.S. and Aljuboori, A.F., 2022\)](#). For this study, three-year period data (2016/17 to 2018/19), was collected from the Kombolcha city police department at the Berberewenz and Shishaber police stations. All crimes committed inside 3-wheeler, at 3-wheeler stations, as well as crimes committed by commuters and drivers while walking or driving towards one of the three-wheeler stations, were recorded as three-wheeler-related crimes. Each three-wheeler station or terminal and area of the city presented a range of crimes unique to the area; however, the most common criminal activities were general theft, including pickpocketing, robbery, including attempts, beating (purposefully or with other crimes), snatching, fraud, and kidnapping in lesser amounts.

According to a book from the Tesol-Ukraine Research Academy 2020, "Robbery on the objective side is expressed in the open theft of someone else's property, which involves seizing of it in the sight of the owner or other persons who are aware that the crime is being perpetrated." Simultaneously, the criminal is aware that his activities are being watched but chooses to ignore it. If the perpetrator makes a mistake and believes he has been recognized when in fact his activities have gone unnoticed, he is accountable for the robbery; nevertheless, if the scenario is reversed and the individual believes no one sees him when in fact they are observing him, the act is termed theft. According to the book, robbery can occur when stealing becomes public due to incidents (such as when a security guard appears unexpectedly) [\(Shcherbak, 2020\)](#).

In the study period, a total of 584 crime victims were recorded. A single victim may experience more than one crime type; for instance, a crime victim may be bitted and snatched, kidnapped and raped or kidnapped and robbed. This type of situation increases the number of total crime incidents by crime type to 637.

4.2.1 Gender-based security statistics

A comparison was made between the number of males and females who reported 3-wheeler related crimes to the police. Primarily, it should be noted that the volume of crime is much higher than that recorded by the police. According to [\(Walklate, S., 2013\)](#) out of the total actual crime incidents, only one-fourth were recorded by the police, and most of those recorded crimes involved no identifiable known offenders. However, the victims can be easily identified from reports. For this particular study, *Figure 4.2. 1* below compares male and female victims in terms of incidents recorded over a three-year period. According to the data, both male and female were crime victims, in contrast, males were victimized in the majority of the criminal incidents reported each year. This was evident in 2016/17, when males reported 58% of the overall incidents (113) that happened in that year. Consecutively, 2017/18 also recorded one of the highest males–females split, with 72% of incidents being reported by males and the remaining 28% by females. Similarly, men accounted for the highest proportion of crime victims (68%) in 2018/19. As the figure indicates, the number of three-wheeler-related crimes increased in consecutive years, and the largest were recorded in the final study year (2018/19) with a total of 333 incidents and 306 victims. It shows a 46% increase from the preceding year, and the increase in crime incidents indicates an increase in the number of crime-involved parties (perpetrators). More on this: crimes can be related to political, economic, and security instabilities [\(Kusuma, H., Hariyani, H.F. and Hidayat, W., 2019\)](#). Particularly those public transport-related crimes have a relationship with economic and security instability; for instance, an increase in the unemployment rate will result in an increase in criminal activities. A study conducted in Canada states that it gets difficult to pay bills when unemployment rises and persists. This causes a financial problem, which increases motivation to commit property crimes. As a result, unemployment and criminal motives have a direct relation, particularly when it comes to property crime [\(Andresen, M.A., 2015\)](#). Another study conducted in Japan found that, GDP growth and volume of crime had a direct relationship; more clearly, the study discovered that as economic development accelerated, crime rates climbed, and as economic development slowed, crime rates declined [\(Li, X., Joutsijoki, H., Laurikkala, J. and Juhola, M., 2018\)](#). On the contrary, according to [\(Andresen, M.A., 2015\)](#), as the economy expands, GDP rises and unemployment falls, however, more people get away from the relatively safe environment of the home, as well as more goods available for theft, and consumer spending rises during these times, creating more opportunities for property crime.

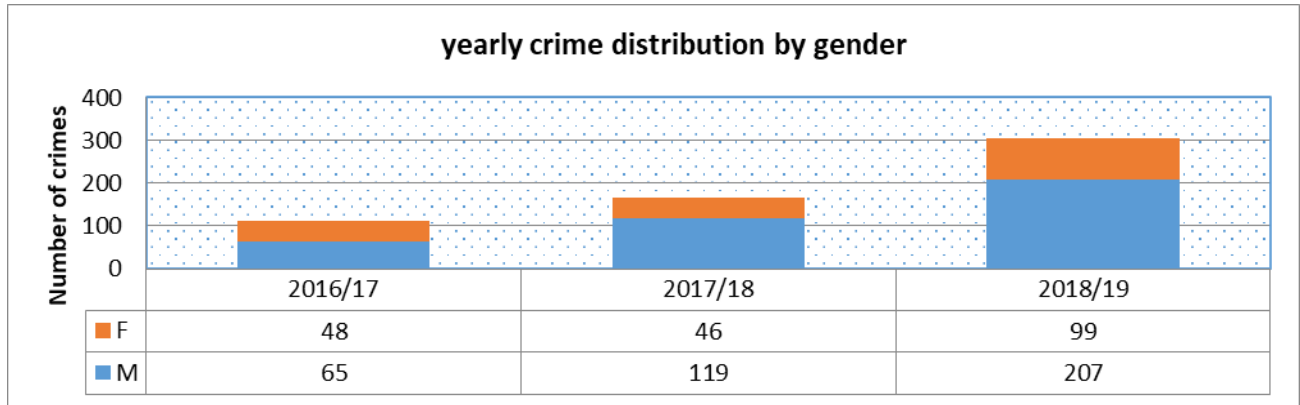


Figure 4.2. 1 Crime distribution by gender

4.2.2 Three-wheeler related crime types over three years period

For this particular study, the criminal activity accounting for the highest statistics (69%, 437 incidents) was theft (pickpocketing) or stealing of property. Perpetrators use different methods to steal property from passengers, including hitting or striking, deception, and stealing/pickpocketing by distraction. Throughout the three-year period, the second most popular crime was beating, which accounted for 11% of the total crimes committed in the city. Beating was the method of committing other crimes in addition to committing it purposefully. Out of the total crimes recorded under the category of beating/hitting, 30 percent (22 crimes) were committed purposefully alone and termed "beating." The other 30 percent (22 incidents) were committed for the purpose of stealing, 25 % with snatching, and the remaining eight and seven % with fraud and kidnapping, respectively, and termed as hitting/ kicking. In most cases beating alone was related with three-wheeler drivers in one or the other way, for instance out of 22 beating crimes 11 incidents were committed by drivers and 8 incidents were committed on drivers. Snatching (48 incidents, 8%) was the other crime type that takes the third rank in the total crime category. Perpetrator’s snatch some one’s bag/phone/money, then immediately escape by three-wheeler and to some extent (2 incidents) by motor cycle. In some areas, snatching was committed by force. Meaning that if the victim is aware that he/she is going to be snatched, he/she tries to fight with the criminal, and the perpetrator uses force to get dominance and snatch the victim's property (most of the time a mobile phone). Robbery, including attempted robbery, accounted for about 5% (29 incidents) of total crimes, followed by fraud and kidnapping, which accounted for 3% each with 20 and 17 incidents, respectively. Out of the total crimes (29 incidents) grouped under robbery, 66 percent (19) related to drivers (either the driver was involved in it or the driver alone committed the crime). Besides

this, the data indicates that restaurants and shops were robbed by three-wheeler drivers and their associates.

Insulting, sexual assault, damaging the body of the three-wheeler, threatening with weapons, and grabbing and disappearing of the driver with the three-wheeler were grouped under other categories and accounted for 2% of the total three-wheeler-related crimes in the city (*Figure4.2. 2*). Study conducted in Nigeria also indicates that majority of public transport crimes were thefts and robbery (*Badiora, A. I., Ojewale, O. S., & Okunola, O. H. , 2015*). That is slightly similar to this study.

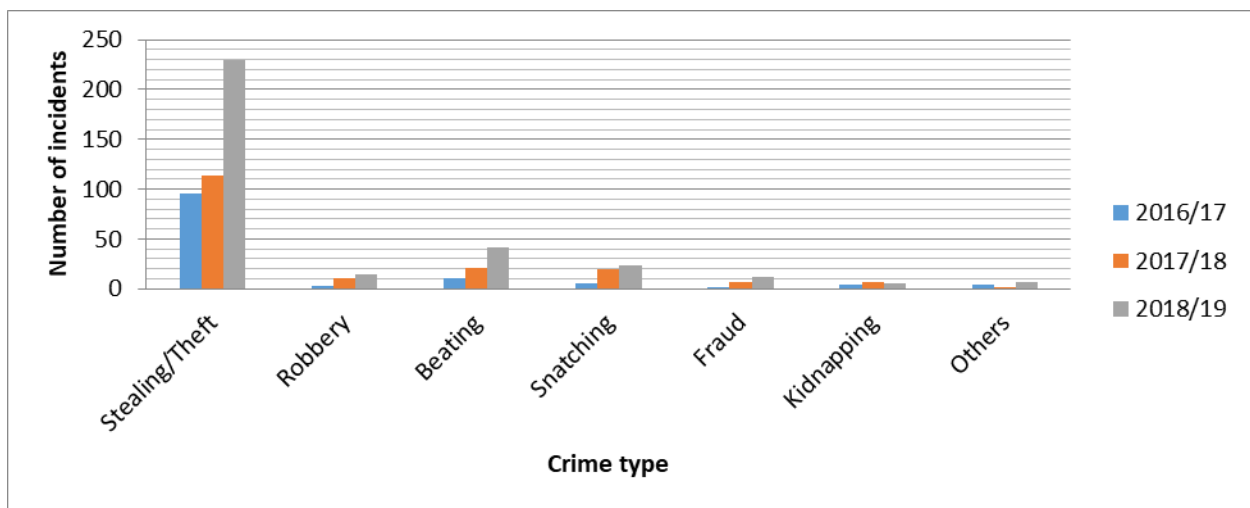


Figure4.2. 2 Three-wheeler related crime in Kombolcha city

In this particular study, the criminal events (especially theft) showed an increasing trend for the three consecutive study years. Different reasons may be raised for the growth of the problem, but the main reason here is the low-level enforcement of crime control by the police. The increase in three-wheeler taxis and social activities in the city creates a favorable environment for criminals. Following that, the security monitoring should grow together, but in reality, it does not show that. Evidence obtained from questionnaire data in this study indicated that out of the total crime victims participated in the survey 64% didn't report the crime for the police and these respondents were asked why they didn't report the crime, for this regard the majorities (63%) reason was that "others who have applied before me have not received a favorable response (I think I won't get a solution)" and the others(19%) said that "there is no police station around", not only this but majority(53%) of the respondents who reported the crime for the police also said that they didn't get any response from the police and 38% said they didn't get a good response, however, only 24% said that they

got good response from the police. As a result, the above-mentioned reasons give confidence to perpetrators and account the lion's share for three-wheeler-related crimes, which is increasing every year.

4.2.3 Crime distribution over days of the week

The graph below indicates that the largest numbers (114 incidents, 18%) of crimes were committed on Wednesday, followed by Monday and Friday, with 95 incidents each. In the study area, Wednesday is the biggest market day, which creates favorable conditions for perpetrators to commit a crime. As stated before, offenders use a method of distraction and deception to steal someone's property (mainly, cell phone and money). When there is a lot of chaos and there is not enough transport access, the thieves may pretend to be a coordinator and confuse the passengers, or they may take advantage of the situation by mixing with the passengers by pretending to be a passenger. Market days are favorable for this type of stealing method. On the other hand, Thursday (79) and Tuesday (73) were the days that the least number of crimes were committed in the area. On all days, the leading crime type was theft/stealing. In all the three years of data, most of the crimes (87%, 509 crimes) were committed during the day, and nighttime accounts for only 13% (75 incidents). This demonstrates that daytime is the most problematic in terms of crimes involving three-wheeler taxis as a mode of public transportation and requires more attention than nighttime.

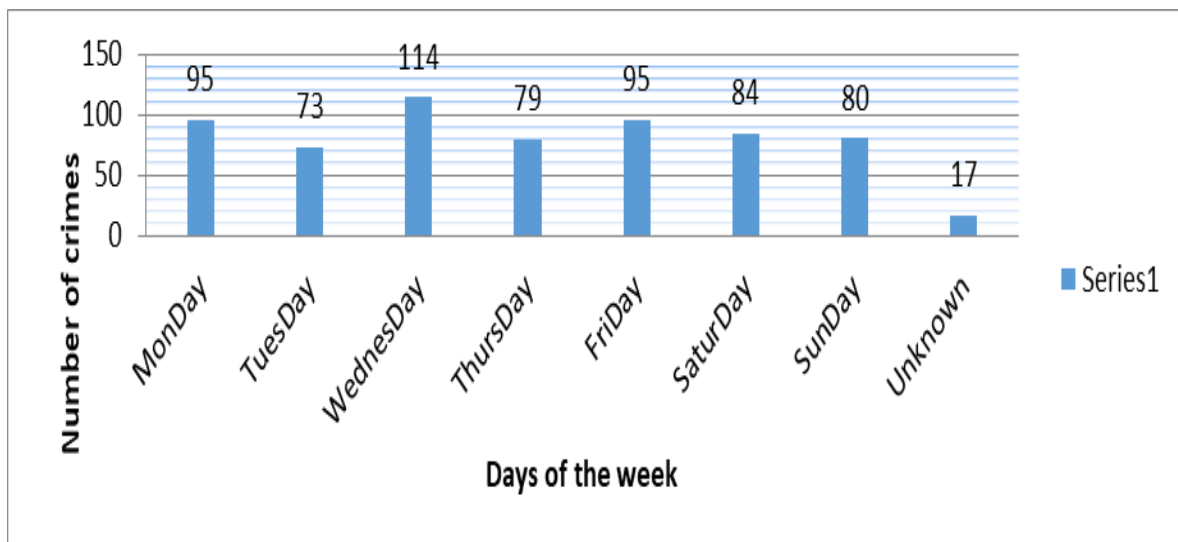


Figure 4.2. 3 Crime distribution over days of the week

4.2.4 Crime targets/Driver involvement in crimes

In the study area, both drivers and passengers of three-wheeler taxis were victims of crime. Data obtained from a three-year study period indicates that, out of 584 incidents, 20 percent (119 incidents) were targeted on three-wheeler drivers, and the remaining 80 percent (465) were targeted on passengers. Theft, stealing, or pickpocketing accounted for 72% (93) of incidents committed against drivers, while beatings or hits accounted for 13%, and snatching (6%). The trend was similar for passengers as well (see [Appendix 2, Table 1](#)). The evidence shows that three-wheeler drivers were victims of the crime, and in another way, they were also involved in criminal activities. From the total (584) crimes committed in the city during the study period, in 23 % (133 crime incidents) the drivers were involved, out of these (133 crime incidents) 6% of the crimes were committed by the drivers alone, and in 100 incidents (17%) the drivers involved themselves directly with their associates (see *Figure4.2. 4* below). In terms of driver involvement in criminal activities, a study done in Sri Lanka found a similar conclusion, stating that "sometimes 3-wheeler drivers are involved in illegal activities" (Somasundaraswaran, 2008).

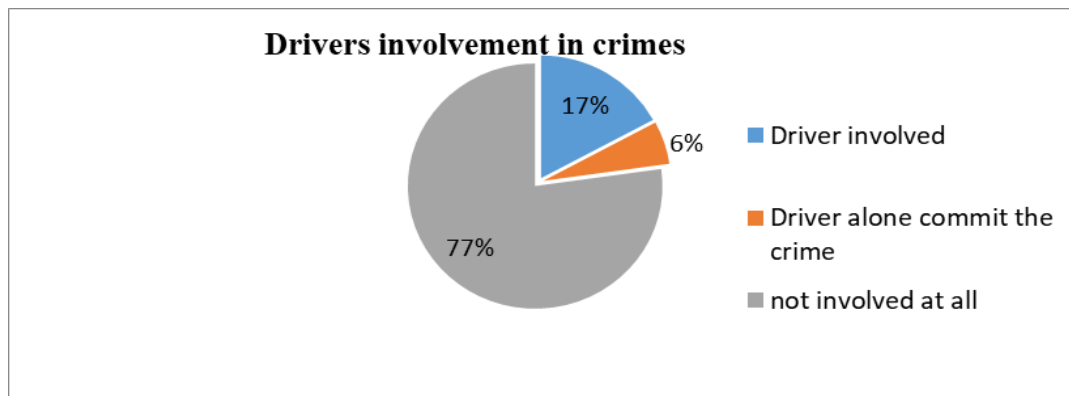


Figure4.2. 4 Percentage of drivers involved in a crime

4.2.5 Crime distribution by region of the town

Just as it was for the traffic accidents, Kebele 03 was the most crime-infested area in the city, accounting for approximately 45 percent (260 incidents). Kebele 05 was the next region with the most crimes, accounting for 17% (97 incidents), followed by Kebele 04 (48 incidents) and Kebele 02 (44 crime incidents). Kebele 12, Kebele 08, Kebele 07, and Kebele 06 were the regions where the least number of crimes were registered (altogether, 23 crime incidents) and accounted for about 1% each.

Crimes with no known region account for about 12% (72 incidents), and there were no recorded crimes from kebele 09 or kebele 10 of the city.

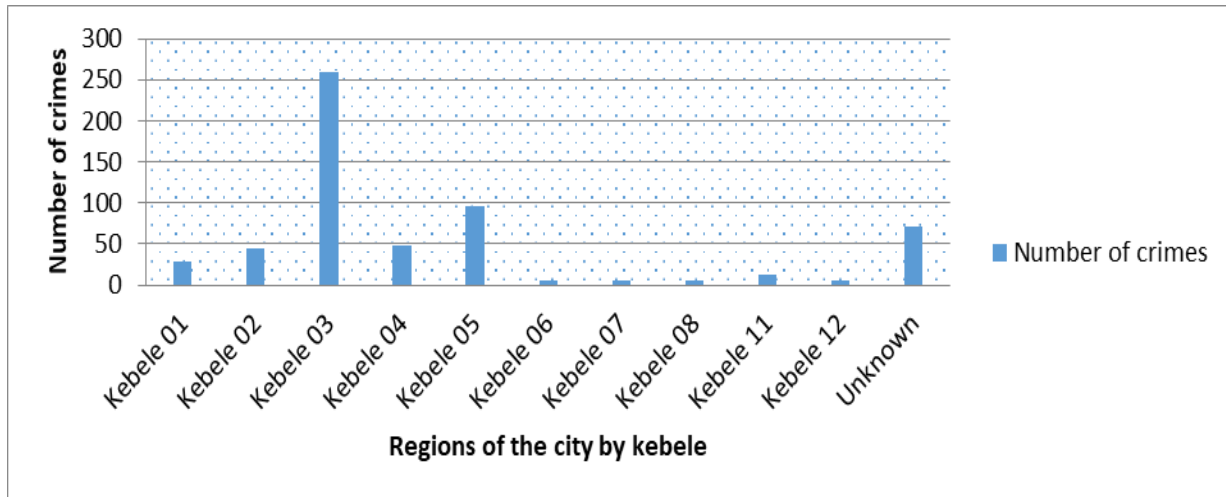


Figure 4.2. 5 Crime breaks down by regions of the town

4.2.6 Possible scenarios that crimes to occur

According to [\(Newton, Andrew D., 2014\)](#), the three possible scenarios in which crime events related to public transport can occur are the transfer point between stations, including from stations to destination points and from anywhere to stations, at stations (terminals), and on-board modes of public transport (inside the vehicle). As the data obtained from the three-year study period indicated, the majority of the crimes (57 percent, or 333 incidents) were committed inside the three-wheeler while the vehicle traveled. At three-wheeler stations (terminals), 120 (21%) of total crime incidents were recorded, and in the third scenario of walking or transferring between stops on foot (traveling to or from three-wheeler terminals), 73 incidents were recorded, accounting for 12% of all crimes committed during the study period.

Crimes committed inside villages, robbery from restaurants using three-wheeler, kidnapping to a hidden place, and stealing of the three-wheeler itself from where it stops are grouped under other categories that account for 10% (59 incidents) of the total crime. (See *Figure 4.2. 6* above)

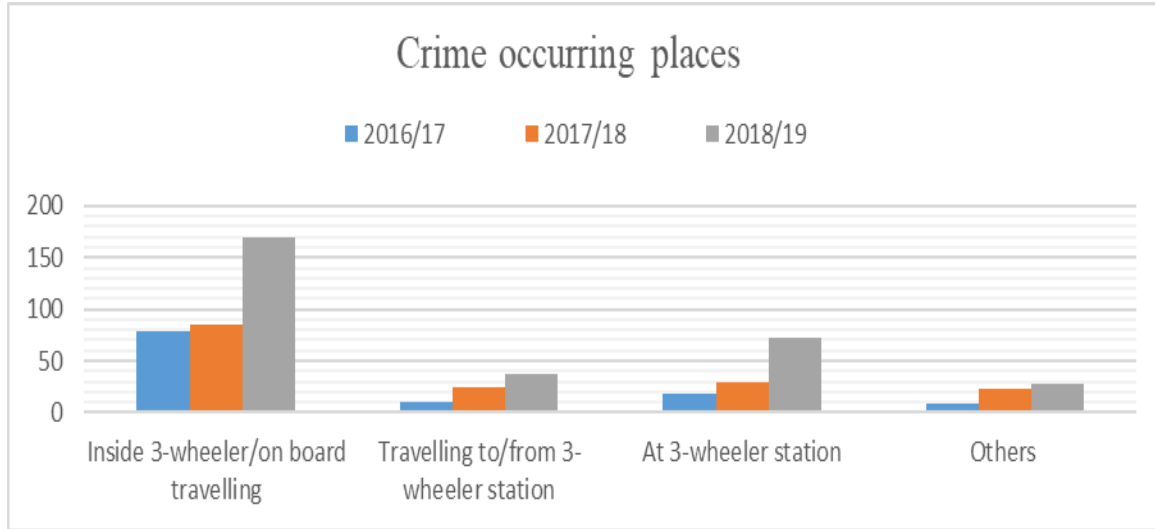


Figure4.2. 6 Crime distribution by place

4.2.7 Prediction of crime types using multinomial logistic regression

Crime data obtained from police stations was analyzed using multinomial logistic regression to investigate the relationship between victims' gender, shift of the day, and driver involvement in criminal incidents as independent variables and crime types (dependent variable).

To do that, important assumptions of MLR were checked before going to the analysis by recoding the variables into K-1 dummy variables. Interestingly, SPSS v26 gives an output for each of the K-1 dummy variables of the dependent variable to check for an outlier, and the result showed that there was no outlier for the given data. Multicollinearity assumptions were also checked, and as can be seen from the result, all multicollinearity checking parameters fell within the permissible range (VIF<2.5, tolerance > 0.2, Eigen values far from zero, condition index <15, and proportions of variance <0.9). This was done after the elimination of other variables that were not significant and then continuing testing of interaction effects with only significant variables.

With chi-square statistics ($\chi^2 (9) = 127.195$ and a very small P-value of $P < 0.001$), the model fit the data very well. Therefore, the null hypothesis was rejected ($H_0 =$ **There is no significant difference between the base line model and the final model; the base line model is the model without any of the independent variables, and the final model is the model with the possible independent variables included in the analysis**). The "Goodness of Fit" table contains the Deviance and Pearson chi-square tests, which are useful for determining whether a model exhibits a good fit to the data. The Deviance $\chi^2 (12) = 17.435$; $p = 0.134$; and the Pearson chi-square $\chi^2 (12)$

= 16.164; $p = 0.184$; both are greater than 0.05 and are non-significant. Since non-significant test results are indicators that the model fits the data well, the model fits well. Once the model has been fitted, the estimated coefficients will be used to interpret the fitted model.

As shown in the table below (*Table 4. 7*) there was a higher chance of daytime crimes being theft crimes than other crime types. The chance that the crime committed by three-wheeler users during the day being theft was 4.28 times higher than the chance that it becomes other crimes. This means that 3-wheeler-related theft crimes were more commonly committed during the day than at night. The reason for this is that during the day, human activities to perform different tasks are higher than at night, and following that, three-wheeler activity is also higher to serve the people. Not only this, but the majority of theft crimes were also committed inside three-wheelers. As a result, theft crimes were higher during the day than at night. Additionally, with a higher odd (11.6), the drivers were not involved at all in theft crimes compared to other crimes. Here, it is better to remember that the crime types that are categorized under other categories are insulting, sexual assault, damaging the body of the three-wheeler, threatening with weapons, and grabbing and disappearing of the driver with the three-wheeler (see 4.2.2). Therefore, the logistic regression result shows that the driver's involvement in these crime types was higher than their involvement in theft crimes. In comparing the driver's involvement in robbery/snatching crimes and theft crimes, the likelihood that the driver's involvement in robbery/snatching crime types was higher than the likelihood of their involvement in theft crimes was about 5.9 times. Showing that there was an 85.5% probability for the drivers to be involved in robbery crimes and 14.5% for their involvement in theft crimes. As the multinomial logistic regression result shows, during their journey, male passengers were exposed to beatings or hitting by perpetrators at a rate 3.44 times higher than their exposure to other crimes (insulting, sexual assault, grabbing, etc.). Indicating that there was a higher probability for male passengers to be beaten or hit than their exposure to the above-listed crime type. When the comparison was made between theft and robbery in terms of crime victims, male three-wheeler users were less likely to be exposed to robbery and snatching crimes than theft crimes. In other words, the odds of the occurrence of theft crimes rather than robbery and snatching were 1.2 times higher in male travelers than in female passengers.

Theft or stealing during the day ($OR = 3.2$) remained greater than beating when the reference category was changed to beating/hitting, but the likelihood that male three-wheeler passengers

would be exposed to theft crime was almost 71% lower than the likelihood that they would be exposed to beating/hitting crime (OR = 0.4, 95% CI = 0.203–0.791). Stated differently, the chance of male three-wheeler users being exposed to theft crimes was about 2.5 times lower than their exposure to beating crimes. This result indicates that beating and hitting crimes were more serious for male passengers than female passengers. However, robbery/snatching and theft/stealing beating was committed in conjunction with other crimes such as snatching, robbery, and theft, but it was also committed solely. When the perpetrators use beating to commit other crimes like theft and snatching, they hit the target passenger to distract and divert his or her attention. After the target victim distracted his attention, they did what they wanted to do and suddenly left that place by the three-wheeler. The victim then realizes what happened to him after they left that area. This mostly happens when perpetrators use the three-wheeler exclusively for this purpose; however, it also sometimes happened when they work in coordination with the three-wheeler drivers. That's the evidence to arrive at the decision that the three-wheeler drivers were involved in criminal crimes were more serious for female passengers. As stated in the descriptive analysis, activities. According to the regression analysis of this study, drivers were involved in beating/hitting crimes three times more than they were involved in theft crimes, implying that drivers' involvement in beating/hitting crime types was three times greater than their involvement in theft crimes. Related to this, the majority of beating and hitting crimes were committed at three-wheeler stations and on the way to or from three-wheeler stations. Those crimes committed at stations were highly related to drivers, and they were committed by drivers or on drivers due to disagreements of different reasons, like not loading the passengers according to their queue, or it could also be with passengers due to a dispute over fares. That's why the driver's involvement in beating crimes was higher than their involvement in theft crimes.

As shown in the table below (*Table4. 7*), robbery or snatching is not significant, and it indicates there is no significant difference between robbery or snatching and beating crimes in their occurrence during the day and night.

Three-wheeler drivers were more likely (1.9 times) to be involved in robberies and snatchings than in beating or hitting crimes when it came to their involvement in criminal situations. Indicating that rather than being involved in beating crimes, three-wheeler drivers were more likely to be involved in robbery and snatching crimes. Related to this, most of the crimes recorded as

robbery in this study are either committed by the drivers or the drivers directly involved in it with their associates. For instance, shops and restaurants were robbed by three-wheelers, and indirectly, it indicates the driver's engagement in the crimes. Regarding the involvement of drivers in criminal activities, previous studies also showed that the drivers were engaged in illegal or criminal activities. For example, a study conducted in Sri Lanka stated that "sometimes three-wheeler drivers are involved in illegal activities and use the vehicle for illegal activities" (Somasundaraswaran, 2008).

In considering the gender of victims, there was a lower probability for male three-wheeler users to be stolen, snatched, and exposed to other crimes (insulting, sexual assault, and grabbing) than their probability to be beaten or hit. To the contrary, female travelers were exposed to these crime types rather than beating and hitting. Based on the evidence obtained from multinomial logistic regression, the chance of male passengers being exposed to robbery or snatching was about 75 % (3 times) lower than the chance that they were exposed to beating crimes (OR = 0.333, 95% CI (0.154–0.722)). On the other hand, the likelihood of male travelers being exposed to other crimes was 3.4 times lower than their exposure to beating crimes (see *Table 4. 7* below).

Moreover, according to the classification table, the model correctly predicted theft/stealing crimes 99.3 % of the time, and it did a particularly poor job of predicting robbery/snatching hitting and beating crimes at 8.3% and 0%. Generally, the overall prediction of the model was 67.5%.

Table 4. 7 Estimated parameters for crime types

Crime Types	predictor variables	Parameter Estimates					95% CI for Exp(B)		
		B	Std. Error	Wald	df	Sig.	Exp(B)	Lower Bound	Upper Bound
Theft	Intercept	1.815	0.386	22.167	1	0.000			
	shift of the day (night time=1)	-1.146	0.332	11.951	1	0.001	0.318	0.166	0.609
	shift of the day (day time=2)	0 ^b			0				
	gender of victim(male=1)	-0.916	0.347	6.943	1	0.008	0.400	0.203	0.791
	gender of victim(female=2)	0 ^b			0				
	Driver involvement (not involved at all=1)	1.101	0.294	14.036	1	0.000	3.008	1.691	5.351
	Driver involvement (driver involved=2)	0 ^b			0				
Robbery/ snatching	Intercept	1.513	0.416	13.246	1	0.000			
	shift of the day (night time=1)	0.078	0.377	0.043	1	0.836	1.081	0.517	2.262
	shift of the day (day time=2)	0 ^b			0				
	gender of victim(male=1)	-1.099	0.395	7.759	1	0.005	0.333	0.154	0.722
	gender of victim(female=2)	0 ^b			0				
	Driver involvement (not involved at all=1)	-0.670	0.329	4.144	1	0.042	0.512	0.268	0.975
	Driver involvement (driver involved=2)	0 ^b			0				
Other crimes	Intercept	1.176	0.454	6.716	1	0.010			
	shift of the day (night time=1)	0.308	0.442	0.484	1	0.486	1.360	0.572	3.236
	shift of the day (day time=2)	0 ^b			0				
	gender of victim(male=1)	-1.236	0.450	7.553	1	0.006	0.291	0.120	0.702
	gender of victim(female=2)	0 ^b			0				
	Driver involvement (not involved at all=1)	-1.351	0.394	11.736	1	0.001	0.259	0.120	0.561
	Driver involvement (driver involved=2)	0 ^b			0				

a. The reference category is: Beating/hitting.

b. This parameter is set to zero because it is redundant.

4.2.8 Application of binomial logistic regression on crime place

Crime place refers to the place where the offenders target to commit a particular crime. For the purposes of this study, "crime place" refers to the location of the crime in terms of three-wheeler stations, inside the three-wheeler, while traveling on the way to take three-wheeler, and in other

places such as villages, hotels, and places off the street that are related to the 3-wheeled vehicles and that the vehicle traverses. Crimes related to three-wheelers are committed either inside the vehicle or outside of it, but in both cases, the criminals use the three-wheeler to commit the crime in one or the other way. This analysis was done by categorizing the variables as binomial dependent variables by collecting the crimes at stations, on the way traveling to or from three-wheeler stations, and other crimes that are committed outside of the vehicle as “crimes committed outside the three-wheeler”, and those crimes committed inside the vehicle, either on drivers or passengers, as “crimes committed inside the three-wheeler”. For this analysis binary logistic regression was applied.

To go through the analysis, the assumptions of binary logistic regression should be checked, and for the first assumption, the dependent variable is dichotomous (inside the three-wheeler/outside the three-wheeler). The next two assumptions are outlier and multicollinearity issues. In order to look for an outlier, SPSS v26 provides an output for each of the dependent variable's K-1 dummy variables. The outcome indicates that the given data didn't contain an outlier. The results of the multicollinearity checking parameters (VIF<2.5, tolerance >0.2, Eigen values far from zero, condition index <15, and proportions of variance <0.9) show that all of the multicollinearity checking assumptions were verified (see *Table 4.2.8. 1* below), and there was no important multicollinearity among the independent variables. This was carried out after the exclusion of non-significant variables and the examination of interaction effects containing only significant variables.

Table 4.2.8. 1 Multicollinearity diagnostic table for crime place
Coefficients

Model	predictor variables	Collinearity Statistics	
		Tolerance	VIF
1	crime type 1	0.925	1.081
	crime type 1	0.864	1.157
	crime type 1	0.860	1.163
	victims' type	0.959	1.043
	shift of the day	0.954	1.048
	driver involvement	0.822	1.216

a. Dependent Variable: place with 0

After checking the assumptions of binary logistic regression, the next step is testing the hypothesis and interpretation of the regression results.

Null hypothesis: the variables (crime type, victims' type, shift of the day, and the drivers' involvement in crimes) do not have a significant relationship with the dependent variable (the place where the crime was committed).

Omnibus tests of model coefficients are used to test the model fit. If the model is significant, this shows that there is a significant improvement in fit as compared to the null model; hence, the model is showing a good fit. Therefore, the null hypothesis is rejected, and the full model has a significant prediction performance ($\chi^2 = 122.873$; $df = 6$; $P < 0.001$), to mean that the independent variables have significant relationship with the dependent variable. In addition to that, Hosmer-Lemeshow tests are also used to test the model fit, but in this case, the null hypothesis states that the model adequately fits the data, and we hope to find insignificant results. As shown in the table below, the p value is greater than 0.05, which leads fail to the rejection of the null hypothesis.

Table 4.2.8. 2 Omnibus and Hosmer - Lemeshow tests to test the model fit

Omnibus Tests of Model Coefficients				Hosmer and Lemeshow Test				
		Chi-square	df	Sig.	Step	Chi-square	df	Sig.
Step 1	Step	122.873	6	0.000	1	8.346	5	0.138
	Block	122.873	6	0.000				
	Model	122.873	6	0.000				

Source: SPSS output result for the given data

Furthermore, the classification table provides an indication of how well the model able to predict the correct category once the predictors are added into the analysis. It showed that there was a good improvement in the model when the predictor variables are included in the analysis. In comparison with the beginning block (over all percentage = 55.3 %) the model indicated 70.9 % accuracy in classification. Interestingly, the classification table gives informations on specificity (the percentage of cases that are correctly predicted by the model that will not choose the target category in the dependent variable) and sensitivity (the percentage of cases that are correctly predicted by the model that will choose the target category in the dependent variable).

Generally, the classification table indicates for this model specificity was 50% while sensitivity was 87.8%, but overall, the accuracy of the model was 70.9%. Based on these two features it can

be said that the model has a good sensitivity, since among the three-wheeler related crimes, the crimes committed inside the 3-wheeler over outside of the vehicle 87.8 % was predicted to be committed inside the vehicle.

Table 4.2.8. 3 Classification table for the final model

Observed			Predicted		
			Crime place		Percentage Correct
			Outside	Inside	
Step 1	Crime place	Outside the vehicle	146	146	50.0
		Inside the vehicle	44	317	87.8
		Overall Percentage			70.9

4.2.8.1 Interpretation of odds ratio for binomial regression

Crimes involving three-wheelers that are perpetrated during the night shift were more likely to occur inside the vehicle than crimes that occur during the day. This means that the likelihood of nighttime crimes being committed inside the three-wheeler was $2.2(\frac{1}{0.457})$ times higher than the chance of daytime crimes being committed inside the three-wheeler (OR = 0.457, 95% CI (0.27–0.773)).

Drivers were more likely to be exposed to criminal incidents inside three-wheelers than passengers. The likelihood that the crimes committed on three-wheeler drivers being inside the vehicle was 2.4 times higher than the chance that passengers were attacked by perpetrators inside the vehicle. As the drivers spent most of the time inside the vehicle, there may not be a greater chance for criminals to get the drivers outside of the vehicle. As a result, the criminals entered the vehicle as passengers or, by any other technique, and commit the crime inside the vehicle. Not only this, but the drivers also stop the vehicle to wait for the queue, and they travel somewhere until they get a chance to load passengers. At that time, the offenders stole something from the vehicle: it may be a mobile phone, money, or another item of property and they disappeared from that place. Consequently, these crimes were reported as crimes committed on drivers inside the vehicle, and that is the reason for drivers having a higher chance of being attacked by perpetrators inside the vehicle than the likelihood that the same incident happened to passengers.

Related to their involvement on crimes, the three-wheeler drivers had higher chance of involvement in crimes that are committed inside the vehicle than outside crimes. According to the results of the regression analysis, there was a 1.5 times greater chance that a three-wheeler driver

will be involved in a criminal incident committed inside the vehicle (OR = 1.499, 95% CI = 0.955–2.354), compared to no participation at all (*Table 4. 8*). As it was stated before, when offenders work in collaboration with the drivers, they use different techniques like distraction and deception in order to divert the target passenger's attention, and the majority of the crimes were also committed by loading the perpetrators as passengers and coordinated with the drivers. After they commit the crime, the driver created different reasons to unload the passenger from the vehicle, and they disappeared from that place before the victim noticed what happened to him. At that time, the crime victim will have a chance to remember whether the driver was involved in the crime or not. As a result, during the reporting of the crime, they can confidently mention the driver's involvement in the crime. As a whole, these will be the reasons why the driver's involvement in crimes is more likely inside the three-wheeler than outside of the vehicle.

The other variable that had a significant relationship with the crime place was crime type. For this particular model, the types of crimes were categorized as theft, robbery or snatching, beating, and others (crimes not included in other categories), and theft was taken as a reference category. As it can be seen in the table below (*Table 4. 8*), there was a lesser probability of robbery and snatching crimes being committed inside the three-wheeler than theft crimes. In another term, the likelihood that robbery and snatching crimes would happen inside the three-wheeler was 86.4% (1-0.136) less than the likelihood that theft crimes would happen inside the three-wheeler. Indicating that there was a higher chance of theft crimes (7.4 times higher) being committed inside the three-wheelers than robbery and snatching being committed in the same place. Regarding robbery and snatching, there should be enough space and time for the offenders to snatch/rob something and to escape before they are caught by either the police or the victim himself. As it was discussed in the descriptive statistics, most robbery and snatching crimes occurred on the travel way while the passengers were traveling to or from the three-wheeler stations. At that time, the criminals snatched the travelers' phones, bags, or any other easily handled property, and they could escape by the three-wheeler. However, when they want to commit these types of crimes inside the vehicle, they should fight with the targeted victim, and this will lead them to be arrested by the police or beaten by individuals. Due to that, there was a greater chance of snatching and robbery being committed outside the vehicle than inside it. Similarly, beating and hitting crimes were less likely to be committed inside the vehicle than theft crimes. According to the data obtained from the city police departments, the volumes of these crimes were higher at Bajaj stations and on travel ways

to or from one of the three-wheeler stations. Here, the logistic regression also proved that the chance of beating and hitting crimes committed inside the three-wheelers was 11.4 times less than the likelihood of theft crimes committed inside the three-wheelers. As it was for robbery and snatching, there was also a higher chance for beating and hitting crimes to occur outside the vehicle than inside it. When the comparison was made between beating and robbery/snatching, there was relatively a higher probability for robbery and snatching to occur inside the vehicle than beating crimes (OR = 1.55, 95% CI = 0.729–3.275). This most likely happened in a congested traffic system in such a way that while the passengers were inside the vehicle and took something on their hand (most of the time a mobile phone), the perpetrators used the congested system to snatch the passengers’ phone and immediately hide themselves from the victim.

Finally, a comparison was made between other crimes in one group: theft, beating, and robbery/snatching crimes in another group. As it was mentioned in the crime types, other crimes grouped together are insulting, sexual assault, fraud, and grabbing. These crimes categorized under other crimes were $3.5(\frac{1}{0.289})$ times less likely to be committed inside the three-wheeler than theft crimes (OR = 0.289, 95% CI = 0.149–0.56), whereas the chance that these crimes were committed inside the vehicle was 3.28 and 2.12 times higher than the chance that beating and robbery crimes were committed inside the vehicle, respectively. In general, theft crimes were more likely to occur inside the three-wheeler than other crimes included in the analysis of this particular model; on the other hand, beating, robbery, and snatching crimes were less likely to occur inside the vehicle than other crimes.

Table 4. 8 Odds ratio table for binomial logistic regression

Variables in the Equation									
Predictor Variables	Categories	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I for EXP(B)	
								Lower	Upper
Shift of the Day	day	-0.78	0.269	8.502	1	0.004	0.457	0.27	0.773
	night								
Crime Victim	driver	0.878	0.239	13.508	1	0.000	2.407	1.507	3.845
	passengers								
Driver Involvement	drivers involved	0.405	0.23	3.095	1	0.079	1.499	0.955	2.354
	not involved at all								
Crime Types	theft			86.303	3	0.0000			
	robbery/snatching	-1.99	0.279	51.234	1	0.0000	0.136	0.079	0.235
	other crimes	-1.24	0.337	13.527	1	0.0000	0.289	0.149	0.56
	beating	-2.43	0.333	53.263	1	0.0000	0.088	0.046	0.169
	Constant	1.272	0.276	21.265	1	0.0000	3.569		

Source: - spss output result for the given data

4.3 Participants general responses for questionnaire data

To support the secondary data, 430 survey questionnaires were distributed for both passengers and drivers of 3-wheelers as part of the investigation. The questionnaire was made up of multiple-choice questions. This type of question was chosen to ensure that none of the participants was disadvantaged due to writing limitations. This section presents the data collected from the completed questionnaires. Out of 287 questionnaires for passengers of three-wheeler and 143 questionnaires for three-wheeler drivers, the data received was as follows: from passengers, 265 questionnaires were completed, 15 were distributed but never returned by the respondent, and 7 were impermissible because all the questions were not completely answered. Similarly, from drivers, 130 questionnaires were completely filled out and returned, 10 were not returned, and the remaining 3 were wrongly filled and rejected. As a result, the investigation sample size was 395 (265 from passengers and 130 from drivers).

4.3.1 Passengers' demographic information

From all three-wheeler users surveyed in this study, the majorities (36%) were in the age group of 21–26, and the next highest number of respondents (25%) falls under the age group of 27–31. The gender distribution of respondents shows that male and female have a ratio of 3:2 division respectively, meaning that 60% of the respondents were male and the remaining 40% were female passengers.

In both cases (male and female), the majority of respondents were between the ages of 21 and 31, which is considered to be the working age (*Table 4. 9*), indicating that, this age group of society makes more travel than the others. Generally, the table below shows that the majority (91 %) of three-wheeler users are from the working class (16–40). The above table shows that 111 (42%) respondents were married, a similar number of 111 respondents were single and 37 (14%) were in a relationship, educational background of respondents indicated that the majority of both male and female respondents had an educational qualification of secondary school (9–12 grades); at the second level, male respondents had completed their primary school education, whereas female respondents were college graduates. Based on the table below, private workers accounted for the greatest number of three-wheeler users (128, 48%), while government workers were the second largest group of traveler respondents (37) accounting for approximately 14% of all respondents (*Table 4. 9*). When the income level of respondents was considered, the majority of the three-

wheeler users (43%) had an income level of less than 1500 Ethiopian birr, and very few (about 8% each) were from the income groups earning 4501-6000 and 6001-7500. The remaining 13% were from the income group earning more than 7500 Ethiopian birr (Table4. 9).

Table4. 9 Passengers' basic information

Variable	Frequency	Percent	
Gender	male	160	60.4
	female	105	39.6
Age of respondents	<=15	4	1.5
	16-20	44	16.6
	21-26	96	36.2
	27-31	65	24.5
	32-40	35	13.2
	41-50	14	5.3
	>=51	7	2.6
	Educational level	uneducated	2
basic education		10	3.8
primary (1-8)		45	17
secondary (9-12)		109	41.1
collage graduate		49	18.5
degree and above		50	18.9

Variable	Frequency	Percent	
Marital status	married	111	41.9
	in a relation ship	37	14
	Single (never married)	111	41.9
	divorced	3	1.1
	other	3	1.1
Occupation	student	32	12.1
	government	37	14
	private	128	48.3
	daily labor	35	13.2
	Unemployed	26	9.8
	other	7	2.6
Income level	<=1500	114	43
	1501-3000	40	15.1
	3001-4500	36	13.6
	4501-6000	22	8.3
	6001-7500	20	7.5
	more than 7500	33	12.5

Moreover, as shown in the Figure4.3. 1 more than 70% of the respondents use 3-wheelers as their main mode of transportation in the city and the next mode used by travelers was walking.

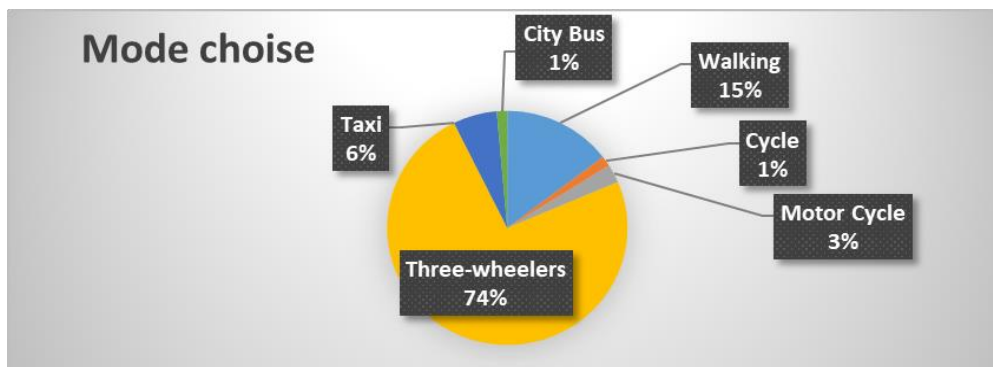


Figure4.3. 1 Respondent's mode choice

4.3.2 Reasons for choosing three-wheeler

Evidence obtained from multiple response questions indicates that the lack of other alternative modes of public transportation was the primary reason for respondents to choose a three-wheeler, accounting for about 49% (157 respondents), and the availability of three-wheelers (22% of respondents) was the second-ranked reason for choosing it. Here it can be observed that lack of alternative transport and availability of these 3-wheelers made the passenger to use them frequently.

Table4. 10 Reasons for choosing three-wheeler

Reasons to choose three-wheeler	Number of respondents	Percentage
Comfort	24	7%
Absence of other alternative transport mode	157	49%
Travel time	59	18%
Travel cost	8	3%
Availability	72	22%
Other reason	4	1%
Total	324	100%

Source: questionnaire survey

4.3.3 Frequency of three-wheeler usage and purpose of travel

According to the data obtained from respondents (Table4. 11), the majority (105,40%) of respondents used 3-wheelers for daily travel, and 65 (25% of them) used them more than five days per week. The data indicates that most of the travelers use 3-wheelers for their daily travel.

Table4. 11 Frequency of three-wheeler usages and purpose of travel

Travel frequency in			purpose of travel		
	Frequency	Percentage		Frequency	Percentage
1-2 days	33	13%	Work	198	75%
3-4 days	62	23%	Education/School	24	9%
5 days and more	65	25%	Recreation	9	3%
daily	105	40%	Market/Shopping	19	7%
Total	265	100%	Others	15	6%

Source: questionnaire survey

The data indicates that majority (75 percent) of respondents travel by three-wheeler for work; 9 % travel to school or for education; the remaining use it to shop or market; to travel for recreational movement; and for other reasons (see Table4. 11 above).

4.3.4 Demographic and other basic informations of drivers

The table below (*Table4. 12*) reveals that the majority (76%) of the drivers were in the age group of 18 to 31, with 48% in the age group of 18–26, and the least number of drivers were in the age interval of below 18 and above 50, together accounting for 4% of the total questioned drivers. This result was similar with the secondary data obtained from traffic police records that were described before (see 4.1.1.1). In terms of three-wheeler driver age, both primary and secondary data produced similar results, implying that a large proportion of three-wheeler drivers (76%) belonged to the younger generations (18-32). The gender distribution of drivers indicates that around 92% were male and only 8% were female. Similar patterns were observed from the secondary data. Similar to the secondary data, the majority of the drivers (35%) completed secondary school education (9–12), 18% completed primary school (1–8), and 22% had an educational qualification of a BSc degree or higher. A small number of three-wheeler drivers (2%) had basic education, and the remaining drivers (18%) were college graduates. In terms of marital status, married drivers account for half (50%) of all drivers who took part in the study, while 28% were single and had never been married before, and 19% were in a relationship. The table above indicates that 48% of three-wheeler drivers work all seven days in a week, 39% work for six days, and 12 % work for four to five days. Least number of drivers (2%) work for three days or less. Therefore, the working days of the majority of the drivers were above 6 days in a week. Furthermore, on weekdays, 47 percent of drivers work between 8 and 12 hours, 24% work between 6 and 8 hours, 21 percent work more than 12 hours, and the remaining 9 percent work less than 6 hours. On weekends (Saturday and Sunday); 45% of drivers work for 4–8 hours; 35% for 8–12 hours; the least number of drivers (11%) work for four hours; and 9% didn't work the whole day (*Table4. 12*).

Table4. 12 Demographic and other basic informations of surveyed three-wheeler drivers

Variables		Frequency	%	Variables		Frequency	%
Sex	male	120	92.3	vehicle & driver relation	Owner	83	63.8
	female	10	7.7		Employee	42	32.3
Age of driver	below18	2	1.5		other	5	3.8
	18-26	62	47.7	Vehicle service life (age of the vehicle)	< 1 year	7	5.4
	27-31	36	27.7		1-2 years	14	10.8
	32-40	24	18.5		2-5 years	45	34.6
	41-50	4	3.1		5-10 years	42	32.3
	above 50	2	1.5		> 10 years	16	12.3
Educational level	Basic education	3	2.3		unknown	6	4.6
	Primary school (1-8)	30	23.1	working days per week	<=3 days	2	1.5
	Secondary school (9-12)	45	34.6		4-5 days	16	12.3
	college graduate	23	17.7		6 days	50	38.5
	degree and above	29	22.3		7 days	62	47.7
Marital status	Married	65	50		working hours weekdays	<=6 hours	11
	In a relation ship	25	19.2	6-8 hours		31	23.8
	Single never married	37	28.5	8-12 hours		61	46.9
	other	3	2.3	> 12 hours		27	20.8
Driving experience	Have no driving license	4	3.1	working hours per weekends	<=4 hours	11	8.5
	below 1 year	18	13.8		4-8 hours	58	44.6
	1-2 years	38	29.2		8-12 hours	46	35.4
	2-5 years	37	28.5		> 12 hours	6	4.6
	5-10 years	23	17.7		No work at all	9	6.9
	above 10 years	10	7.7				

Source: researchers own questionnaire survey

4.4 Safety concerned questions

4.4.1 Passengers feeling of safety while travelling by three-wheeler

The emerging problems related to 3-wheelers were at risk of accidents in a mixed traffic system; those 3-wheelers are very problematic, and the drivers are exposed to accidents. Regarding this, passengers were asked about their safety feelings while travelling by three-wheelers, and 31% (82) of the total respondents feel unsafe while travelling by three-wheeler, and 26% (68) responded that their threat was high while they travelled or thought to travel by three-wheeler, meaning that they feel very unsafe. The other 23% (61) of respondents were neutral in their feelings (neither felt safe nor unsafe) during travel by three-wheeler. Respondents who said they were safe account (for about 12% (32 respondents) (*Figure4.4. 1* below)

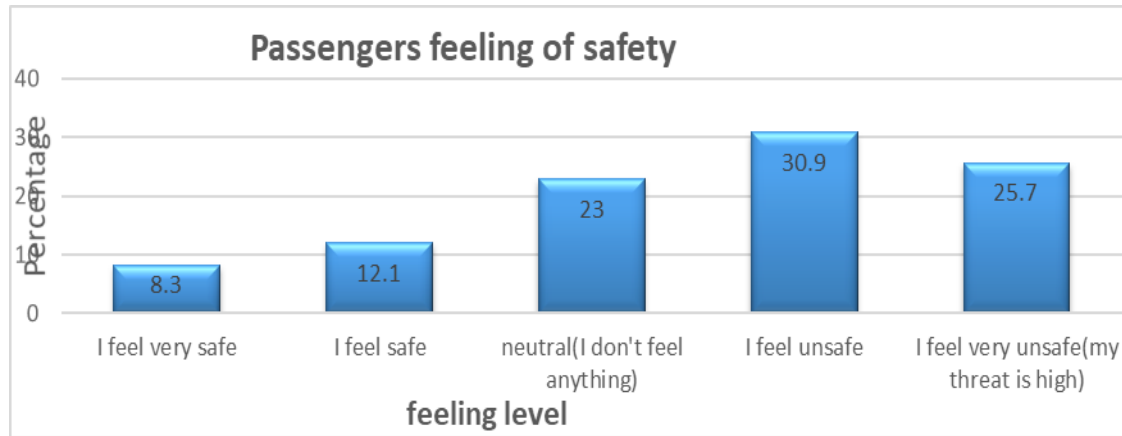


Figure 4.4. 1 Passengers feeling of safety while travelling by three-wheeler

4.4.2 Application of OLR on safety feeling of passengers

For the first assumption, the dependent variable is ordinal, ordered in five categories, with the level of feeling ranging from feeling very unsafe (=1) to feeling very safe (=5), and for the second assumption, one of the independent variables is nominal and the other two are ordinal.

The third assumption is the assumption of proportional odds, which states that the slopes of the regression lines defined by the family of equations are equal (the test of parallel lines in SPSS). In SPSS, one can access ordinal logistic regression in one of two ways: the PLUM (polytomous universal model) procedure or the GENLIN (generalized linear regression) procedure. Both have their own advantages and disadvantages. For this study, both procedures are applied based on the advantages of one over the other. Since the PLUM procedure is good for estimating the parameters of predicted probabilities in a more convenient way than the GENLIN procedure, it is used to test the assumptions of OLR.

For proportional odds, the result of the test of parallel lines should be insignificant, meaning that the dependent variable categories are parallel to each other. If the p value is less than 0.05, we reject the null hypothesis, and the proportional odds assumption fails to be met, but the non-significant result ($p > 0.05$) suggests that the assumption of proportional odds is met, which means the effects of the independent variables on the cumulative probability of falling into a higher or lower category do not vary across categories on the dependent variable. As shown in the table below (*Table 4.4.2. 1*), $p = 0.999 > 0.05$, and because it is insignificant, the assumption of proportional odds holds (the null hypothesis is accepted).

Table 4.4.2. 1 Proportional odds assumption test

Test of Parallel Lines				
Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	458.384			
General	442.893 ^b	15.491 ^c	36	0.999
The null hypothesis states that the location parameters are the same across response categories.				
a. Link function: Logit.				

In checking the fourth assumption (multicollinearity), VIF values, tolerance, Eigenvalues, condition indexes, predictive variables, and bivariate correlations between variables were examined in order to assess the problem of multicollinearity between variables. SPSS result shows that tolerance for all the predictor variables was very close to 1 (greater than 0.2) and variance inflection factor (VIF) values were smaller than 5 (Table 4.4.2. 2 below) which indicates that multicollinearity cannot be a cause for further concern (Midi, H., Sarkar, S. K., & Rana, S. , 2010).

Table 4.4.2. 2 Values of VIF and tolerance for multicollinearity assumption test

Model	Collinearity Statistics	
	Tolerance	VIF
1 Sex of respondent	0.918	1.089
Age1	0.793	1.261
Age2	0.255	3.917
Age3	0.267	3.749
usage frequency1	0.794	1.260
usage frequency2	0.768	1.302
usage frequency3	0.780	1.282
Occupation 1	0.484	2.066
Occupation 2	0.463	2.161
Occupation 3	0.315	3.178
Occupation 4	0.462	2.164
Occupation 5	0.794	1.259

a. Dependent Variable: users feeling of safety when traveling by 3-wheelers

The other factors to check for multicollinearity are Eigen values and condition indexes. An Eigen value close to zero indicates the existence of a multicollinearity problem, and condition indices increase. An informal rule of thumb about condition index tells us that if CI is 15, multicollinearity is a concern, and if it is greater than 30, multicollinearity becomes a very serious concern (Midi, H., Sarkar, S. K., & Rana, S. , 2010). From the analysis result, it can be observed that the CI values of all predictor variables fall below 15, which indicates that the multicollinearity problem can't be an issue for further concern in the analysis of the regression model. In the case of Eigen values, if they are closer to zero, it indicates the existence of multicollinearity problem, and if they are far from zero, the problem tends to be reduced. In this particular study, all Eigen values of the variables

included in the study were far from zero, as a result, the problem of multicollinearity can't be a concern.

After checking the assumptions of OLR, each output result should be interpreted and tested to see if the model fits and has good goodness of fit. In the analysis, model-fitting information tells whether there is a significant difference between the baseline model and the final model or not. The base line model is without any independent variables, and the final model has all possible independent variables. **The null hypothesis states that there is no significant difference between the baseline model and the final model.** If we find statistical significance for this test, then we infer that the full model represents a significantly better fit to the data than the null model. Non-significance is taken as an indicator that the full model does not fit the data substantially better than a model without predictors. As it is seen in the table below (*Table 4.4.2. 3*), the model is significant ($LR \chi^2 (12) = 32.67, p < .05$) indicating that there is a significant difference between the base line model and the final model, which leads to supporting the correlation between the predictive variables and the response variable and rejection of the null hypothesis ([Cokluk, 2010](#)).

Table 4.4.2. 3 Significance values for model fitting information

Model Fitting Information				
Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	491.053			
Final	458.384	32.670	12	0.001

Link function: Logit.

Source: SPSS output for the given data

Additionally, the Pearson chi-square and deviance chi-square tests are additional tests goodness of to the model. Non-significant test results indicate a good fit to the data, whereas significant test results indicate a poor fit. ([Allison, P. D., 2014](#)) provides a more thorough description of what these tests are testing. He described them as "testing whether there are any non-linearity's or interactions" that are not included in your model. In goodness-of-fit statistics, one can observe whether the observed data have goodness of fit with the fitted model or not. In this case, the null hypothesis states that the observed data has goodness of fit with the fitted model. In the output, it can be seen below (*Table 4.4.2. 4*), both the Pearson chi-square [$\chi^2 (316) = 356.724, p = .057$] and Deviance chi-square [$\chi^2 (316) = 312.767, p = 0.541$] tests are non-significant, suggesting a well-fitting model, and the null hypothesis is accepted, meaning that the observed data has goodness of fit with the fitted model.

Table 4.4.2. 4 Goodness of fit statistics for ordinal logistic regression

Goodness-of-Fit			
	Chi-Square	df	Sig.
Pearson	356.724	316	0.057
Deviance	312.767	316	0.541

Source SPSS output for goodness of fit of the data

Moreover, Pseudo R-square indicates how much proportion of the variance on the dependent variable is explained by the independent variables in the regression model. And adding more predictor variables will increase the pseudo-R-square value. Its indication is that more independent variables in addition to gender, age, occupation of passengers and frequency of three-wheeler usage should be considered to express the three-wheeler user's feeling of safety.

In the analysis, all assumptions and goodness of fit requirements are checked, and they all met the required criteria to go to further analysis and interpretation of OLR. As stated before, of the two procedures that can access OLR, the generalized linear regression (GENLIN) procedure has an advantage in computing the anti-logarithms of the regression coefficients over the PLUM procedure.

The output result of SPSS v26 from the generalized linear model can be interpreted as below; see the whole estimate in. In most models, the interpretation involves the estimated coefficients of the independent variables in the model. These estimated coefficients for independent variables represent the rate of change (slope) of a function of the dependent variable per unit of change in the independent variable. The interpretation of logistic regression outputs contains two parts: one is determining the functional relationship between the dependent variable and the independent variable, and the other is appropriately defining the dependent variable for the unit of change of the independent variable (Hosmer Jr, D. W., Lemeshow, S., & Sturdivant, R. X., 2013).

Generally, the interpretation rules for the antilog of the factors will fall into one of the following three categories:

If the antilog (odds ratio) is greater than 1 for a certain category, it suggests an increasing probability of being a higher level of the dependent variable as values on an independent variable increase, whereas an odds ratio less than 1 suggests a decreasing probability with increasing values on an independent variable. And if the antilog (odds ratio) is equal to 1 for a certain category, it implies that there is no predicted change in the likelihood of being in a higher or lower category

as values on an independent variable change. Let us interpret the outputs of each category one by one.

For the gender category (male = 1), $\exp(\beta) = 1.2$. Initially, from the estimates (coefficient), one can see that male passengers have slightly a greater feeling of safety than female passengers, since β is greater than zero compared to the reference category (female passengers). The interpretation of log odds looks like this: the odds that male passengers feel safe when traveling by three-wheeler were about 1.2 times higher than the same odds for female passengers.

As it has been seen in the table below, all age groups had a positive estimate, and one can conclude that the safety feeling of three-wheeler users above 41 years old (the reference category) was less than all other passengers grouped under each age group, meaning that all three-wheeler users categorized under the age groups indicated above had a higher feeling of safety than passengers whose age is greater than 41 years old.

Table 4. 13 Estimates and odds ratio for safety feeling of passenger

Predictors		B	Exp(B)	Predictors		B	Exp(B)
Gender	Male=1	0.196	1.216	Age	<=15=1.00	0.768	2.156
	Female=2	0a	1.000		16-26=2.00	0.998	2.714
Travelers's occupation	Student=1	0.448	1.565		27-40=3.00	0.201	1.223
	Government=2	-0.059	0.943		>=41=4.00	0a	1.000
	Private=3	0.058	1.059	Travel frequency in a week	1-2 days=1	0.365	1.440
	Daily labor=4	1.037	2.821		3-4 days=2	0.601	1.825
	Others=5	0.653	1.921		5 days and more=3	0.258	1.295
	Unemployed=6	0a	1.000		Daily=4	0a	1.000

Source: - SPSS v26 output for parameter estimates

For the age group (16–26), $\beta = 0.998$ and $\text{EXP}(\beta) = 2.71$, which can be interpreted as the probability that passengers aged 16–26 had 2.7 times higher feeling of safety than passengers aged 41 and above. The probability that passengers in the age group of 16–26 feel safe when traveling by three-wheeler taxi was 73%, and the probability that these passengers feel unsafe was 27%. Similarly, three-wheeler users categorized under the age group of 27–40 feel safe 1.2 times more than the reference age group (≥ 41). Passengers aged 15 and under were 2.2 times more likely to feel safe than those aged 41 and above. In general, compared to the reference category (age ≥ 41), the age groups ≤ 15 and 27–40 are not significant, which implies that passengers categorized

under these age groups and passengers in the reference category didn't have any significant differences in their feelings of safety during their travel by three-wheeler.

The third predictor variable was the occupation of travelers; in this case, government workers had a lesser safety feeling than unemployed travelers, whereas students, private workers, and daily laborers slightly felt safer than unemployed passengers. For instance, daily labor travelers have 2.82 times more safety feelings than unemployed three-wheeler users.

The last predictor variable for this particular response variable is passengers' frequency of three-wheeler usage in a week. The SPSS v26 output of the estimates and log odds indicate that there is no significant difference in safety feelings between three-wheeler usage frequency categories. However, less frequent travelers feel slightly safer than more frequent travelers. As evidence, the odds that passengers who travel by three-wheeler for 3–4 days in a week feel safe are 1.8 times higher than the same odds for passengers who use 3-wheelers for daily travel.

From the estimates, it can be seen that the other three categories of three-wheeler users had a higher feeling of safety than the passengers who use the three-wheeler frequently (daily). meaning that passengers traveling by three-wheeler on all days of the week feel unsafe than passengers grouped under other categories (less frequent users).

4.4.3 Respondents' involvement in three-wheeler related accident

Respondents (drivers) were asked whether they were involved in an accident or not while driving the three-wheeler; out of the total questioned drivers, nearly half (49%) answered yes, and the remaining (51%) said no. They were also asked how many times they had been involved in an accident; 84% (54 drivers) had been involved once, 13% (8 respondents) had been involved twice, and the remaining 3 (2%) respondents had been involved three or more times.

Similarly, those respondents involved in an accident were also asked about the severity level of the accident in which they were involved. As obtained from the secondary data, most of the three-wheeler accidents resulted in slight injuries (see *Figure4. 6*), and this evidence is again supported by the survey obtained from three-wheeler drivers, out of 64 drivers involved in three-wheeler accidents, 34% responded that the injury level was slight, 22% said property damage, 27%

responded that no injuries occurred, and the rest, a small number of drivers, responded that there were serious injuries (6%). Both primary and secondary data reveal that the majority of three-wheeler accidents in the city cause slight injuries. According to the driver's response, the majority (80%) of three-wheeler accidents happened during the day, and the remaining 20% happened at night.

4.4.4 Questions related to driver behavior

Respondents(passengers) were asked to rate the number of drivers that did talk on a hand-held phone while they drove. The results show that most of the commuters (58%) said that most of the drivers do that and 77 respondents (29%) said that some of the drivers talk on a hand-held phone. Similarly, they were also asked to rate the number of three-wheeler drivers who eat chat while driving; 110 respondents (40%) said that most of them, 90 (34%), some of them, and 50 (19%) said that very few drivers eat chat while driving (*Table4. 14* below).

As indicated in the above table, according to the passengers, 159 respondents (60%), and both median and mode also indicate that most three-wheeler drivers drive inappropriately, such as illegal maneuvering and suddenly stopping the three-wheeler in front of other vehicles, which exposes them to traffic crashes (see *Table4. 14*). Respondents (passengers) were asked whether the three-wheeler drivers give priority to pedestrians or not. The largest number of respondents (198, or 75 %) answered no, and the 58 remaining respondents (22%) said yes. This data supports the secondary data that the main type of collision for 3-wheelers was a pedestrian collision (See *Figure4. 5*), and here the evidence indicates that the cause were the drivers not giving priority for pedestrians.

When the passengers were asked about their indirect experience (whether they have seen or heard) of three-wheeler-related crashes in the city, the majority (39%) said they saw/heard about it repeatedly (see *Table4. 14* for mode and median), 23% sometimes, 36% occasionally, and 2% said they had never seen/heard about three-wheeler-related crashes. Generally, results from other studies in Ethiopia ([Getachew, 2019](#)) and Sri Lanka ([Somasundaraswaran, 2008](#)) come up with the same conclusions, as the majority of three-wheeler drivers were exposed to accidents. Furthermore, passengers were asked to give their comments on whether the traffic police regularly control traffic activities (not only in rush hours) related to the operation of 3-wheelers. This time, the majority (58%) of respondents said "No", and 31% (83 respondents) said that the traffic polices

do that; however, the remaining (11%) responded they didn't know whether the traffic polices control three-wheeler activity or not.

Table4. 14 Questions related to driver behavior

Questions	Category	Frequency	Percent	Median	Mode
Have you ever seen/heard a Bajaj related accident in Kombolcha city?	Repeatedly	103	39	2	1
	Sometimes	60	23		
	Occasionally	96	36		
	Never seen/heard	6	2		
Do three-wheeler drivers talk with a hand-held phone/read or write text messages while driving?	Most of them	154	58	1	1
	Some of them	77	29		
	Very few	20	8		
	Never do like that	14	5		
Do three-wheeler drivers eat chat while driving?	Most of them	110	42	2	1
	Some of them	90	34		
	Very few	50	19		
	I don't know	15	6		
Do three-wheeler drivers drive with inappropriate manner like illegal maneuvering, suddenly stopping in front of other vehicles and zigzag driving to over pass other vehicles?	Most of them	160	60	1	1
	Some of them	83	31		
	Very few	13	5		
	Never do like that	9	3		
How many of the Bajaj drivers violet traffic laws and regulations?	Most of them	127	48	2	1
	Some of them	100	38		
	Very few	29	11		
	They never do that	9	3		

Source: - questionnaire survey

In addition to descriptive statistics, the Kruskal-Wallis test and Mann-Whitney u test (as the data is not normally distributed and the dependent variables are ordinal categorical) were utilized to identify the existence of differences in passengers' attitudes towards the city's three-wheeler driver's behavior and their indirect experience of three-wheeler related crashes and crimes across users' gender and travel frequency.

4.4.5 Mann-Whitney U Test and Kruskal-Wallis Tests

To evaluate the difference between male and female passengers' attitudes towards the drivers' behavior of using their phones while driving, the Mann-Whitney U test was utilized. The test revealed a non-significant difference in passengers' attitudes: male (median = 1, n = 160) and female (median = 1, n = 105), $U = 8120.5$, $z = .519$, $p = .604$. Hence, H_1 was not supported (fail to reject the null hypothesis), and it can be concluded that there is no difference in passengers' attitudes towards three-wheeler drivers using their phones while driving, between males and

females. For the same dependent variable (passengers’ observation of drivers’ habit of using their hand-held phone while driving) but different group (travel frequency), the Kruskal-Wallis test was performed and the test showed that there was a statistically significant difference in passengers’ attitudes towards three-wheeler drivers using their cell phones while driving between the frequency of travels by three-wheeler, $H(2, n=265) = 8.672, P = 0.013$, with a mean rank attitude of 165.42, $n = 33$ for 1-2 day travelers, 129.04, $n = 62$ for 3-4 day travelers, and 128.15, $n = 170$ for 5 days and more travelers. Similarly significant result was obtained regarding three-wheeler drivers’ vulnerability to accidents $\chi^2(2) = 8.983, P = 0.011$, with a mean rank attitude of 158.39, $n = 33$ for 1–2-day travelers, 142.8, $n = 62$ for 3–4-day travelers, and 124.5, $n = 170$ for 5 and above day travelers.

In the same way, the Mann-Whitney U test was conducted to determine whether there is a difference in indirect experience of three-wheeler accidents between male and female passengers. The results indicated a non-significant difference between males ($median = 2, n = 160$) and females ($median = 2, n = 105$), $u = 8311, z = .155, p = .877$. In this case, the null hypothesis fails to be rejected, which means there is no difference in three-wheeler users indirect experience of accidents between male and female travelers.

Table4. 15 Mann-Whitney test results

Test statistics		Wilcoxon W	Z	Sig. (2-tailed)
Passengers indirect experience of 3-wheeler crashes in the city	8311.0	21191.000	-0.155	0.877
Regarding the experience of drivers using their cellphones while driving	8120.5	13685.500	-0.519	0.604
Regarding three-wheeler drivers’ vulnerability to accidents	8176.5	21056.500	-0.400	0.689
Regarding violation of traffic rules and regulation	8215.5	21095.500	-0.331	0.741
Indirect experience of three-wheeler related crimes	7525.0	20405.000	-1.571	0.116
a. Grouping Variable: Sex of respondent				

The same variable was tested by Kruskal-Wallis test with three groups (travel frequency), and the result revealed non-significant differences (*Asympt. Sign. = .714*) in indirect experience of three-wheeler crashes for three levels of their travel frequency in a week (1-2 days, *n* = 33; 3-4 days, = 62; and 5 days and more, *n* = 170).

Additionally, passengers indirect experience of crimes was tested by the Mann-Whitney U test (crossed with sex) and the Kruskal-Wallis test (crossed with travel frequency). In both cases, the tests resulted in non-significant results, which indicates there is no difference between groups in indirect experience of crimes related to 3-wheelers (see *Table4. 15* above and *Table4. 16* below). In this test, the majority of the results are non-significant, which indicates that there is no difference between groups for the test variable.

Table4. 16 Kruskal-Wallis test

Test Statistics	Kruskal-Wallis H	df	Asymp. Sig.
Passengers indirect experience of three-wheeler crashes in the city	0.675	2	0.714
Regarding the experience of drivers using cellphones while driving	8.672	2	0.013
Regarding 3-wheeler drivers' vulnerability to accidents	8.983	2	0.011
Regarding violation of traffic rules and regulation	3.592	2	0.166
Indirect experience of 3-wheeler related crimes	1.099	2	0.577
a. Kruskal Wallis Test			
b. Grouping Variable: Three-wheeler usage frequency			

4.4.6 Common causes and types of traffic accident in Kombolcha city

Evidence obtained from three-wheeler users indicates that the leading responsible bodies for accidents in the city were 3-wheelers (their drivers), accounting for almost 53% (202) of the respondents' response rate. This conclusion backs up previously examined secondary data, which showed that among other vehicle categories, 3-wheelers had the highest accident share (See *Figure4. 1*). Respondents said that freight vehicles were the second leading cause of accidents, accounting for approximately 16% of the overall response, followed by small-sized public transportation vehicles (minibuses) (14%), and pedestrians (8%). Whereas according to the three-

wheeler drivers, the narrowness of the road and traffic mixes were the leading causes of accidents in the city (39%) and the presence of a high number of 3-wheelers in the city (26%), the experience and passing of more trucks and trailers through the city at any time (17%), and pedestrians not following pedestrian moving and crossing facilities (moving on the road way and crossing any place without any crossing facility) (16%) were causes of accidents in the city as per the drivers response. For the occurrence of accidents in the city, both drivers and passengers principally blame 3-wheelers added to the traffic mix and the inadequacy of the road facilities.

In this regard, according to their experience, three-wheeler drivers were also questioned on the type of collision that mostly happened in city, and the majority (23%) said three-wheeler with small public transport vehicles (mini buses). As the city is the center for traversing to Dessie from other cities located in the southern part of the region like Shewarobit, Ataye, Kemise, Debrebrhan, and Harbu, small-sized public transport vehicles pass through the city at any time of the day. Due to that, most of the crashes were three-wheelers with those vehicles and followed by three-wheeler with 3-wheelers (22%), and thirdly (19%), three-wheeler with fright vehicles (trucks and trailers).

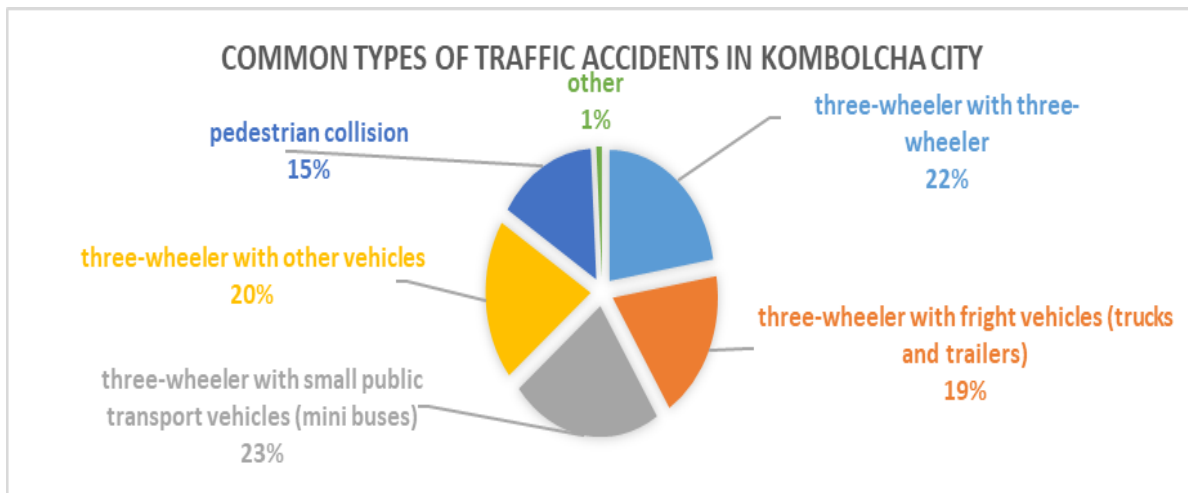


Figure4.4. 2 Common types of three -wheeler related collisions as per the drivers view

4.5 Security Concerned Questions

4.5.1 Passengers feeling of security during travelling by three-wheeler

Respondents were asked to rate their level of security when traveling or considering traveling by three-wheeler; the majority (68%) said "I don't feel secure while traveling by three-wheeler", 17% said "I feel secure", and the remaining 15% said "I don't feel anything (neutral)" (see *Figure4.5. 1* below). Respondents who said "I don't feel secure" were also asked why they were afraid;

approximately 57 percent of those who said they did not feel secure were victims of a crime, 18 % were afraid after hearing about three-wheeler-related crimes from different sources as information, and the remaining 6 % were afraid after seeing or hearing about victims of crime from their intimates.

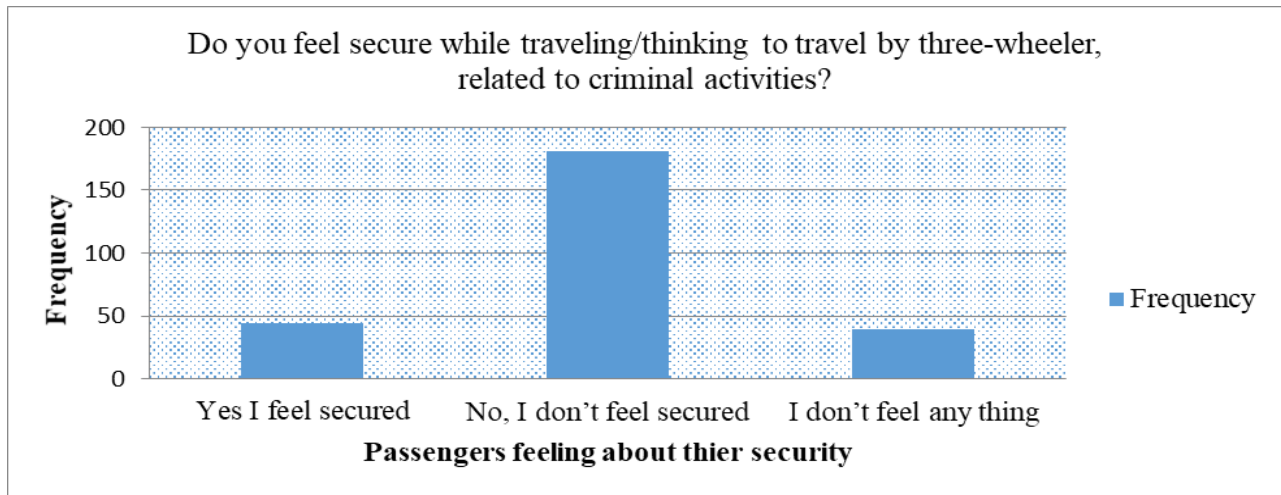


Figure4.5. 1 Passengers feeling of security

4.5.2 Analysis of passengers' security feeling using ordinal logistic regression

Similar to safety feeling, the security feelings of passengers were analyzed using ordinal logistic regression, and sex, age, occupation, and frequency of travel were the predictor variables. The model is significant (LR χ^2 (11) = 20.75, $p < .05$). Indicating that there was a significant difference between the base line model and the final model. In the same way, in goodness of fit statistics, both the Pearson chi-square [χ^2 (143) = 148.317, $p = .363$] and Deviance chi-square [χ^2 (143) = 148.022, $p = .370$] tests were non-significant, suggesting a well-fitting model, and the null hypothesis was accepted, meaning that the observed data has goodness of fit with the fitted model. In checking the main assumption of OLR (proportional odds assumption), we hope to get non-significant results in order to accept the null hypothesis (there is no difference in the coefficients between models), so the result shows that $p = 0.940 > 0.05$, and because it was insignificant, the assumption of proportional odds holds (the null hypothesis is accepted). In addition to that, the assumption of multicollinearity was checked and met the criteria.

As shown in the table below, when travelling by three-wheel taxis, male passengers had a greater feeling of security than female passengers, to mean that male three-wheeler users feel secured 1.38

times more than female passengers. This may due to that male traveler feel confident in order to confront the perpetrators and save their property from those criminals. Regarding age, passengers whose age group is ≤ 15 and 27-40 had a lower security feeling than passengers whose age is ≥ 41 years, whereas travelers aged 16–26 had a greater security feeling than passengers whose age is greater than 41 years. As revealed by the table above, three-wheeler users aged 16–26 feel secured 2.1 times more than older passengers (≥ 41 years). Occupation of three-wheeler users was the other predictor variable, and it indicates that government employees, private workers, and daily laborers feel secured less than the unemployed and others; on the contrary, students feel secured more than unemployed travelers (students who travelled by three-wheeler feel secured 1.54 times more than those unemployed travelers). In general, government workers and private workers had lower odds of feeling secure in comparison to unemployed travelers and others.

Table4. 17 Parameter estimate for passengers’ security feeling

Predictors		B	Exp(B)
Gender	Male=1	0.321	1.379
	Female=2	0	1
Age of travelers	$\leq 15=1.00$	-0.680	0.507
	16-26=2.00	0.587	1.798
	27-40=3.00	-0.291	0.747
	$\geq 41=4.00$	0	1
Occupation of three-wheeler users	Student=1	0.431	1.538
	Government employed=2	-0.110	0.896
	Private worker=3	-0.459	0.632
	Daily labor=4	-0.131	0.878
	Unemployed and others=5	0	1
How often do you use three-wheeler taxi in a week?	1-2 days=1	-0.437	0.646
	3-4 days=2	-0.580	0.560
	5 days and more=3	-0.841	0.431
	Daily=4	0	1

Source: -OLR analysis result (researcher own)

The last predictor variable for this particular response variable was frequency of three-wheeler usage, in this case the ordinal logistic regression result indicates that less frequent travelers have a lesser security feeling than more frequent travelers. For instance, passengers who use 3-wheelers for 1-2 days feel secured 1.5 times less than daily travelers. In other words, the odds of feeling secured are about 35% lower for passengers who travel by 3-wheeler for 1-2 days in a week (see Table4. 17 above). When the passengers travel by 3-wheelers more frequently, they tend to adopt (know about) the perpetrator's crime-committing techniques and also know how to take care of

themselves and their properties. Due to these reasons, more frequent travelers had a greater security feeling than less frequent travelers.

4.5.3 Three-wheeler related crime types

Respondents were asked about the type of crime of which they were victims. From those respondents who were victims of crime, most (45 percent of respondents who were victims of crime) faced a theft problem, followed by robbery and snatching together with a percentage share of 10%. This is similar to the secondary data obtained from the city’s regular police office (see *Figure4.2. 2*). Fraud and sexual assault were experienced by 26 and 25 respondents, respectively, accounting for 8% of the total number of attacked respondents. Moreover, the study found that the least number of respondents (11, or 4%) had been kidnapped by 3-wheelers (*Figure4.5. 2* below) and three-wheeler users who were victims of crime were also asked the number of times that the perpetrators attacked them, 37% (97 respondents) were attacked once, 17% (46) were attacked twice, and least number of travelers (17% ,45 respondents) said that crimes were committed on them about three times or more.

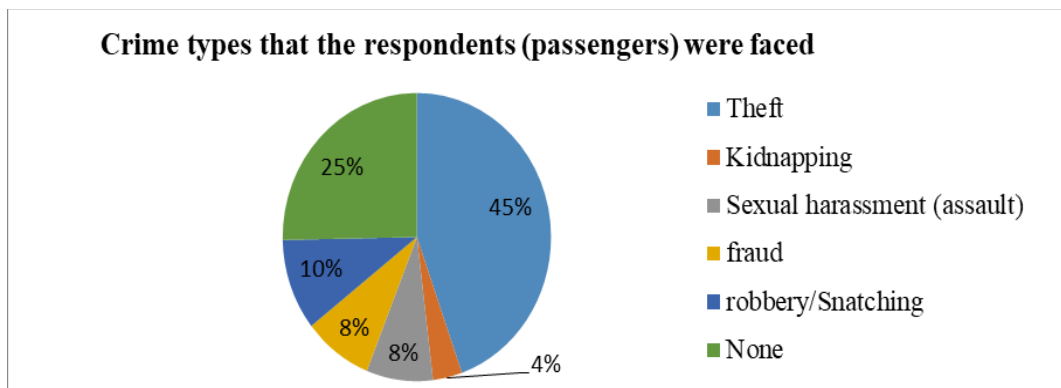


Figure4.5. 2 Three-wheeler related crime types

4.5.4 Crime address

Crimes can be committed at a certain place, and during a certain specified time of the day. In this regard, respondents were asked at what place perpetrators attack passengers in terms of the road environment. The majority (146 respondents, 62 %) reported being exposed to crime and attacked by perpetrators while traveling by three-wheeler (inside three-wheeler)(for more information on this, see secondary data at 4.2.6), 49 respondents (21%) reported that three-wheeler stations were the next perpetrators' target area collectively, including while boarding on three-wheeler (15

incidents), stepping down from three-wheeler (14 incidents), and waiting to board at three-wheeler stations (20 incidents). According to the respondents', the third target area of the perpetrators was the traveling environment. Based on the findings (*Figure4.5. 3*), 39 respondents (16%) reported being attacked while traveling to or from three-wheeler stations, indicating that the walking environment was the third-most problematic area for three-wheeler passengers.

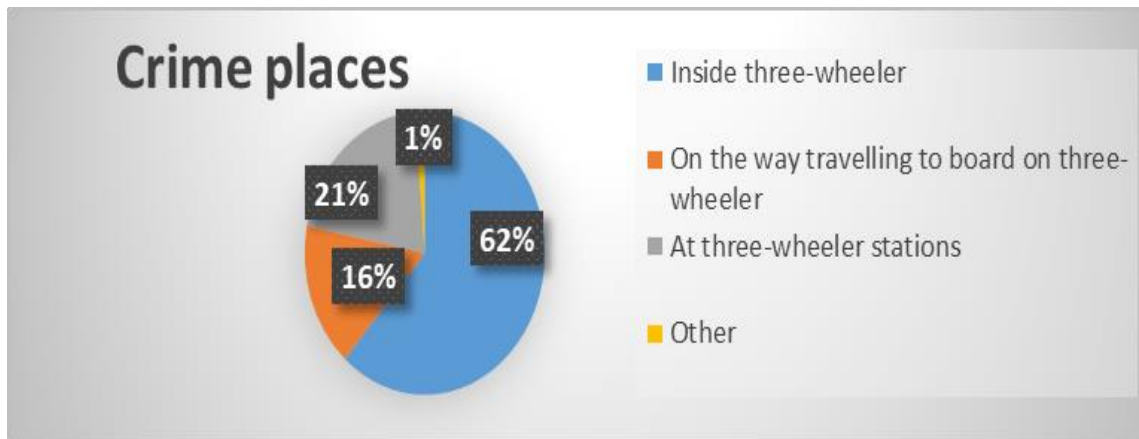


Figure4.5. 3 Places that perpetrators use to commit a crime

Respondents who were victims of a crime were asked whether they reported the crime to the police or not. The majority (45%) said they didn't report it to the police, and 26% of them did report the crime to the police. Furthermore, those respondents who didn't report the crime to the police gave different reasons for not reporting the crime. The majority (32%) said that they didn't report the crime to the police because others who have applied before have not received a favorable response (by thinking that they won't get a solution), the other 9% said they didn't report because there was no police station around, and 22% said the damage was minor. Not only that, but also from those crime victims who reported the crime to the police, 36 participants (46%) said that they didn't get any response from the police, meaning that the police recorded the crime and left it as if nothing happened; and 26 participants (33%) didn't get a good response from the police, but only 16 respondents (21%) said they got a good response. In this regard, it was tried to ask some of the police officers why they can't handle the crimes and why they don't go through investigations. One of the police members said that *"there is a shortage of manpower to follow up and control three-wheeler related crimes in all transit lines of the city, additionally, for the crime to go through investigation, the criminal should be obtained and give information about him; however, in three-wheeler-related crimes, the applicants also didn't come with complete information, and they didn't*

even know where they had been stolen, who committed the crime, the time of the incident, and other necessary information can't be obtained from victims." According to the police, the above-listed reasons made it impossible to arrest and investigate the criminals and made it difficult to obtain general information about the criminals. Even though police member said shortage of man power as a problem to control the crime, passengers said that the police members by themselves are careless to follow up, arrest the perpetrator and in recording those criminal incidents.

4.5.5 Indirect experience of crime

In addition to the problem, they faced participants who were asked to indicate their indirect experience of crime. by asking them a question like, "Have you ever seen or heard three-wheeler-related crimes in Kombolcha City?" For this question, 140 participants (53%) said they heard or saw three-wheeler-related crimes committed on others most of the time; 57 respondents (22%) answered sometimes; 56 participants (21%) heard or saw such crimes occasionally; *Table4. 18* indicates that both the mode and the median fall on “most of the time” category and it can be concluded that three-wheeler related crimes are serious issues in the city.

Table4. 18 Respondents indirect experience of crimes

Question		Frequenc y	Percent	Media n	Mode
Have you ever heard/seen crimes committed on others related to 3-wheeler on it?	Most of the time	140	53	1.0	1.0
	sometimes	57	22		
	occasionally	56	21		
	never heard or seen	12	5		

Source: - questionnaire survey

4.5.6 Most common time for a crime to occur

From their experience, respondents were asked when the most likely time for crimes to occur was and for this regard, 109 respondents (28%) said the most likely time for crimes to occur was during morning rush hour (7:00 a.m. to 9:00 a.m.) and afternoon rush hour (4:00 p.m. to 6:00 p.m.). This is because during this time the chaos increases, which makes it easy for criminals, especially thieves, to steal properties from pockets. 102 respondents (26%), said mid-day (12:00 a.m. to 2:00 p.m.), and 101 respondents (25%), said the third most likely time for crimes to occur was after 8:00 p.m. (See *Figure4.5. 4* below).

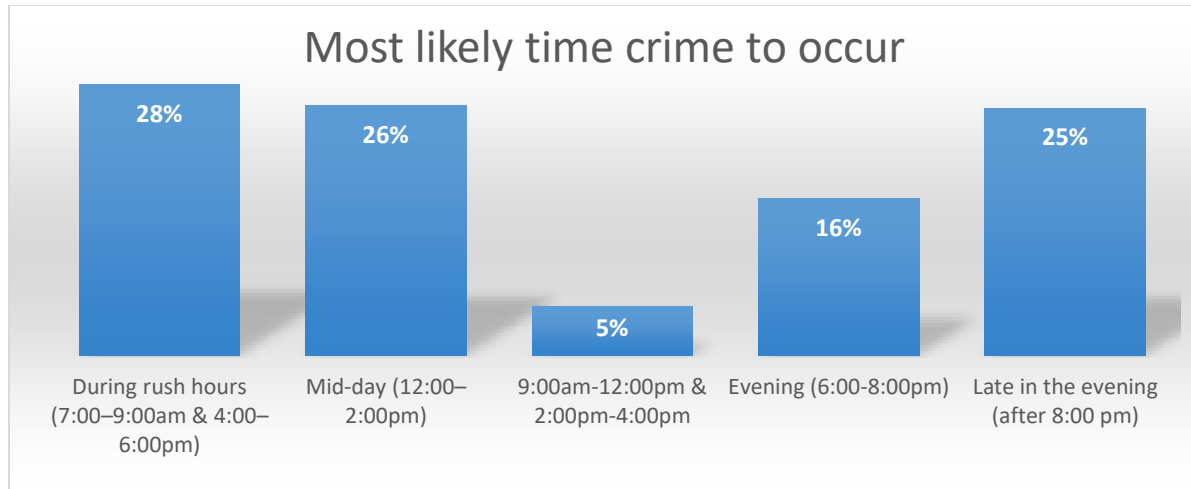


Figure 4.5. 4 Most likely time crime to occur

4.5.7 Method used by perpetrators to commit a crime and drivers' involvement

As information obtained from three-wheeler users who were victims of crime indicates, perpetrators use different techniques to commit crimes against three-wheeler users. The majority of respondents (178) agreed that perpetrators commit a crime by boarding as passengers and coordinating with the drivers. This was the most common system that perpetrators and drivers coordinated to commit crime, especially thefts from commuters, either by deception or distraction of the target passenger. Around 93 respondents (23%) said that perpetrators commit a crime on three-wheeler users by boarding as passengers without the driver knowing them, and 91 respondents (22%) said that the criminals commit a crime by renting the three-wheeler for a day and using their own drivers. This time for clarity, three-wheeler drivers were asked whether they were asked their vehicle for daily contract or not, and 39% of the participant drivers said that they requested their vehicle for a daily contract, and the rest said no. Furthermore, they were also asked whether they knew the purpose of the contract; 46% didn't know the purpose, 32% said for work, 19% said for vacation, and the rest, 3%, said for other travel outside of the city. As the passengers said, 72 percent of the surveyed three-wheeler drivers also agreed with the method that "perpetrators commit crimes by renting the three-wheeler" whereas, 9% didn't agree. Additionally, the drivers were asked whether they knew the types of crimes committed by renting a three-wheeler, and the majority (36%) said theft, followed by robbery (25%). However, the least number of drivers agreed that sexual assault (11%), and kidnapping (10%) were the other types of crimes committed by renting a three-wheeler. According to the information obtained from 3-wheeler

passengers, the crimes committed by criminals acting as coordinators around three-wheeler terminals were small (5%), but the coordination of criminals and three-wheeler drivers was the leading system used by perpetrators to commit a crime. This type of coordination is not common in mass transport systems, which makes it different from other public transport systems. Separately, passengers were asked whether the driver involves in criminal activities or not. As the secondary data gave information about the involvement of three-wheeler drivers in criminal activity (See *Figure4.2. 4*), the questionnaire results also support that, and 107 respondents (40%) said that some of the drivers were involved in criminal activity; 62 respondents agreed that very few drivers do that, whereas 54 respondents (20%) said that most of the drivers were involved in criminal activity; and the other small number of respondents (33) didn't have any comment on the issue. This time, some respondents were asked informally how criminals coordinated with drivers to commit a crime, and most of them said that *"the driver and the perpetrator (being as a passenger) load the targeted passenger either by deception or normally as usual loading way, and after travelling some distance and after they did what they wanted (steal something), force him to get out of the vehicle by creating different reasons like saying that" the traffic police going to punish me" and so on, and then they escaped immediately from the victim"*. According to the experience of the respondents, this type of crime committing technique by 3-wheeler is more common in the city.

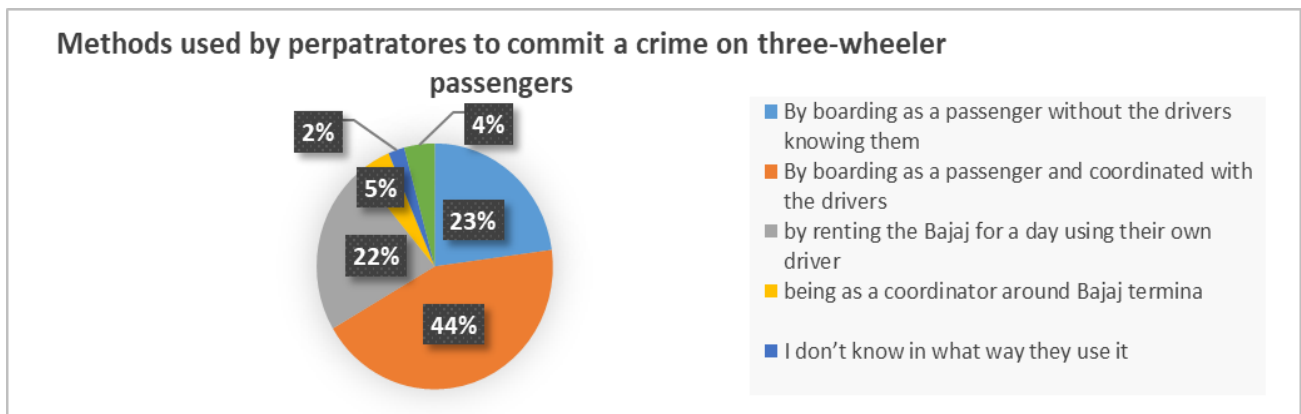


Figure4.5. 5 Crime committing methods used by perpetrators

Again, when both passengers and drivers were asked to comment on nighttime travel by three-wheeler, 215 passenger participants (81%) said it exposes them to crime attacks, but only 12 respondents (5%) said it was secure/safe against crime. A similar result was obtained from drivers as well: the majority of drivers (64%) believe that nighttime was more vulnerable to

crime attacks than daytime; 7% (9 drivers) believe it is secure; and the remaining 29% are unsure. Generally, nighttime travel by 3-wheelers is fearful because the numbers of passengers are small and there is no guarantee for both drivers and passengers. Furthermore, as terminals are public places that are targeted for criminal activities, passengers and drivers were also asked to rate the security status of these three-wheeler terminals. As evidenced by secondary data, three-wheeler terminals were the second-ranked places in terms of the number of crime incidents. Around 68% of the participant drivers in this study also said that the terminals were not secured, 21% said they were secured, and the rest, 12%, didn't know about it. Similarly, the majority (66%) of the passengers said that three-wheeler terminals are not secured against crime; only 34 % responded that three-wheeler terminals were safe and secure against crime. Generally, as the majority said, three-wheeler terminals in Kombolcha City were not secured against crime. A study conducted in Debre Markos City obtained the same result and shows that three-wheeler stations were not secured and passengers were exposed to theft crimes at the stations (Getachew, 2019).

4.5.8 Satisfaction level of commuters related to their security

When commuters are asked to rate their general satisfaction level with three-wheeler service related to criminal activities on a 5-point scale, the majority 38% (100 respondents) were dissatisfied with three-wheeler's security related service; 69 respondents (26%) were very dissatisfied; 47 participants (18%) were neutral; whereas a small number (25 and 24) of respondents were satisfied and very satisfied, respectively, accounting for 9% each (Figure 4.5. 6 below) and (see OLR part on 4.5.9). A study on three-wheeler users' satisfaction conducted in Debre Markos city also indicates similar results: Security was one variable that affects three-wheeler users' satisfaction and shows that passengers were dissatisfied with the three-wheeler services due to the unkind behavior of three-wheeler drivers and an unsecured three-wheeler terminal (Getachew, 2019).

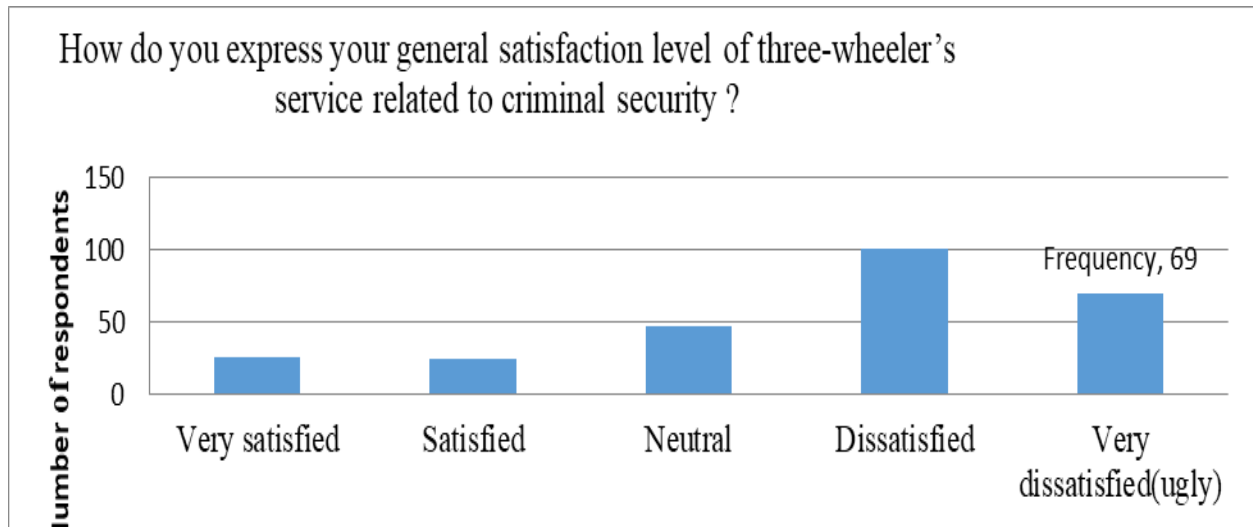


Figure 4.5. 6 Three-wheeler users' satisfaction level regarding to their security

4.5.9 Prediction of passengers' general satisfaction level (OLR)

Finally, the satisfaction level of passengers with the three-wheeler service was analyzed using ordinal logistic regression. For this dependent variable, sex, age, occupation, frequency of travel, education level, marital status, and purpose of travel were taken as the predictor variables. The model was significant (LR χ^2 (24) = 37.152, $p < .05$) indicating that there is a significant difference between the base line model and the final model. In the same way, in goodness of fit statistics, both the Pearson chi-square [χ^2 (744) = 806.478, $p = .056$] and Deviance chi-square [χ^2 (744) = 601.7, $p = 1.00$] tests were non-significant, suggesting a well-fitting model, and the null hypothesis is accepted, meaning that the observed data has goodness of fit with the fitted model. In checking the main assumption of OLR (proportional odds assumption), again we hope to get non-significant results in order to accept the null hypothesis (there is no difference in the coefficients between models), so the result shows that $p = 0.176 > 0.05$, and because it is insignificant, the assumption of proportional odds holds (the effects of the predictors are the same across the levels of the dependent variable). In addition to that, the assumption of multicollinearity was checked and met the criteria.

In predicting the relationship between passengers' general satisfaction level related to security and the predictor variables, sex was the significant predictor. In this case, the analysis results reveal that male three-wheeler users have greater satisfaction than female passengers. In other words, the odds that male passengers are satisfied with three-wheeler services related to security were 1.7

times higher than the same odds for female travelers. Generally speaking, the probability that male passengers were satisfied with three-wheeler (Bajaj) taxi service was 63.2%. In the same way, passengers age was the other predictor variable, and it indicates that passengers whose age group is ≤ 15 less satisfied than passengers whose age is ≥ 41 years, and there was no significant difference in satisfaction level between passengers aged 16–26, 27–40, and 41 and above (see *Table 4.19* above). Regarding the marital status of travelers, passengers who are married, in a relationship, and divorced were less satisfied than those who are single and have never married. Besides this, occupation was the other variable that significantly affects the satisfaction level of passengers, here, government workers, students, private workers, and daily laborer's had greater satisfaction than those unemployed travelers. It can be seen that the odds that passengers who are three-wheeler users and students were satisfied by three-wheeler service were three times higher than the same odds for unemployed three-wheeler users. The purpose of travel was the other predictor variable, and the result indicates that passengers who use 3-wheelers for recreational purposes have greater satisfaction than travelers who use 3-wheelers travelling to work, school, and markets. That is, the odds that passengers who travel for recreational purposes are satisfied with three-wheeler service were 5.6 times higher than the same odds for school travelers. Regarding this three-wheeler, users who use it for recreational purposes were more satisfied with the service than other travelers due to the fact that they get it as they want to get it at a reasonable cost. As evidenced by researchers, one of the reasons for the importance of these three-wheeler taxis is their availability and their door-to-door service. In addition, market travelers had greater satisfaction than work and school travelers. As a whole, passengers who use 3-wheelers to travel to school/education were less satisfied than other travelers, and the frequency of travel by 3-wheelers also indicates that less frequent travelers are less satisfied than more frequent travelers.

Table4. 19 Parameter estimates for passengers' satisfaction level

Predictors		B	Exp(B)	Predictors		B	Exp(B)
Gender	Male=1	0.541	1.717	Age	<=15=1	-0.92	0.397
	Female=2	0a	1		16-26=2	0.208	1.231
Marital status	Married=1	-0.481	0.618		27-40=3	0.083	1.087
	in a relationship=2	-0.609	0.544		>=41=4	0a	1
	Others=3	-2.912	0.054	Educational level	Un-educated1=1	-0.09	0.919
	Divorced=4	-0.732	0.481		Basic education=2	0.089	1.093
	Single (never married) =5	0a	1		Primary school (1-8) =3	0.452	1.571
Purpose of travel	Work=1	0.067	1.07		Secondary school (9-12)	0.19	1.209
	Market/Shopping=2	1.33	3.78		Collage graduate=5	0.88	2.41
	Recreation=3	1.728	5.632		Degree and above=6	0a	1
	Others=4	0.346	1.413	Travelers' occupation	Student=1	1.101	3.006
	School/Education=5	0a	1		Government=2	0.505	1.657
Travel frequency	1-2 days=1	-0.187	0.83		Private=3	0.99	2.691
	3-4 days=2	-0.333	0.717		Daily labor=4	0.907	2.476
	5 days and more=3	0a	1		Others=5	2.243	9.418
					Un employed=6	0a	1

source: - spss output from questionnaire survey data

As indicated in *Figure4.5. 6* above, the majority of three-wheeler users responded that they were dissatisfied with three-wheeler's services. Owing to this, they were asked whether there is a need for an additional/alternative public transport system or not. A large number (91%, 240 participants) of the respondents need an additional or alternative public transport mode; however, a small number of respondents (7%, 19 respondents) don't need another public transport service, and 6% (2%) don't have a comment on the issue. The evidence shows that there should be an alternative public transport mode in the city, and large number (140,54%) of respondents prefer additional taxis, followed by city buses (96 respondents, 34%).

CHAPTER FIVE

5. Conclusion and recommendations

5.1 Conclusions

The study aimed to evaluate the safety and security level of three-wheeler taxis as a public transport mode in Kombolcha city. In the city, 3-wheelers are an extensively used mode of transportation.

In investigating the types of three-wheeler crashes and the causes of crashes in the city; -

- It was found that the dominant type of collision among 3-wheelers were pedestrian collisions, followed by overturning (toppling) and vehicle to vehicle collisions.
- The likelihood for the occurrence of pedestrian collisions in 3-wheeler crashes was higher than vehicle-to-vehicle collisions. But more than that, overturning (toppling) was more common in 3-wheelers than in other vehicles. The logistic regression result indicates that the chance of overturning accidents occurring in 3-wheelers was higher than the likelihood of vehicle-to-vehicle and pedestrian collisions.
- Another relevant finding of this study was that the types of accidents involving the falling of passengers from the vehicle and passengers jumping and falling from the vehicle while the vehicle is in motion were observed mainly in three-wheelers.
- Lack of caution, speeding, failure to give way for pedestrians and vehicles, technical problems, and lack of experience were the major causes of three-wheeler crashes in the city, where speeding was more likely to account for overturning and pedestrian collisions than vehicle-to-vehicle collisions.
- In examining the factors that affect the severity level of crashes, the vehicle type involved in an accident, the type of crash, and the cause of accidents were found to be the factors that impact the severity level of crashes. For this case, multinomial logistic regression analysis results showed that most of the 3-wheeler crashes resulted in injury crashes, and pedestrian collisions were the leading type of accident that accounted for injury and fatal crashes.
- In terms of the cause of accidents, there was a higher probability of a lack of caution causing injury crashes and property damage than fatal crashes. Speeding, on the other hand, more likely caused fatal crashes than injury crashes and property damage.

Related to criminal incidents, all crimes committed inside 3-wheelers, at 3-wheeler stations, as well as crimes committed in other places that have a relationship with 3-wheelers, were recorded as 3-wheeler-related crimes.

- In identifying the three-wheeler crime types and crime-committing techniques in Kombolcha city, theft, beating, snatching, robbery, fraud, and kidnapping were the most common crime types observed in the city, with theft crimes accounting for the highest statistics, followed by beating and robbery.
- Three-wheeler-related crime types were subjected to multinomial logistic regression analysis, and victims' gender, shift of the day, and drivers' involvement were found to significantly affect the crime types. The result revealed that beating crimes were more likely committed on male passengers, whereas theft, robbery, and snatching were more common among female travelers.
- Beating and robbery crimes were more likely committed at night; in contrast, there was a higher probability for theft crimes to occur during the daytime than at night. In addition, 3-wheeler drivers were involved in all criminal activities. However, they were less likely to be involved in theft crimes and more likely to be involved in robbery, snatching, and beating crimes.
- Moreover, boarding as a passenger by coordinating with drivers, boarding as a passenger without the drivers knowing them, and renting the three-wheeler were the most common techniques that the criminals used to commit crimes. They also use deception and distraction techniques in order to divert the targeted victims' attention,
- Regarding crime-occurring places, victim type, driver involvement in crimes, and crime types had a significant relationship with the crime places (inside the vehicle or outside the vehicle). In this case, the drivers were more likely to be exposed to criminal incidents inside 3-wheelers than passengers, and they were more likely to be involved in crimes that are committed inside the vehicle than outside crimes.
- Theft crimes were more likely to happen inside the three-wheeler; however, beating, robbery, and snatching crimes were less likely to occur inside the vehicle than other crimes.
- Generally, Kebele 03 of the city location, as well as Wednesday and Saturday of the week, had the highest crime and crash records.

5.2 Recommendations

Based on the problems identified during the data collection process and the findings of the analysis, the following recommendations are proposed to the respective sectors.

- First of all, the recommendation points to Kombolcha city police department's human resource management; the sector should designate well-trained traffic police and security police staffs in order to record and manage both traffic and criminal data precisely, and there should be an appropriate and informative crime recording format.
- As indicated in the analysis, the common type of crash in the city was pedestrian collisions; based on that, pedestrian facilities like walkways, guardrails, and pedestrian crossing facilities at necessary sections of the roadway, specifically for roads in kebele 03 should be provided.
- Serious traffic control and security police supervision should be applied on Wednesday and Saturday (both are market days, and the highest crime and crash records were on these days).
- The public police should respond quickly to reported crimes by apprehending and punishing perpetrators in an educative manner for others.
- By restricting the entry of additional 3-wheelers, alternative public transportation vehicles (either minibus taxis or public buses) should be provided for the city on a demand-based basis.

5.3 Implication of future researches

Based on the limitations of this study the following future researches are recommended

- Safety of three-wheeler taxis in rural and pre-urban areas of the country and security in urban Ethiopia separately.
- Mobility gap filled by three wheelers and their negative impact on traffic congestion in a mixed traffic system.
- Comparison in number, type and severity of accidents by motor cycle and 3-wheelers in rural and pre-urban areas.

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APPENDIXES

APPENDIX: 1 Crash Data Tables

Table 1. Crash severity level by vehicle types

Vehicle types		3-wheelers	Large truck	Medium Truck	Small Truck	Large Bus	Medium Bus	Mini Bus	Car	Motor Cycle	Cycle	Animal drawn cart	Unknown	Total	
Crash Severity level	Fatal	No	47	4	27	13	3	5	20	3	2	0	0	1	125
		%	38%	3%	22%	10%	2%	4%	16%	2%	2%	0%	0%	1%	100%
	Serious Injuries	No	48	6	7	9	3	5	12	0	0	0	0	0	90
		%	53%	7%	8%	10%	3%	6%	13%	0%	0%	0%	0%	0%	100%
	Slight Injuries	No	105	4	17	7	2	2	18	6	4	6	5	2	178
		%	59%	2%	10%	4%	1%	1%	10%	3%	2%	3%	3%	1%	100%
	Property Damage	No	41	35	37	45	8	6	25	4	0	0	1	0	202
		%	20%	17%	18%	22%	4%	3%	12%	2%	0%	0%	0%	0%	100%
	Total	No	241	49	88	74	16	18	75	13	6	6	6	3	595
		%	41%	8%	15%	12%	3%	3%	13%	2%	1%	1%	1%	1%	100%

Table 2. Number of collision types by vehicle types

Vehicle Type		3-wheelers	Large truck	Medium Truck	Small Truck	Large Bus	Medium Bus	Mini Bus	Car	Motor Cycle	Cycle	Animal drawn cart	Unknown	Total (horizontally)	
Type of accident	Pedestrian Collision	No	133	12	34	22	4	8	43	11	3	10	5	4	289
		%	46%	4%	12%	8%	1%	3%	15%	4%	1%	3%	2%	1%	100%
	Vehicle-vehicle collision	No	37	37	33	39	6	6	19	3	3	4	1	1	189
		%	20%	20%	17%	21%	3%	3%	10%	2%	2%	2%	1%	1%	100%
	Overturning	No	34		4	4		1	6	1					50
		%	68%		8%	8%		2%	12%	2%					100%
	Collision with static object	No	1	1		3								1	6
		%	17%	17%		50%								17%	100%
	Unknown	No	1		3									1	5
		%	20%		60%									20%	100%
	Others	No	7	2	2	1	1								13
		%	54%	15%	15%	8%	8%								100%
Total (vertically)		213	52	76	69	11	15	68	15	6	14	6	7	552	

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Table 3. Crash severity level by causes of accidents																	
Crash severity level		Death (Fatal)				Serious Injuries				Slight Injuries				Property Damage			
Vehicle types		Others		3-wheelers		Others		3-wheelers		Others		3-wheelers		Others		3-wheelers	
		No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Cause of accident	Failure to give way for pedestrian	11	14%	11	23%	5	12%	12	25%	12	16%	22	21%	1	1%	0	0%
	Failure to give way for Vehicles	0	0%	1	2%	1	2%	2	4%	2	3%	4	4%	13	8%	7	17%
	Speed	21	28%	15	32%	9	21%	18	38%	14	18%	20	19%	19	12%	2	5%
	Technical Problem	1	1%	0	0%	2	5%	0	0%	4	5%	2	2%	5	3%	2	5%
	Improper overtaking and Not keeping enough distance.	5	7%	0	0%	7	16%	0	0%	6	8%	2	2%	40	26%	8	20%
	lack of caution	20	26%	13	28%	14	33%	12	25%	29	38%	44	42%	56	36%	15	37%
	Lack of experience	2	3%	1	2%	1	2%	1	2%	1	1%	1	1%	3	2%	1	2%
	Others and Unknowns	16	21%	6	13%	4	9%	3	6%	8	11%	10	10%	17	11%	6	15%
Total(vertical)		76	100%	47	100%	43	100%	48	100%	76	100%	105	100%	154	100%	41	100%

APPENDIX 2: Crime Data Tables

Table 1 Distribution of crime types by crime victims				
Crime type	Drivers		Passengers	
	No	percentage	No	percentage(vertical)
Stealing/theft	93	76%	344	67%
Robbery	3	2%	26	5%
Beating	16	13%	57	11%
Snatching	7	6%	41	8%
Fraud	2	2%	18	4%
Kidnapping	0	0%	17	3%
Others	2	2%	11	2%
Total	123	100%	514	100%

ክፍል ሦስት፡- ከወንጀል ጋር በተያያዘ ደህንነትን የሚመለከቱ ጥያቄዎች

1. በባጃጅ ለመጓጓዣ ሲያስገቡ/ሲጓዙ ከወንጀል ድርጊቶች ደህንነት ምንም ዓይነትም አዎ ደህንነት ይሰማኛል ጋር በተያያዘ ደህንነት ይሰማዎታል? አይሰማኝም
2. ደህንነት አይሰማኝ ከዚህ በፊት ወንጀል በተለያዩ መንገድ ሰለባጃጅ በቅርብ የማይቀጠል ሰው ሌላ ም ካሉ ለምን? ስለተፈጠሩት ላይ ወንጀል ስለመሰማ ወንጀል ስለተፈጠሩት
3. በባጃጅ ሲጓዙ/ በባጃጅ ለመሰጠት ሲንቀሳቀሱ ወንጀል ስርቆት ያታዩ ትንኮሳ ዝርፊያ/ ሌላ ተፈጻሚነት ያወቃል ካሉ ምን ዓይነት ወንጀል? አፈና (ጥቃት) ማጭበርበር ቅጫያ
4. ምን ዓይነት ጊዜ ነው ወንጀሉ የተፈጠመበት? 1 ጊዜ 2 ጊዜ 3 ጊዜ እና ከዛ በላይ
5. ወንጀሉ የተፈጠመበት ባጃጅ ባጃጅ ለመሰጠት በመሰጠት ከባጃጅ ባጃጅ መሰጠት አላወቅም የት በታነው? ውስጥ በመሄድ ላይ ሳለሁ ላይ ሳለሁ ስወርድ ቆሜ ስጠብቅ
6. በጊዜው ወንጀሉን ለፖሊስ አመልክተው ነበር? አዎ አላመለከትኩም
7. መልስዎ አዎ ከሆነ፤ ከፖሊስ ጥሩ ምላሽ ጥሩ ምላሽ ምንም ዓይነት ምላሽ አላገኘሁም ምን ዓይነት ምላሽ አገኙ? አግኝቻለሁ አላገኘሁም
8. አላመለከትኩም ጉዳቱ ቀላል በቅርብ ፖሊስ ከኔ በፊት ያመለከቱ ሌሎች ሰዎች ጥሩ ምላሽ ሌላ ካሉ ለምን? ስለሆነ ጣቢያ ስለሌላ ስለላገኙ (መፍትሄ አላገኝም ብዬ ስለማስብ)
9. ባጃጅ ላይ/ከባጃጅ ጋር በተያያዘ ወንጀል በተደጋጋሚ አንዳንድ አልፎ አይቸም ሰምቸም ስለተፈጠመባቸው ሰዎች አይተው/ሰምተው ያወቃሉ? ጊዜ አለፎ አላወቅም
10. በአብዛኛው ባጃጅ ላይ/በባጃጅ የሰራ መግቢያና መውጫ ቀትር ከ 3:00- ምሽት ከምሽት 2:00 ወንጀሎች የሚፈጠሩት ምን ሰዓት ላይ(1:00-3:00 እና ላይ(6:00- 6:00 እና 8:00- ላይ(12:00- ሰዓት በኋላ ሰዓት ነው? 10:00-12:00) 8:00(ሰዓት) 10:00 2:00 ሰዓት)
11. የባጃጅ አሽከርካሪዎች በወንጀል ድርጊቶች ይሳተፋሉ? አብዛኛዎቹ የተወሰኑት በጣም ጥቂቶቹ አይሳተፉም
12. ወንጀሎች ወንጀል ለመስራት ባጃጅን ይጠቀማሉ? አዎ ይጠቀማሉ አይጠቀሙም አላወቅም
13. መልስዎ አዎ ሹፊናም ከሹፊና ጋር ባጃጅን በመከራየትና የባጃጅ ከሆነ በምን ሳያወቃቸው ተሳፋሪ ተመሳጥረው ተሳፋሪ እራሳቸው በማሸከርከር ተራአስተባባሪ አላወቅም አይነት ዘዴ? መስለው በመግባት በመምሰል በመምሰል
14. የባጃጅ መጠበቂያና መሰጠቻ ጠቃሚዎች ደህንነታቸው የተጠበቀ ነው? አዎ አይደለም
15. መልስዎ አይደለም ከሆነ፤ በአካባቢው የፖሊስ በባጃጆችና በሰው ግልፅ የሆነ አላወቅም እንዴት? ቢሮ ስለሌላ/ፖሊስ ጠጣም ሰለሚጫናነቅ የመጠበቂያና መሰጠቻ ጠቃሚዎች ስለሌላ
16. በአጠቃላይ ከወንጀል ደህንነት ጋር በተገናኘ በጣም አያረካም አያረካም አስተያየት ያረካል በጣም በባጃጆች አገልግሎት ምን ያክል ረክተዋል? (አስቀያሚ ነው) የለኝም ያረካል
17. ለከምባልቻ ከተማ ሌላ/ተጨማሪ የሆዙበት አዎ ያስፈልጋል አያስፈልግም አስተያየት የለኝም ትራንስፖርት አይነት ያስፈልጋል ብለው ያስባሉ?
18. መልስዎ ያስፈልጋል ከሆነ ምን ተጨማሪ የከተማ አውቶብስ ተጨማሪ ባጃጆች አላወቅም አይነት የትራንስፖርት ስርቢስ? ታክሲዎች

English version

1. Gender
 - a) Male b) Female
2. Age
 - a) below 15 b) 16-20 c) 21-26 d) 26-31 e) 32-40 f) 41-50 g) above 51
3. Educational level
 - a) Un-educated b) basic education c) Primary school (1-8) d) Secondary school (9-12) e) college f) degree and above
4. Marital status
 - a) Married b) In a relationship c) Single never married d) Divorced e) others
5. occupation
 - a) student b) government Employee c) private d) daily labor e) Unemployed f) another
6. Average monthly income

a) 1500 and less b) 1501-3000 c) 3001-4500 d) 4501-6000 d) 6001-7500 e) more than 7500

7. Which type of transport mode do you use in Kombolcha city?
a) Walking b) cycle c) motor cycle d) three-wheeler (Bajaj) e) Minibus taxi f) city bus
8. If you say three-wheeler, what is your reason to use Bajaj as a main transport mode?
a) Comfort b) absence of other alternative transport mode c) travel time d) travel cost e) availability f) other reason
9. How often do you use three-wheeler in a week?
a) 1-2 days b) 3-4 days c) 5 days and more d) daily
10. When travelling by three-wheeler, what is the purpose of your trip?
a) work b) education c) recreation D) market/shopping e) other

Safety concerned questions

1. How do you feel about your safety related to accidents when travelling by three-wheeler taxis?
a) I feel very unsafe (my threat is high) b) I feel unsafe c) neutral (I don't feel anything) d) I feel safe e) I feel very safe
2. Have you ever seen/heard a three-wheeler related accident in Kombolcha city?
a) Repeatedly b) Sometimes c) Occasionally d) I have never heard or seen
3. Do three-wheeler drivers talk with a hand-held phone/read or write text messages while driving? a) Most of them b) some of them c) very few d) Never do like that
4. Do three-wheeler drivers eat chat while driving? a) Most of them b) some of them c) very few d) Never do like that
5. Do three-wheeler drivers give priority for pedestrians, while pedestrians cross a line?
a) Yes b) No c) I don't know
6. Do three-wheeler drivers drive with inappropriate manner like illegal maneuvering, suddenly stopping in front of other vehicles and zigzag driving to over pass other vehicles?
a) Most of them B) some of them c) very few d) Never do like that
7. Do Kombolcha city three-wheeler drivers are exposed to accidents?

- a) Most of them b) Some of them c) very few d) they are not exposed to accidents
8. Do Kombolcha city's three-wheeler drivers' violate traffic laws and regulations?
a) Most of them B) some of them c) very few d) never do that
9. Does traffic polices control the traffic activities regularly (not only in the rush hours) related to the operation of three-wheeler taxis? a) Yes b) No d) I don't know
10. Who plays a major role for the occurrence of road accidents in Kombolcha city?
a) Three-wheeler taxis (drivers) b) pedestrians c) freight vehicles(drivers) c) small sized public transport vehicles (mini buses) d) other vehicles(drivers) d) I've no comment

Security concerned questions

1. Do you feel secure while traveling/thinking to travel by three-wheeler related to criminal activities?
a) No, I don't feel secured b) I don't feel anything(neutral) c) Yes, I feel secured
2. If your answer is no, what was your reason?
a) Because, I've been convicted before b) I heard crimes on three-wheelers in different ways c) the man I knew intimately committed a crime d) other reason
3. If you say "I've been convicted before" while traveling by three-wheeler/ to board on it, what type of crime was it?
a) Theft b) Kidnapping c) Sexual harassment (assault) d) fraud e) robbery/Snatching
e) other crime
4. How many times did the crime committed on you?
a) Once b) two times c) three times and more
5. Where did the crime committed?
a) Inside three-wheeler b) on the way travelling to board on three-wheeler c) during boarding d) While stepped down e) while waiting three-wheeler at the station f) I don't know
6. Did you report the crime to the police at the time?
a) Yes, I have reported b) no I hadn't report
7. If your answer is yes, what type of response did you get from the police?
a) I got a good response b) I didn't get a good response c) I didn't get any response
8. If your answer for question no 6 is No, what was your reason?

- a) Because the damage is minor b) there is no police station around c) others who have applied before me haven't received a good response (because I think I won't find a solution) d) other reason
9. Have you ever heard/seen crimes committed on others related to three-wheeler taxis?
a) Most of the time b) sometimes c) occasionally d) never heard or seen
10. At what time of the day are most of the crimes committed on three-wheelers?
a) during rush hours (7:00–9:00am & 4:00–6:00pm) b) mid-day (12:00–2:00pm) c) 9:00am-12:00pm & 2:00-4:00pm d) evening (6:00-8:00pm) e) late in the evening (after 8:00 pm)
11. Do three-wheeler drivers involved in criminal activities?
a) Most of them b) some of them c) very few d) I don't know
12. Do perpetrators use three-wheelers to commit a crime?
a) Yes b) No c) I don't know
13. If your answer is yes, in what way?
a) By boarding as a passenger without the drivers knowing them b) By boarding as a passenger and coordinated with the drivers c) by renting the three-wheeler for a day using their own driver d) being as a coordinator around three-wheeler taxi terminals e) I don't know in what way they do it
14. Are the three-wheeler stations (waiting areas) or terminals secured against crime?
a) Yes b) no
15. If your answer is no, how?
a) Because, there is no police officer/security guard around b) it is very crowded of passengers and vehicles c) no appropriate and clearly specified waiting area d) I don't know
16. How do you express your general satisfaction level with the three-wheelers' service related to criminal security in Kombolcha City?
a) very dissatisfied(ugly) b) dissatisfied c) neutral d) satisfied e) Very satisfied
17. Do you think that there is a need for an alternative or additional public transport mode in the city? a) Yes b) No c) I don't have comment
18. If your answer is yes, what type of public transport service?
a) Minibus taxis b) city bus c) Additional three-wheeler taxis d) I don't know

Questionnaires for drivers

ክፍል አንድ:-ስለ ሾጬና እሴት/እሴት ስለሚነዳው ተሽከርካሪ (ባጃጅ) መሰረታዊ መረጃ

1. ፆታ ወንድ ሴት
2. ዕድሜ ከ18ዓመት በታች 18-26 27-31 32-40 41-50 ከ50 ዓመት በላይ
3. የትምህርት ደረጃ መሰረተ የአንደኛ ሁለተኛ ደረጃ የኮሌጅ ዲግሪ እና ከዚያ
ያልተማሩ ትምህርት ደረጃ (1-8) እናመሰናዶ (9-12) ምሩቅ በላይ
4. የጋብቻ ሁኔታ ባለትዳር በፍቅር ብቸኛ እና ከዚህ በፊትም አግብቶ የፈታ ሌላ
ግንኙነት ላይ ያለ ትዳር ያልነበረኝ
5. የአሽከርካሪ እና የተሽከርካሪ ግንኙነት ባለቤት ተቀጣሪ ሌላ
6. የማሽከርካሪ የመንጃ ከ 1 1-2 2-5 5-10 ዓመት ከ10 ዓመት በላይ
ልምድ ፈቃድ የሌለው ዓመት በታች ዓመት ዓመት
7. የተሽከርካሪው የአገልግሎት ከ 1 1-2 2-5 5-10 ዓመት ከ10
ዘመን(የባጃጅ ዕድሜ) ዓመት በታች ዓመት ዓመት ዓመት ዓመት አይታወቅም
በላይ
8. በሳምንት ውስጥ ምን ያክል 3 ቀንና ከዛ 4-5 ቀናት 6 ቀን ሙሉ ሳምንት
ቀናት ይሰራሉ? በታች (7 ቀን)
9. በስራ ቀናት በቀን በአማካኝ ለ 6 ሰዓታትና ከ 6-8 ከ 8-12 ከ12 ሰዓት በላይ
ለምን ያክል ሰዓት ይሰራሉ? ከዛ በታች ሰዓታት ስታት
10. ከስራ ቀናት ውጭ(ቅዳሜ እና እሁድ) ለ 4 ሰዓትና ከ4-8 ከ8-12 ከ12 ሰዓት ሙሉቀን
በቀን ለምን ያክል ሰዓታት ይሰራሉ? ከዛ በታች ሰዓት ሰዓት በላይ አልሰራም

ክፍል ሁለት:- የትራፊክ አደጋን የሚመለከቱ ጥያቄዎች

1. ባጃጅ በማሽከርከር ላይ ሳሉ አደጋ አጋጥሞዎት ያዉቃል? አዎ አያዉቅም
2. አደጋ አጋጥሞኝ ያዉቃል ካሉ ምን ያክል ጊዜ ነው አደጋ ያጋጠመዎት? አንድ ጊዜ ሁለት ጊዜ ሦስት ጊዜና ከዛ በላይ
3. በእርሰዎና በተሳራሪዎ ላይ ቀላል ከባድ የንብረት ጉዳት
የደረሰው ጉዳት ምን ያክል ነበር? የአካል ጉዳት የአካል ጉዳት ሞት ጉዳት አልደረሰም
4. በከምባልቻ ከተማ የባጃጅ አደጋ አይተው/ሰምተው ያዉቃሉ? በተደጋጋሚ አንዳንድ ጊዜ አልፎ አልፎ
5. በከተማዎ፤ በአብዛኛው ባጃጅ ባጃጅ ባጃጅ ከአነስተኛ የህዝብ ባጃጅ ከሌሎች ሌላ
ምን አይነት ግጭት ነው ከባጃጅ ጋር ከጭነት ማመላለሻ ተሽከርካሪዎች(ተሽከርካሪዎች ጋር እግረኛ
የሚከሰተው? መኪኖች ጋር ሚኒባሶች ጋር) ግጭት
6. ለከምባልቻ ከተማ የመንገዱ ጠባብ የባጃጆች በከተማዎ እግረኞች የእግረኛ አስተያየት
የባጃጅ አደጋ ምክንያቶች መሆንና የትራፊክ ቁጥር ከፍተኛ የሚንቀሳቀሱ የጭነት መጓዣና ማቋረጫ የለኝም
ምንድን ናቸው? መጨናነቅ መሆን መኪኖች መብዛት አለመከተል

ክፍል ሦስት:-ከባጃጅ ጋር የተያያዙ ወንጀሎችን የሚመለከቱ ጥያቄዎች

1. ባጃጅዎን ለቀን ገቢ ከንትራት ተጠይቀው ያዉቃሉ? (እርሰዎ ሳይኖሩ አዎ ተጠይቄ አላዉቅም
አሽከርካሪ ከራሳቸው አድርገው)
2. መልስዎ አዎ ከሆነ፣ አከራይተው ያዉቃሉ? አዎ አከራያለሁ (አከራይቼ አዉቃለሁ) አላከራይም (አከራይቼ አላዉቅም)
3. ተከራዮቹ ባጃጁን ለምን እንደሚከናወኑት ለሌላ ጉዞ ለምን እንደሚጠቀሙበት
/እንደሚከራዩት ያዉቃሉ? ለመዝናናት ከከተማ ውጭ ለስራ በግልፅ አላዉቅም
4. ባጃጅ በመከራየት ወንጀል ይፈጸማል ብለው ያስባሉ? አዎ እንደዚህ አይደረግም አስተያየት የለኝም
5. መልስዎ አዎ ከሆነ ምን አይነት ወንጀል? ስርቆት ዝርፈያ ፆታዊ ጥቃት አፈና ሌላ
6. ምን ያክል ጊዜ ነው ባጃጅ ላይ ወንጀል የሚፈጸመው? በተደጋጋሚ አንዳንድ ጊዜ አልፎ አልፎ
7. የባጃጅ መጨናኛ ማዉረጃ በታዎች(ተርሚናሎች) አዎ ይህንነታቸው የተጠበቀ አይደለም አስተያየት የለኝም
ይህንነታቸው የተጠበቀ ነው? ነው

English version

Part I Basic information about the driver and the vehicle she/he drives

1. Gender a) Male b) Female

- 4 Age a) below18 b) 18-21 c) 21-26 d) 26-31 e) 31-50 f) above 51
- 5 Educational level
a) un-educated b) basic education c) primary school (1-8) d) secondary school (9-10) e) preparatory school (11-12) f) college graduate g) degree and above
- 6 Marital status
a) Married b) in a relationship c) single never married d) divorced e) widowed
- 7 Driver and vehicle relationship
a) Owner b) employee c) another
- 8 Driving Experience of the driver
a) Have no driving license b) below 1 year c) 1-2 years d) 2-5 years e) 5-10 years f) above 10 years
- 9 Vehicles service life (age of the vehicle) a) Less than1 year b) 1-2 years c) 2-5 years d) 5-10 years e) above 10 years f) unknown
- 10 How many days a week do you work?
a) 3 days and less b) 4 to 5 days c) 6 days d) whole week (7 days)
- 11 How many hours of the day do you work on weekdays?
a) 6 hours and less b) 6 -8 hours c) 8-12 hours d) more than 12 hours
- 12 How many hours of the day do you work on weekends?
a) 4 hours and less b) 4-8 hours c) 8-12 hours d) more than 12 hours e) I didn't work the whole day on weekends

Part II TRAFFIC SAFTY part

1. Have you ever been involved in an accident?
a) Yes b) no
2. If your answer is yes, how many times have you involved in an accident?
a) Once b) two times c) three times and more
3. What were the injuries to you or your passenger as a result of the accident?

- a) Slight injuries b) serious injuries c) killed d) property damage e) no injury happened
4. Have you ever seen/ heard three-wheeler accidents in the city?
 - a) Repeatedly b) sometimes c) occasionally
5. What type of accident is most common in Kombolcha city?
 - a) three-wheeler with three-wheeler b) three-wheeler with trucks and trailers c) three-wheeler with medium public transport vehicles (mini buses) d) three-wheeler with other vehicles not mentioned here e) pedestrian collision f) others
6. What are the common causes of three-wheeler-related traffic crashes in Kombolcha City?
 - a) the narrowness of the road and traffic mix b) the presence of a high number of three-wheelers in the city c) more trucks and trailers experience and pass through the city d) pedestrians don't follow pedestrian moving and crossing facilities (they move on roadways and cross any place without any crossing facility e) I've no comment

Part III questions related to crime

1. Have you ever been requested your vehicle for daily income contract (driver from themselves)? a) yes b) no
2. Have you ever rented the vehicle?
 - a) Yes, I rent it b) No, I didn't rent
3. For what purpose do they rent the three-wheeler?
 - a) for vacation b) for other travel out of the city c) for work d) I don't know clearly for what purpose they use it
4. Do perpetrators commit crimes by renting a three-wheeler (Bajaj) taxi?
 - a) Yes b) No c) I've no comment
5. If your answer is yes, what type of crime committed by renting three-wheeler?
 - a) Theft b) robbery c) sexual assault d) kidnapping e) another
6. How often do crimes committed on three-wheelers in Kombolcha city?
 - a) Repeatedly b) sometimes c) occasionally
7. Are three-wheelers loading and unloading terminals safe(secured) against crime?
 - a) Yes, they are secured b) no, they aren't secured c) I've no comment

