YANGON UNIVERISTY OF ECONOMICS

DEPERATMENT OF STATISTICS

ANALYSIS OF PEDESTRIAN CRASH SEVERITY ON CONTRIBUTING FACTORS IN INSEIN TOWNSHIP

BY

HTET HTET HTAY

M.Econ (Statistics)

Roll No. 26

JANUARY, 2021

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Thesis submitted as a partial fulfillment towards
the Degree of Master of Economics

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This thesis is submitted to Board of Examination as partial fulfillment of the requirement for the Degree of Master of Statistics.

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DEPERATMENT OF STATISTICS

This is to certify that the thesis entitled **"ANALYSIS OF PEDESTRIAN CRASH SEVERITY ON CONTRIBUTING FACTORS IN INSEIN TOWNSHIP"** submitted as a partial fulfillment towards the requirements of Master of Economics (Statistics) has been accepted by the Board of Examiners.

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ABSTRACT

This study intended to investigate the impact of contributing factors influencing the pedestrian-vehicle crash severity. Data were collected from the pedestrian-vehicle crash records from traffic accident records of No (2) Office of Traffic Police (Yangon), covering the year 2015 to 2019. Descriptive statistics and multinomial logit model were applied in this study. By the descriptive analysis, 24 percent of pedestrians were fatal, 26 percent were serious injury and 50 percent were non-serious injury. According to the results of multinomial logistic regression analysis, the contributing factors such as pedestrian gender, age and mode, driver driving behavior, location type, crash partner and time of collision were affected to the pedestrian- vehicle crash severity. According to pedestrian gender, male pedestrians were more likely to be fatal rather than female pedestrians. The old pedestrians over 50 years were more likely to be serious injury and middle age pedestrians between 25 and 50 years old were likely to be non-serious injury. Based on the result of pedestrian mode, crossing mode were more likely to be serious injury rather than the other modes. The reckless, speeding and inexperience driving of drivers were likely to be non-serious injury while the other or unknown driving behaviors might affect the fatal severity of pedestrians. Moreover, pedestrians were more likely to be fatal at non-junction location type rather than junction. By the result of crash partner, car and motorcycle were likely to be non-serious injury than the other or unknown vehicles. By the result of time of collision, pedestrians were suffered serious injury at the other off peak times although they were more likely to be non-serious injury at AM peak.

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
UN	United Nations
WHO	World Health Organization

CHAPTER I
INTRODUCTION

As broadly recognized, preventing injuries from the occurrence of road traffic accident should be the main objective of the road safety strategy and action. Therefore, in Myanmar, government has given the attention in major roads. Although major roads have received government attention and undergone safety improvements by international community, many roads in Myanmar still lack pavement, lighting, shoulder and grading. Driving under these conditions has led to an increase in fatalities and injuries. Therefore, over the recent year, there has been an increased rate of fatalities and injuries in Myanmar.

1.1 Rationale of Study

Death and injury due to road traffic collisions are a major public health issue, especially in developing country due to rapid and unplanned urbanization. This is exacerbated by the absence of adequate infrastructure in cities and lack of legal regulatory frame work, which exponentially increases the number of road accidents (WHO, 2004).

Accidents involving pedestrians constitute one of the single largest causes of death, injury and disability. Because pedestrian-vehicle collision can result in serious injury to pedestrians who are exposed to danger when in close proximity to moving vehicle. Furthermore, these injuries can be considerably serious and even lead to death in a manner. Therefore, pedestrians have an increased rate of death and injury from road traffic collisions. Especially, pedestrian fatalities remained higher than all other fatalities such as driver and passengers over several years.

Nowadays, pedestrian safety issues have been considered as one of the major traffic collisions. Although a number of studies have been done in the area of pedestrian safety in developed counties, it doesn’t mean that the same result will be in developed countries. Results from pedestrian studies conducted in developed countries cannot be directly compared with developing countries as there are fundamental differences between the pedestrian environment, behavior and characteristics in developed and developing countries.

The developing countries reveal differences in driver and pedestrian behavior, site characteristics, road design and pedestrian demography compared to developed countries. Therefore, there need the increased attention and research in the area of pedestrian safety in developing countries, in order to reduce its devastating impacts (Gyimah, Aidoo, Akaateba, & Appiah, 2016).

According to pedestrian safety, it is necessary to analyze the factors that affect the severity of pedestrian injury of a pedestrian-vehicle collision. Crash severity analysis is a major topic in the transportation safety area because of the substantive economic and social costs associated with serve outcomes (Liu & Fan, 2018). Thus, understanding the various factors contributing to pedestrian-vehicle crash severity will provide policy makers, safety professionals and government planners with evidence-based recommendations to reduce the negative impacts of pedestrian-vehicle collisions (Gyimah, Aidoo, Akaateba, & Appiah, 2016).

And the results from accident reconstruction are useful in developing recommendations for making roads safety, transport infrastructure and improving safety aspects on motor vehicle designs improving (Levulyte, Baranyai, Sokolovskij, & Torok, 2016). Furthermore, transportation engineers and planners need to be mindful of the injuries which a vehicle can cause to a pedestrian in a collision and any policy or programme to encourage modal shift towards the more sustainable modes has to be accompanied by complementary programmes to improve the safety of pedestrians (Rifaat, Tay, & Barros, 2012).

Since 2013, Myanmar has already drawn up its national road safety action plan which is aligned with UN Resolution on road safety and road safety guidelines of ADB for improving road safety. In 2018, 457 pedestrians died and 1881 pedestrians were injury due to pedestrian crashes in Myanmar. This is partly due to the absence of law enforcement in multiple domains such as controlling vehicle and motorway standards and random alcohol testing. CCTV seems to be in some downtown areas for speed and red light enforcement but these do not prevent reckless driving.

For reducing the risk of injury among road users, sidewalks, towpaths, cycling lanes and safe crossing points are important. Although sidewalks are basic requisite for pedestrians, these are lacking and obviously non-functioning in Yangon. The deadlocked pavements in Yangon push pedestrians onto the perilous roads because these are either pocked by several uncovered openings of several drains, obstructed by park cars or fully occupied by street vendors.

In Yangon, 397 pedestrian-vehicle crashes were occurred in 2019. Among the districts of city of Yangon, the northern district was the highest pedestrian crashes in 2019 by the records of traffic accidents. Among townships of the northern district, Insein was one of the major pedestrian-vehicle crashes and in 2019, it is about 10 percent of total pedestrian-vehicle collisions in Yangon city.

Thus, this study concentrates on pedestrian-vehicle collisions in Insein township and also intends to assist road safety and transportation professionals and planners for predicting the pedestrian-vehicle collisions and to inform them for establishing road design and road safety policies that aim at reducing pedestrian crashes and implementing the functions of the pedestrian traffic safety.

1.2 Objectives of the Study

The main objectives of this study are

i. To examine the pedestrian-vehicle crash severity and contributing factors of pedestrian-vehicle crashes in Insein township.

ii. To investigate the impact of contributing factors to pedestrian-vehicle crash severity.

1.3 Method of Study

In this study, descriptive method was used to examine the pedestrian-vehicle crashes in Insein township. Multinomial logit model was used to investigate the effect of contributing factors influencing the pedestrian crash severity.

1.4 Scope and Limitation of the Study

This study focused on the pedestrian-vehicle crashes in Insein township, Yangon. The required data were organized and summarized by collecting the pedestrian-vehicle crash records from traffic accident records of No (2) Office of Traffic Police (Yangon), covering the year 2015 to 2019. The variables in this study were considered and analyzed by the collected pedestrian-vehicle crash records from traffic accident records of No (2) Office of Traffic Police (Yangon).

1.5 Organization of the Study

This study is organized into five chapters. Chapter I is introduction which includes rationale of the study, objectives of the study, method of study, scope and limitations of the study and organization of the study. Chapter II is the literature review of the pedestrian-vehicle collisions. Chapter III is the theoretical background of Multinomial logit model. Chapter IV is presented the results and findings and Chapter V is submitted the conclusion of this study.

CHAPTER II
LITERATURE REVIEW

This chapter reviews the pedestrian-vehicle collisions, the background information of Insein township and the theoretical concept of pedestrian-vehicle collisions. The concept and theories provided are used to formulate the conceptual framework and variables that possibly determine pedestrian-vehicle collisions.

2.1 Pedestrian-Vehicle Collisions

Rifaat et al. (2012) studied the pedestrian crashes for the City of Calgary from 2003 to 2005 using a partially constrained generalized order logit model. This study examined the effect of different urban street patterns on pedestrian-vehicle crash severity. The results indicated that currently popular urban street patterns, like loops and lollipops design, were found to be associated with higher pedestrian crash severity, when compared to the traditional gridiron pattern.

Tom & Granie (2013) studied that gender differences in pedestrian rule compliance and visual search at signalized and unsignalized crossroads. This study founded that male pedestrians are over-represented in road accidents and they violate more rules than female pedestrians.

Kadilar (2014) studied that effect of driver, roadway, collision and vehicle characteristics on crash severity. The results founded that weather plays the key role in pedestrian-vehicle accidents, due to slippery roadways, bad visibility and other adverse weather conditions. This study also implicated that the adverse weather conditions as a significant factor in causing pedestrian crash severity.

Gyimah et al. (2016) investigated the pedestrian-vehicle crash data in Ghana from 2009 to 2013 using the multinomial logit model. The results showed that there is a link between pedestrian-vehicle crash severity and natural and built environmental characteristics. Factors that were found to significantly increase the probability of fatal injury to pedestrians when involved with a vehicle in a collision included; off-peak periods, unclear weather, weekends, night time with no lights, curved and inclined roads, untarred roads, mid-blocks and wider roads.

Bianco (2017) analyzed the characteristics and contributing causes of pedestrian crashes that occurred in Central Florida over a 5 year-period (2011-2015) at intersections and along roadway segments at mid-block locations using the data obtained from the Signal 4 analytic database. This study used that the ordinal regression model was developed to identify the significant factors affecting the level of injury severity sustained by pedestrians. The results observed that red light running related to intersection crashes, as well as pedestrians failing to yield to the right of way and driver under influence related to mid-block crashes were associated with high injury severity and an increase in the likelihood of severe injuries.

Khan (2017) studied that injury severity of truck drivers in crashes at highway-rail grade crossings. The results founded that pedestrian injuries involving a large vehicle, such as a bus, truck or van are likely to be severe than injuries from accidents, especially trucks which have unique characteristics compared to other motor vehicles in terms of size, weight and acceleration characteristics. Thus, it was shown that the particular vehicles that are directly involved in pedestrian crashes play a significant role in pedestrian casualty risk.

Park and Bae (2020) considered the pedestrian-vehicle crashes in Daegu from 2013 to 2015 using binary logistic regression model. This study examined the determinants of pedestrian injury severity by pedestrian age. Factors in the built environment, such as road characteristics and land use of the places, were considered, as were the accident characteristics of pedestrians and drivers. The results founded that the accident characteristics of pedestrians and drivers are more influential in pedestrian-vehicle crashes than the factors of built environment characteristics.

This study also showed that there are substantial differences in injury severity relative to pedestrian age and it has explanatory power in relation to the severity of injury. Pedestrian age is analyzed by dividing the age groups. It was founded that the pedestrian age, older pedestrians are more likely to suffer fatalities or serious injuries in the accidents compared to the other age groups. Therefore, this study determined that pedestrian's physical characteristics and behaviors particularly in relation to roads with moving vehicles differ depending on the pedestrian 's age. However, there are substantial differences in injury severity relative to the pedestrian's age.

2.2 Conceptual Framework of Pedestrian Injury Severity

The conceptual framework expresses the contributing factors that influence the pedestrian-vehicle crash injury severity, which is presented in Figure (2.1). According to Figure (2.1), the contributing factors are divided into three groups such as pedestrian characteristics, situations of driver and environmental characteristics. Pedestrian gender, age, mode and crossing behavior are involved in pedestrian characteristics. In situations of driver, driver driving behavior and driver condition are included. Location type, crash partner, months, time of collision and day of week are contained in environmental characteristics. These contributing factors are used as the independent variables. The pedestrian injury severity is used as the dependent variable.

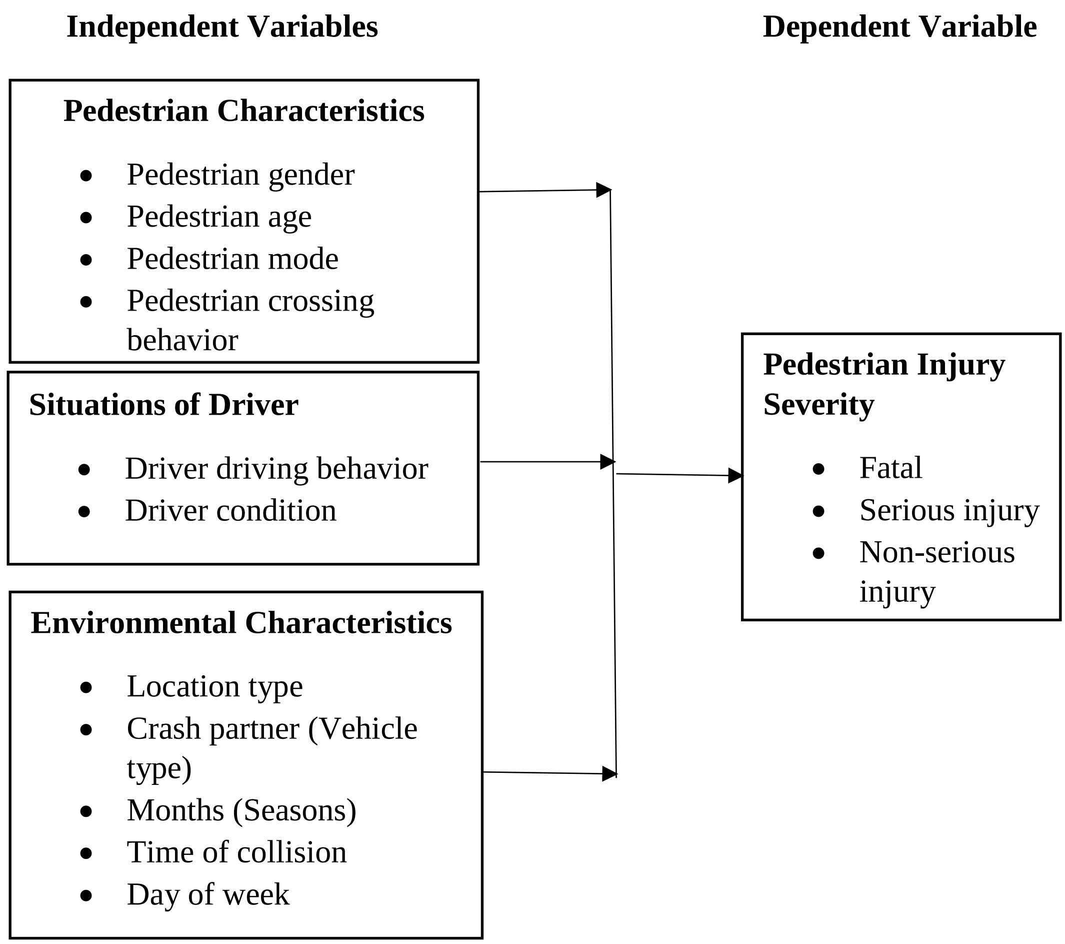

Figure (2.1) Conceptual Framework

2.3 Background of Insein Township

Insein township is a township where exists in Northern Yangon District. Its area is 35 km^2. It comprises with 21 quarters and is alongside with Shwe Pyi Thar in the North, Hlaing Thar Yar in West, Mingalar Don in East and Mayangon in South.

Insein is home to the Insein Prison, the most notorious prison in the country that houses hundreds of political prisoners. Until the 1990s, Insein, about 20 miles (32km) from the central Yangon, was beyond Yangon's city limits although by 1980s, Insein was already integrated with the rest of the city. With the expansion of Yangon's city limits in the 1990s which also included founding new satellite towns, Insein was formally incorporated into Yangon.

The word “Insein” means “precious lake” in the Burmese language and is also a former name of Inya lake. However, the etymology of “Insein” is derived from the Mon language and means “elephant lake”. Insein was a famous battle site in the Burmese civil war that erupted after the country’s independence from the United Kingdom in January 1948. It was the Karen insurgents reached in January 1949 in their ambitious attempt to take Yangon and oust the Burmese government.

According to the 2014 Myanmar Population and Housing Census, there are 305,283 people who live in Insein township. The population density of Insein township is 8,717 persons per square kilometer. The population in conventional households are 278,986 persons and the number of conventional households are 61,676 persons. There are 4.5 persons living in each household in Insein township. This is slightly higher than that of Union average.

Insein has been urbanized with human activities over the past many years. According to the development of the wholesale market in the Danyingone area of the Insein township in Yangon, this became the one of the major economical place and there is always complex with pedestrians and vehicles. Thus, Insein was one of the major pedestrian-vehicle crashes and among the townships in Yangon city, it was about 10 percent of pedestrian-vehicle collisions in 2019.

CHAPTER III
THEORETICAL BACKGROUND

As the pedestrian-vehicle crash injury severity, this study considers three severity outcomes such as fatal, serious injury and non-serious injury which are used as dependent variables. The dependent variables with polytomous outcomes are unordered categories. Hence, this study uses the multinomial logit model to investigate the impact of contributing factors influencing the pedestrian crash severity.

3.1 Descriptive Statistics

The term descriptive statistics is confined to the presentation of information in an understandable form. Given a large amount of numerical information, a statistician would try to arrange it in a form that makes it easy to read understand. This may include the classification and presentation of the data in a table of frequencies, or, in order to convey its meaning more directly, the data may be presented as diagrams or graphs. Measures, such as proportions or averages, may then be calculated. The first stage of statistical function, which includes the organization, presentation and summarization of data, falls within the domain of descriptive statistics.

3.2 Multinomial Logit Model

The multinomial logit model is one of the most commonly used methods for analyzing unordered categorical response variables in social science research. This can be cited some reasons for its popularity: (1) it is a natural generalization of the binomial logit model; (2) it is equivalent to the log linear model with grouped data; and (3) statistical software for estimating the model is widely available.

When a qualitative variable is unordered, it means that each category is unique in comparison with other categories. There is no added advantage in locating a category in relation to other categories. The basic idea behind the multinomial logit model is to compare two outcomes at one time. Although both would provide the basis for constructing the multinomial logit model, the baseline logit is more commonly used.

Without any loss of generality, for an outcome variable (y) with J categories $(j = 1, \dots, J)$, let us contrast the j^{th} $(j > 1)$ category with the first or ‘‘baseline’’ category, deriving the baseline logit for the j^{th} category,

$$BL_j = \log\left[\frac{\Pr(\ y=j)}{\Pr(\ y=1)}\right] = \log\left(\frac{P_j}{P_1}\right), j = 2, \ldots, J \quad (1)$$

where p_j and p_1 denote the probabilities for the j^{th} and first categories. The choice of using the first category as the baseline is arbitrary. Any other category can be the baseline.

In the transformation framework, it can be regressed the baseline logit specified in Eq. (1) as a linear function of *x*. It is necessary to specify the contrast category (i.e., j) as well as the baseline category (1 in this case) when it is modeled unordered qualitative outcomes. There are $J - 1$ non-redundant baseline logits for an outcome variable with *J* categories.

Let's now consider the case of having only one independent variable x with a limited number of categories (i.e., $x = 1, \ldots, I$). This case is equivalent to a two-way contingency table. At each value of x $(x = i)$, the baseline logit is

$$\log\left[\frac{\Pr(\ y=j\backslash x=i)}{\Pr(\ y=1\ \backslash x=i)}\right] = \log\left(\frac{P_{ij}}{P_{i1}}\right) = BL_{ij} \quad (2)$$

Since in this context it has been specified a saturated model, the estimation of Eq. (2) can be easily obtained as

$$\log\left(\frac{F_{ij}}{F_{i1}}\right) = \log\left(\frac{f_{ij}}{f_{i1}}\right) \quad (3)$$

Where $f_{ij}$and F_{ij} , are the observed and expected frequencies in the i^{th} row and the j^{th} column for the classified table of $x \times y$. It can be easily rewritten the result in the form of a generalized linear model:

$$BL_{ij} = \sum_{i=1}^{I} \log\left(\frac{F_{ij}}{F_{i1}}\right) I(x = i) \quad (4)$$

where $I(\cdot)$ is the indicator function, I = 1 if true, 0 otherwise. With dummy-variable coding and the first category as reference, Eq. (4) is usually written as

$$BL_{ij} = \alpha_j + \sum_{j=1}^{J} \beta_{ij} I(x = i), \qquad x > 1 \quad (5)$$

where α_j is the baseline logit for $x = 1$ and the difference in the baseline logit between $x = i$ and $x = 1$. In this simple case, $\alpha_j$and β_{ij} can be estimated separately for all i and j. Simultaneous estimation will result in an equivalent model in this case. For models other than the saturated model, α and β should be simultaneously estimated.

3.3 Tests of Goodness of Fit for Multinomial Logistic Regression

In general, a goodness of fit test refers to measuring how well do the observed data correspond to the fitted (assumed) model. It compares the observed values to the expected (fitted or predicted) values. The common tests of goodness of fit with categorical data are the following.

Pearson's chi-squared test

Pearson's chi-squared test is a statistical test applied to sets of categorical data to evaluate how likely it is that any observed difference between the sets arose by chance. Its properties were first investigated by Karl Pearson in 1900. It tests a null hypothesis stating that the frequency distribution of certain events observed in a sample is consistent with a particular theoretical distribution. The events considered must be mutually exclusive and have total probability 1. A common case for this is where the events each cover an outcome of a categorical variable.

$$\chi^2 = \sum_j \frac{(O_j - E_j)^2}{E_j}$$

whereO_j is the observed count in cell j and E_j is the expected count in cell j.

Deviance chi-squared test

The deviance is defined as the difference of likelihoods between the fitted model and the saturated model. Deviance chi-squared test measures the deviance of fitted logistic model with respect to the perfect model or saturated model. The deviance is always larger or equal than zero, being zero only if the fit is perfect.

$$G^2 = 2 \sum_j O_j \log\left(\frac{O_j}{E_j}\right)$$

where G^2 is the deviance test statistic.

Likelihood ratio test

The likelihood ratio test is commonly used to evaluate the difference between the logistic models. It requires two models; one of which has a set of parameters (variables), and a second model with all of parameters from the first, plus one or more variables. It involves estimating two models and comparing them. Fixing one or more parameter to zero, by removing the variables associated with parameter from the model, will almost always make the model fit less well, so a change in the log likelihood does not necessarily mean the model with more variables fits significantly better. It compares the log likelihoods of the two models and tests whether this difference is statistically significant. If the difference is statistically significant, then the less restrictive model (the one with more variables) is said to fit the data significantly better than the more restrictive model.

$$LR = -2\log\left(\frac{L_o}{L_1}\right)$$

Where L_0 is the log likelihood of the fitted model and L_1 is the log likelihood of the less restricted model.

Wald test

The Wald test is commonly used to perform multiple degree of freedom tests on sets of dummy variables used to model categorical variables in regression. It examines a model with more parameters and assess whether restricting those parameters (generally to zero, by removing the associated variables from the model) seriously harms the fit of the model.

$$W = \frac{(\hat{\theta}-\theta_o)^2}{var(\theta)}$$

where $var(\hat{\theta})$ is the variance of maximum likelihood estimate.

3.4 Pseudo R^2 for Multinomial Logistic Regression

A non-pseudo R^2 is a statistic generated in ordinary least squares (OLS) regression that is often used as a goodness of fit measure. There are several approaches to thinking about R^2 OLS. These different approaches lead to various calculations of pseudo R^2 with regressions of categorical response variables. When analyzing data with the multinomial logistic regression, an equivalent statistic to R^2 does not exist. The model estimates from the multinomial logistic regression are maximum likelihood estimates arrived at through an iterative process. They are not calculated to minimize variance, so the OLS approach to goodness of fit does not apply. However, to evaluate the goodness of fit of logistic models, several pseudo R^2 have been developed. The following pseudo R^2 are commonly used for multinomial logistic regression.

Cox and Snell's pseudo R^2

$$R^2 = 1 - \left\{\frac{L(M_{Intercept})}{L(M_{Full})}\right\}^{2/N}$$

The ratio of the likelihoods reflects the improvement of the full model over the intercept model (the smaller the ratio, the greater the improvement). Consider L(M) is the conditional probability of dependent variable given the independent variables. If there are N observation in the dataset, then L(M) is the product of N such probabilities. Thus, taking the n^{th} root of the product L(M) provides an estimate of the likelihood of each Y value. Cox and Snell's presents the R^2 as the transformation of the $-2\ln\left[L(M_{Intercept})/L(M_{Full})\right]$ statistic that is used to determine the convergence of a logistic regression. Cox and Snell's pseudo R^2 has a maximum value that is not 1. That means if the full model predicts the outcome perfectly and has a likelihood of 1, Cox and Snell's is then $1 - L(M_{Intercept})^{2/N}$, which is less than one.

Nagelkerke's pseudo R^2

$$R^2 = \frac{1 - \left\{\frac{L(M_{Intercept})}{L(M_{Full})}\right\}^{2/N}}{1 - L(M_{Intercept})^{2/N}}$$

Nagelkerke's pseudo R^2 adjusts Cox and Snell's so that the range of possible values extends to 1. To achieve this, Cox and Snell's is divided by its maximum possible value, $1 - L(M_{Intercept})^{2/N}$. Then, if the fill model perfectly predicts the outcome and has a likelihood of 1, Nagelkerke's is 1. When $L(M_{Full}) = 1$, then R^2 =1; when $L(M_{Full}) = L(M_{Intercept})$, then R^2 =0.

McFadden's pseudo R^2

The log likelihood of the intercept model is treated as a total sim of squared errors. The ratio of the likelihoods suggests the level of improvement over the intercept model offered by the full model. A likelihood falls between 0 and 1, so the log of a likelihood is less than or equal to zero. If a likelihood will have a very low likelihood, then the log of the likelihood will have a large magnitude than the log of a more likely model. Thus, a small ratio of log likelihoods indicates that the full model is a far better fit than the intercept model. If comparing two models on the same data, McFadden's would be higher for the model with the greater likelihood. The formula of McFadden's pseudo R^2 is

$$R^2 = 1 - \frac{\ln \hat{L}(M_{Full})}{\ln \hat{L}(M_{Intercept})}$$

where M_{Full} = Model with predictors

$M_{Intercept}$ = Model without predictors

$\hat{L}$ = Estimated likelihood

CHAPTER IV

RESULTS AND FINDINGS

According to the collection of the pedestrian-vehicle crash records from traffic accident records of No (2) Office of Traffic Police (Yangon), data from 2015-2019 were used to examine the pedestrian-vehicle crashes in Insein township by using descriptive analysis. The impact of contributing factors influencing the pedestrian-vehicle crash severity was analyzed by using multinomial logistic regression analysis in this chapter.

4.1 Descriptive Analysis

The characteristics of pedestrian-vehicle crash injury severity and the contributing factors in Insein township are presented in this section.

4.1.1 Pedestrian-Vehicle Crash Injury Severity

The distribution of pedestrian-vehicle crash injury severity in Insein township is described in following Table (4.1) and Figure (4.1).

Table (4.1)

Distribution of Pedestrian-Vehicle Crash Injury Severity

Pedestrian Crash Injury Severity	Frequency	Percent
Fatal	60	24.4
serious injury	63	25.6
non-serious injury	123	50.0
Total	246	100.0

Source: No (2) Office of Traffic Police (Yangon) (2015-2019)

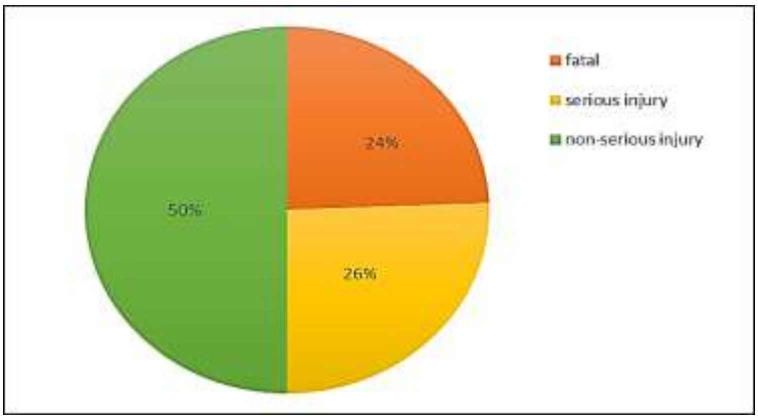

Figure (4.1) Pedestrian-Vehicle Crash Injury Severity

Source: No (2) Office of Traffic Police (Yangon) (2015-2019)

From Table (4.1) and Figure (4.1), it can be seen that 24% are fatal, 26% are serious injury and 50% are non-serious injury in Insein township. Therefore, 24% of pedestrians are killed by the pedestrian-vehicle crashes in Insein township and 26% are affected seriously which may lead to the death.

4.1.2 Contributing Factors

The distribution of contributing factors of pedestrian-vehicle crashes in Insein township are shown in Table (4.2).

Table (4.2)

Distribution of Contributing Factors

Variable		Frequency	Percent	Chi-Square	P-Value
Pedestrian gender	male	163	66.3	11.498	0.003
	female	83	33.7		
	Total	246	100.0		
Pedestrian age	young (under 25)	47	19.1	11.312	0.023
	mid-age (25-50)	144	58.5		
	old (over 50)	55	22.4		
	Total	246	100.0		
Pedestrian mode	walking	51	20.7	13.077	0.011
	crossing	145	58.9		
	other	50	20.3		
	Total	246	100.0		
Pedestrian crossing behavior	careless crossing	58	23.6	10.967	0.004
	other	188	76.4		
	Total	246	100.0		
Driver driving behavior	reckless driving/ speeding	234	95.1	6.548	0.162
	inexperience	10	4.1		
	other/ unknown	2	.8		
	Total	246	100.0		
Driver condition	normal	129	52.4	8.186	0.085
	alcohol impaired	5	2.0		
	other/ unknown	112	45.5		
	Total	246	100.0		

Variable		Frequency	Percent	Chi-Square	P-Value
Location type	not at junction	201	81.7	3.655	0.161
	junction	45	18.3		
	Total	246	100.0		
Crash partner	large vehicle	89	36.2	20.389	0.002
	car	56	22.8		
	motorcycle	40	16.3		
	other/ unknown	61	24.8		
	Total	246	100.0		
Months	summer	97	39.4	4.533	0.339
	raining	63	25.6		
	winter	86	35.0		
	Total	246	100.0		
Time of collision	am peak (6:30-9:30)	40	16.3	11.075	0.026
	pm peak (3;00-7:00)	34	13.8		
	off peak (all other times)	172	69.9		
	Total	246	100.0		
Day of week	weekend	66	26.8	1.59	0.541
	weekday	180	73.2		
	Total	246	100.0		

Source: No (2) Office of Traffic Police (Yangon) (2015-2019)

From the Table (4.2), the chi-square test was carried out to examine the analysis of relationship between pedestrian crash injury severity and contributing factors. Pedestrian gender, age, mode, crossing behavior, crash partner and time of collision were significant at 5 percent level.

The numbers of pedestrians who involved in pedestrian-vehicle crashes are 66.3% in male and 33.7% in female. Hence, it can see that most of the pedestrians who involved in accidents are male. 19.1% of the pedestrians are aged under 25 years old, 58.5% of them are between 25 and 50 years old and 22.4% of them are over 50 years old. According to pedestrian mode, 20.7% of pedestrians are walking, 58.9% of them are crossing and 20.3% of them are in other mode. By the pedestrian crossing behavior, 23.6% of pedestrians are careless and 76.4% of them are in other behaviors.

Furthermore, 95.1% of pedestrians are crashed by drivers' reckless driving or speeding, 4.1%of them are by drivers' inexperience and 8% of them are by other or unknown situation. 52.4% of pedestrians are collided by drivers' normal condition, 2% of them are by drivers' alcohol impaired and 45.5% of them are by other or unknown condition.

As the results of environmental characteristics, 81.7% of pedestrians are crashed at non-junction area and 18.3% of them are at junction. 36.2% of pedestrians are crashed by the large vehicles, 22.8% of them are by car, 16.3% of them are by motorcycle and 24.85% of them are by other or unknown vehicles. 39.4% of pedestrians are caused accidents in summer, 25.6% of them are in raining season and 35% of them are in winter. 16.3% of pedestrians are collided at AM peak during 6:30 am and 9:30 am, 13.8% of them are at PM peak from 3 pm to 7 pm and 69.9% of them are in all other off peak times. By the day of week, 26.8% of pedestrians are crashed on the weekend and 73.2% of them are on the weekday.

4.2 Multinomial Logistic Regression Analysis

The description of variables and results of multinomial logistic regression analysis are presented in this section.

4.2.1 Description of Variables

The dependent variable in this study was the pedestrian-vehicle crash injury severity. The dependent variable was categorized as

1 = Fatal

2 = Serious injury

3 = Non-serious injury (Reference)

The contributing factors of pedestrian-vehicle crash injury severity were considered as the independent variables and the coding of them were shown in Table (4.3).

Table (4.3)

Coding of Independent Variables

Contributing Factors	Variable	Coding
Pedestrian Characteristics	Pedestrian gender	0 = Male 1 = Female (Reference)
	Pedestrian age	1 = Young (Under 25) 2 = Middle age (25-50) 3 = Old (Over 50)(Reference)
	Pedestrian mode	1 = Walking 2 = Crossing 3 = Other (Reference)
	Pedestrian crossing behavior	0 = Careless crossing 1 = Other (Reference)
Situations of Driver	Driver driving behavior	1 = Reckless driving/speeding 2 = Inexperience 3 = Other/ unknown (Reference)
	Driver condition	1 = Normal 2 = Alcohol impaired 3 = Other/unknown (Reference)
Environmental Characteristics	Location type	0 = Not at junction 1 = Junction (Reference)
	Crash partner	1 = Large vehicle 2 = Car 3 = Motorcycle 4 = Other/ unknown (Reference)
	Months	1 = Summer 2 = Raining 3 = Winter (Reference)
	Time of collision	1 = Am peak (6:30-9:30) 2 = Pm peak (3:00-7:00) 3 = Off peak (all other times) (Reference)
	Day of week	0 = Weekend 1 = Weekday (Reference)

Source: No (2) Office of Traffic Police (Yangon) (2015-2019)

4.2.2 Results of Multinomial Logistic Regression Analysis

In order to assess the overall fitting model, this study used the chi-squared tests and pseudo R^2. The results are shown in Table (4.4).

Table (4.4)

Model Fitting Information for Pedestrian-Vehicle Crash Injury Severity with All Independent Variables

Model Fitting Criteria	Chi-Square	df	Sig.
-2 Log Likelihood	82.021	38	.000
Pearson	427.463	358	.007
Deviance	374.170	358	.268
Cox and Snell	.284		
Nagelkerke	.324		
McFadden	.160		
Overall Correct prediction	58.5%		

Source: No (2) Office of Traffic Police (Yangon) (2015-2019)

According to Table (4.4), the value of chi-square statistic by the likelihood ratio test is 82.021 and p-value is 0.000. This can be concluded that the multinomial logistic regression model of pedestrian-vehicle crash injury severity is significant at 1% level. Therefore, this model can explain that the contributing factors may affect the pedestrian-vehicle crash severity.

The Pearson chi-square value is 427.463 and p-value is 0.007, so that the model is significant at 1%level and it indicates that this model fits the data well. The Deviance chi-square value is 374.170 and p-value is 0.268. That is not significant. The Cox & Snell R-square, Nagelkreke R-square and McFadden R-square values are 0.284, 0.324 and 0.160 respectively. These indicate that 16% to 32.4% of variation in pedestrian-vehicle crash injury severity can be explained by the variation of all independent variables used in this model. Overall, 58.5% of pedestrians were predicted correctly.

The parameter estimates of multinomial logistic regression model of pedestrian-vehicle crash injury severity with all independent variables are shown in Table (4.5).

Table (4.5)

Parameter Estimates of Multinomial Logistic Regression Model of Pedestrian-Vehicle Crash Injury Severity with All Independent Variables

Variable	**Pedestrian crash injury severity**					
	Fatal			**Serious Injury**		
	B	**S.E**	**Exp (B)**	**B**	**S.E**	**Exp (B)**
Intercept	17.070***	1.940	_	16.439***	.857	_
Pedestrian gender						
Male	.828*	.444	2.289	-.494	.384	.610
Pedestrian age						
young (under 25)	.027	.595	1.027	-.556	.518	.573
mid-age (25-50)	-.307	.488	.736	-1.237***	.446	.290
Pedestrian mode						
Walking	-.439	.575	.644	.333	.623	1.395
Crossing	.138	.491	1.148	.970*	.545	2.639
Pedestrian crossing behavior						
careless crossing	.268	.510	1.308	.699	.489	2.012
Driver driving behavior						
reckless driving/ speeding	-18.423***	1.754	.000	-17.454	0.000	.000
inexperience	-19.232***	2.011	.000	-34.201	1900.183	.000
Driver condition						
Normal	.067	.513	1.069	-.290	.433	.748
alcohol impaired	1.312	1.383	3.713	-14.815	2949.459	.000
Location type						
not at junction	1.056**	.530	2.875	.737	.475	2.091

Variables	Pedestrian crash injury severity					
	Fatal			Serious Injury		
	B	S.E	Exp (B)	B	S.E	Exp (B)
Crash partner						
large vehicle	-.143	.592	.867	.754	.580	2.125
Car	-1.388**	.709	.250	-.278	.643	.757
motorcycle	-1.682**	.857	.186	-.114	.698	.893
Months						
summer	.022	.450	1.022	-.038	.446	.963
raining	.009	.488	1.009	.433	.474	1.541
Time of collision						
am peak (6:30-9:30)	-.940	.639	.391	-1.017*	.591	.362
pm peak (3:00-7:00)	.551	.548	1.735	.436	.516	1.546
Day of week						
weekend	-.698	.429	.497	-.053	.392	.948

*** denotes significant at 1% level, ** denotes significant at 5% level, * denotes significant at 10% level.

Source: No (2) Office of Traffic Police (Yangon) (2015-2019)

By comparing fatal injury and non-serious injury from the results of Table (4.5), it was found that male is statistically significant at 10% level by comparing male and female of pedestrian gender. It indicates that for fatal relative to non-serious injury, the regression coefficient for male is statistically different from zero when the other variables are fixed. The coefficient of male is positive relation to fatal. The relative risk associated with male increases by 2.289 times for fatal injury compared to non-serious injury. Thus, male pedestrians are more likely to be fatal than non-serious injury.

It was observed that young age under 25 years and middle age between 25 and 50 years old are not statistically significant at all significant level by comparing these two ages and old age over 50 years. It indicates that for fatal relative to non-serious injury, the regression coefficients for these two ages are not statistically different from zero when the other variables are fixed. The coefficient of young under 25 years is positive relation to fatal and the coefficient of middle age between 25 and 50 years is negative relation to fatal. The relative risk associated with young under 25 increases by

1.027 times and it associated with middle age between 25 and 50 years decreases by 0.736 times for fatal injury compared to non-serious injury. Therefore, young pedestrians under 25 years are more likely to be fatal and middle aged pedestrians between 25 and 50 years are less likely to be fatal than non-serious injury.

It was discovered that walking and crossing modes are not statistically significant at all significant level by comparing these two modes and other pedestrian modes. It indicates that for fatal relative to non-serious injury, the regression coefficients for these two pedestrian modes are not statistically different from zero when the other variables are fixed. The coefficient of walking mode is negative relation to fatal and the coefficient of crossing mode is positive relation to fatal. The relative risk associated with walking mode decreases by 0.644 times and it associated with crossing mode increases by 1.148 times for fatal injury compared to non-serious injury. Hence, pedestrians with walking mode are less likely to be fatal and they are more likely to be fatal in crossing mode than non-serious injury.

It was found that careless crossing is not statistically significant at all significant level by comparing careless crossing and other crossing behaviors. It indicates that for fatal relative to non-serious injury, the regression coefficient for careless crossing is not statistically different from zero when the other variables are fixed. The coefficient of careless crossing is positive relation to fatal. The relative risk associated with careless crossing increases by 1.308 times for fatal injury compared to non-serious injury. Thus, pedestrians with careless crossing behavior are more likely to be fatal than non-serious injury.

It was recognized that the reckless driving/ speeding and inexperience are statistically significant at 1% level by the comparison of these two driving behaviors and other/ unknown behaviors. It indicates that for fatal relative to non-serious injury, the regression coefficients for these two driving behaviors are statistically different from zero when the other variables are fixed. The coefficients of these two driving behaviors are negative relation to fatal. The relative risks associated with both the reckless driving/ speeding and inexperience decrease by 0.000 times for fatal injury compared to non-serious injury. Thus, if pedestrians were crashed by drivers with the behaviors of inexperience and reckless driving or speeding, they are less likely to be fatal than non-serious injury.

It was observed that normal and alcohol impaired are not statistically significant at all significant level by the comparison of these two driver conditions and other/

unknown conditions. It indicates that for fatal relative to non-serious injury, the regression coefficients for these two driver conditions are not statistically different from zero when the other variables are fixed. The coefficients of these two driver conditions are positive relation to fatal. The relative risks associated with normal and alcohol impaired increase by 1.069 and 3.713 times respectively for fatal injury compared to non-serious injury. Thus, if pedestrians were crashed by drivers in normal and alcohol impaired conditions, they are more likely to be fatal than non-serious injury.

It was found that non-junction location is statistically significant at 5% level if it was compared to the junction type. It indicates that for fatal relative to non-serious injury, the regression coefficient for non-junction type is statistically different from zero when the other variables are fixed. The coefficient of non-junction type is positive relation to fatal. The relative risk associated with non-junction type increases by 2.875 times for fatal injury compared to non-serious injury. Therefore, pedestrians are more likely to be fatal rather than non-serious injury if they were collided at non-junction than at junction.

It was discovered that large vehicle is not statistically significant at all significant level and car and motorcycle are statistically significant at 5% level by comparing with the other or unknown vehicle types. It indicates that for fatal relative to non-serious injury, the regression coefficient for large vehicle is not statistically different from zero and the regression coefficients for car and motorcycle are statistically different from zero when the other variables are fixed. The coefficients of these three vehicle types are negative relation to fatal. The relative risks associated with large vehicle, car and motorcycle decrease by 0.867, 0.250 and 0.186 times respectively for fatal injury compared to non-serious injury. Hence, if pedestrians were crashed with these three vehicle types, they are less likely to be fatal.

It was observed that summer and raining are not statistically significant at all significant level by the comparison of these two months and winter. It indicates that for fatal relative to non-serious injury, the regression coefficients for these two months are not statistically different from zero when the other variables are fixed. The coefficients of these two months are positive relation to fatal. The relative risks associated with summer and raining increase by 1.022 and 1.009 times respectively for fatal injury compared to non-serious injury. Thus, if pedestrians were crashed in summer and raining, they are more likely to be fatal than non-serious injury.

It was discovered that AM peak and PM peak are not statistically significant at all significant level by comparing with all other off peak times. It indicates that for fatal relative to non-serious injury, the regression coefficients for these two peak times are not statistically different from zero when the other variables are fixed. The coefficient of AM peak is negative relation to fatal and the coefficient of PM peak is positive relation to fatal. The relative risk associated with AM peak decreases by 0.391 times and it associated with PM peak increases by 1.735 times for fatal injury compared to non-serious injury. Hence, pedestrians are less likely to be fatal at AM peak and they are more likely to be fatal at PM peak than non-serious injury.

It was found that weekend is not statistically significant at all significant level by comparing weekend and weekday. It indicates that for fatal relative to non-serious injury, the regression coefficient for weekend is not statistically different from zero when the other variables are fixed. The coefficient of weekend is negative relation to fatal. The relative risk associated with weekend decreases by 0.497 times for fatal injury compared to non-serious injury. Thus, pedestrians are less likely to be fatal on weekend than non-serious injury.

By comparing serious injury and non-serious injury from the results of Table (4.5), it was discovered that male is not statistically significant at all significant level by comparing male and female of pedestrian gender. It indicates that for serious injury relative to non-serious injury, the regression coefficient for male is not statistically different from zero when the other variables are fixed. The coefficient of male is negative relation to serious injury. The relative risk associated with male decreases by 0.610 times for serious injury compared to non-serious injury. Thus, male pedestrians are less likely to be serious injury than non-serious injury.

It was recognized that young age under 25 years is not statistically significant at all significant level and middle age between 25 and 50 years old is statistically significant at 1% level by comparing with old age over 50 years. It indicates that for serious injury relative to non-serious injury, the regression coefficient for young under 25 years is not statistically different from zero and the regression coefficient for middle age between 25 and 50 years is statistically different from zero when the other variables are fixed. The coefficients of young under 25 years and middle age between 25 and 50 years are negative relation to serious injury. The relative risks associated with young under 25 years and middle age between 25 and 50 years decrease by 0.573 and 0.290 times respectively for serious injury compared to non-serious injury. Therefore, young pedestrians under 25 years and middle aged pedestrians between 25 and 50 years are less likely to be serious injury than non-serious injury.

It was found that walking mode is not statistically significant at all significant level and crossing mode is statistically significant at 10% level by comparing with the other pedestrian modes. It indicates that for serious injury relative to non-serious injury, the regression coefficient for walking mode is not statistically different from zero and the regression coefficient for crossing mode is statistically different from zero when the other variables are fixed. The coefficients of walking mode and crossing mode is positive relation to serious injury. The relative risks associated with walking mode and crossing mode increase by 1.395 and 2.639 times respectively for serious injury compared to non-serious injury. Hence, pedestrians with walking mode and crossing mode are more likely to be serious injury than non-serious injury.

It was observed that careless crossing is not statistically significant at all significant level by comparing careless crossing and other crossing behaviors. It indicates that for serious injury relative to non-serious injury, the regression coefficient for careless crossing is not statistically different from zero when the other variables are fixed. The coefficient of careless crossing is positive relation to serious injury. The relative risk associated with careless crossing increases by 2.012 times for serious injury compared to non-serious injury. Thus, pedestrians with careless crossing behavior are more likely to be serious injury than non-serious injury.

It was discovered that the reckless driving/ speeding and inexperience are not statistically significant at all significant level by the comparison of these two driving behaviors and other/ unknown behaviors. It indicates that for serious injury relative to non-serious injury, the regression coefficients for these two driving behaviors are not statistically different from zero when the other variables are fixed. The coefficients of these two driving behaviors are negative relation to serious injury. The relative risks associated with both the reckless driving/ speeding and inexperience decrease by 0.000 times for serious injury compared to non-serious injury. Thus, if pedestrians were crashed by drivers with the behaviors of inexperience and reckless driving or speeding, they are less likely to be serious injury than non-serious injury.

It was found that normal and alcohol impaired are not statistically significant at all significant level by the comparison of these two driver conditions and other/ unknown conditions. It indicates that for serious injury relative to non-serious injury, the regression coefficients for these two driver conditions are not statistically different from zero when the other variables are fixed. The coefficients of these two driver conditions are negative relation to serious injury. The relative risks associated with normal and alcohol impaired decrease by 0.748 and 0.000 times respectively for serious injury compared to non-serious injury. Thus, if pedestrians were crashed by drivers in normal and alcohol impaired conditions, they are less likely to be serious injury than non-serious injury.

It was found that non-junction location is not statistically significant at all significant level if it was compared to the junction type. It indicates that for serious injury relative to non-serious injury, the regression coefficient for non-junction type is not statistically different from zero when the other variables are fixed. The coefficient of non-junction type is positive relation to serious injury. The relative risk associated with non-junction type increases by 2.091 times for serious injury compared to non-serious injury. Therefore, pedestrians are more likely to be serious injury rather than non-serious injury if they were collided at non-junction than at junction.

It was recognized that large vehicle, car and motorcycle are not statistically significant at all significant level by comparing with the other or unknown vehicle types. It indicates that for serious injury relative to non-serious injury, the regression coefficient for large vehicle, car and motorcycle are not statistically different from zero when the other variables are fixed. The coefficient of large vehicle is positive relation to serious injury and the coefficients of car and motorcycle are negative relation to serious injury. The relative risk associated with large vehicle increases by 2.125 times and these associated with car and motorcycle decrease by 0.757 and 0.893 times respectively for serious injury compared to non-serious injury. Hence, if pedestrians were crashed with large vehicle, they are more likely to be serious injury and less likely to be serious injury with car and motorcycle than non-serious injury.

It was discovered that summer and raining are not statistically significant at all significant level by the comparison of these two months and winter. It indicates that for serious injury relative to non-serious injury, the regression coefficients for these two months are not statistically different from zero when the other variables are fixed. The coefficient of summer is negative relation to serious injury and the coefficient of raining is positive relation to serious injury. The relative risk associated with summer decreases by 0.963 times and it associated with raining increases by 1.541 times for serious injury compared to non-serious injury. Thus, if pedestrians were crashed in summer, they are less likely to be serious injury and more likely to be serious injury in raining than non-serious injury.

It was observed that AM peak is statistically significant at 10% level and PM peak is not statistically significant at all significant level by comparing with all other off peak times. It indicates that for serious injury relative to non-serious injury, the regression coefficient for AM peak is statistically different from zero and the regression coefficient of PM peak is not statistically different from zero when the other variables are fixed. The coefficient of AM peak is negative relation to serious injury and the coefficient of PM peak is positive relation to serious injury. The relative risk associated with AM peak decreases by 0.362 times and it associated with PM peak increases by 1.546 times for serious injury compared to non-serious injury. Hence, pedestrians are less likely to be serious injury at AM peak and they are more likely to be serious injury at PM peak than non-serious injury.

It was recognized that weekend is not statistically significant at all significant level by comparing weekend and weekday. It indicates that for serious injury relative to non-serious injury, the regression coefficient for weekend is not statistically different from zero when the other variables are fixed. The coefficient of weekend is negative relation to serious injury. The relative risk associated with weekend decreases by 0.948 times for serious injury compared to non-serious injury. Thus, pedestrians are less likely to be serious injury on weekend than non-serious injury.

CHAPTER V
CONCLUSION

In this chapter, findings and recommendations of the study are presented. It also submits the further studies for pedestrian safety.

5.1 Findings

Although there are several methods to analyze the effect of contributing factors influencing the pedestrian-vehicle crash injury severity, this study used the multinomial logistic regression model. It was exposed that the contributing factors were affected to the pedestrian-vehicle crash injury severity. This study was performed by using the pedestrian-vehicle crash records from traffic accident records of No (2) Office of Traffic Police (Yangon), covering the year 2015 to 2019 and descriptive analysis was also used to describe pedestrian-vehicle crashes in Insein township.

The contributing factors used in this study were pedestrian gender, pedestrian age, pedestrian mode, pedestrian crossing behavior, driver driving behavior, driver condition, location type, crash partner, months, time of collision and day of week. According to the analysis of relation between pedestrian crash injury severity and contributing factors, there is the relationship between pedestrian crash injury severity and pedestrian gender, age, mode, crossing behavior, crash partner and time of collision. According to the results of multinomial logistic regression analysis, by comparing fatal injury and non-serious injury, it was found that male pedestrians were more likely to be fatal rather than non-serious injury. Young pedestrians under 25 years are more likely to be fatal and middle aged pedestrians between 25 and 50 years are less likely to be fatal than non-serious injury.

Pedestrians with walking mode are less likely to be fatal and they are more likely to be fatal in crossing mode than non-serious injury. Pedestrians with careless crossing behavior are more likely to be fatal than non-serious injury. If pedestrians were crashed by drivers with the behaviors of inexperience and reckless driving or speeding, they are less likely to be fatal than non-serious injury. If pedestrians were crashed by drivers in normal and alcohol impaired conditions, they are more likely to be fatal than non-serious injury.

Pedestrians are more likely to be fatal rather than non-serious injury if they were crashed at non-junction than at junction. If pedestrians were crashed with these three vehicle types, they are less likely to be fatal. If pedestrians were collided in summer and raining, they are more likely to be fatal than non-serious injury. Pedestrians are less likely to be fatal at AM peak and they are more likely to be fatal at PM peak than non-serious injury. Moreover, pedestrians are less likely to be fatal on weekend than non-serious injury.

By comparing serious injury and non-serious injury, it was observed that male pedestrians are less likely to be serious injury than non-serious injury. Young pedestrians under 25 years and middle aged pedestrians between 25 and 50 years are less likely to be serious injury than non-serious injury. Pedestrians with walking mode and crossing mode are more likely to be serious injury than non-serious injury. Pedestrians with careless crossing behavior are more likely to be serious injury than non-serious injury.

If pedestrians were crashed with large vehicle, they are more likely to be serious injury and less likely to be serious injury with car and motorcycle than non-serious injury. If pedestrians were crashed in summer, they are less likely to be serious injury and more likely to be serious injury in raining than non-serious injury. Pedestrians are less likely to be serious injury at AM peak and they are more likely to be serious injury at PM peak than non-serious injury. Furthermore, pedestrians are less likely to be serious injury on weekend than non-serious injury.

5.2 Recommendations

According to the findings of this study, some recommendations are presented in the following:

i. The safety standards of pedestrian crossings and the sidewalks and footpaths should be improved and the public awareness in pedestrian safety activities should be raise.

ii. To reduce pedestrian-vehicle crashes and improve pedestrian safety, improving the risky motor way or hazardous pavements and reinforcing the rule of law with serious penalties for speeding, driving while intoxicated or hit-and-run drivers, should be implemented.

iii. The more completed pedestrian crash database and the pedestrian safety research programs should be carried out.

5.3 Further Studies

In this study, it was concentrated on pedestrian-vehicle crashes of Insein township for examining pedestrian crash severity. Therefore, the future studies can consider the other townships, districts and regions. This study used the multinomial logit model to analyze the pedestrian crashes, so further studies can apply the other methods for the categorical data like the mixed logit model. This study did not fully consider the pedestrian behaviors and driver behaviors according to the limitation of the pedestrian crash data. So if the more detailed pedestrian crash data would acquire, future studies can consider and result the more completed information. This study could provide some information for future studies since it presented how the contributing factors are affected to the pedestrian-vehicle crash severity. Lastly, understanding the pedestrian-vehicles crash problem and giving the more attention on pedestrian safety research are important for pedestrian safety.

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APPENDIX

Appendix Table (A) Results of Pedestrian-vehicle Crash Injury severity in Insein Township (2015-2019)

Pedestrian crash injury severity	Variable	B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
Fatal	**Intercept**	17.070	1.940	77.456	1	.000			
	Pedestrian gender								
	male	.828	.444	3.478	1	.062	2.289	.959	5.465
	Pedestrian age								
	young (under 25)	.027	.595	.002	1	.964	1.027	.320	3.299
	mid-age (25-50)	-.307	.488	.395	1	.530	.736	.283	1.916
	Pedestrian mode								
	walking	-.439	.575	.584	1	.445	.644	.209	1.989
	crossing	.138	.491	.079	1	.778	1.148	.439	3.007
	Pedestrian crossing behavior								
	careless crossing	.268	.510	.277	1	.599	1.308	.481	3.557
	Driver driving behavior								
	reckless driving/ speeding	-18.423	1.754	110.320	1	.000	9.977E-09	3.206E-10	3.105E-07
	inexperience	-19.232	2.011	91.497	1	.000	4.445E-09	8.639E-11	2.287E-07
	Driver condition								
	normal	.067	.513	.017	1	.896	1.069	.391	2.925
	alcohol impaired	1.312	1.383	.899	1	.343	3.713	.247	55.894
	Location type								
	not at junction	1.056	.530	3.964	1	.046	2.875	1.017	8.130

Appendix Table (A) Results of Pedestrian-vehicle Crash Injury severity in Insein Township (2015-2019) (Continued)

Pedestrian crash injury severity	Variable	B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
	Crash partner								
	large vehicle	-.143	.592	.058	1	.809	.867	.272	2.764
	car	-1.388	.709	3.832	1	.050	.250	.062	1.002
	motorcycle	-1.682	.857	3.852	1	.050	.186	.035	.998
	Months								
	summer	.022	.450	.002	1	.961	1.022	.423	2.471
	raining	.009	.488	.000	1	.986	1.009	.388	2.626
	Time of collision								
	am peak (6:30-9:30)	-.940	.639	2.160	1	.142	.391	.112	1.368
	pm peak (3:00-7:00)	.551	.548	1.012	1	.314	1.735	.593	5.079
	Day of week								
	weekend	-.698	.429	2.652	1	.103	.497	.215	1.153
Serious injury	**Intercept**	16.439	.857	367.896	1	.000			
	Pedestrian gender								
	male	-.494	.384	1.652	1	.199	.610	.287	1.296
	Pedestrian age								
	young (under 25)	-.556	.518	1.152	1	.283	.573	.208	1.583
	mid-age (25-50)	-1.237	.446	7.685	1	.006	.290	.121	.696
	Pedestrian mode								
	walking	.333	.623	.286	1	.593	1.395	.412	4.728
	crossing	.970	.545	3.173	1	.075	2.639	.907	7.675

Appendix Table (A) Results of Pedestrian-vehicle Crash Injury severity in Insein Township (2015-2019) (Continued)

Pedestrian crash injury severity	Variable	B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
	Pedestrian crossing behavior								
	careless crossing	.699	.489	2.047	1	.153	2.012	.772	5.242
	Driver driving behavior								
	reckless driving/ speeding	-17.454	0.000		1		2.630E-08	2.630E-08	2.630E-08
	inexperience	-34.201	1900.183	.000	1	.986	1.402E-15	0.000	.[c]
	Driver condition								
	normal	-.290	.433	.450	1	.502	.748	.320	1.747
	alcohol impaired	-14.815	2949.459	.000	1	.996	3.680E-07	0.000	.[c]
	Location type								
	not at junction	.737	.475	2.415	1	.120	2.091	.825	5.299
	Crash partner								
	large vehicle	.754	.580	1.692	1	.193	2.125	.682	6.619
	car	-.278	.643	.187	1	.666	.757	.215	2.671
	motorcycle	-.114	.698	.026	1	.871	.893	.227	3.507
	Months								
	summer	-.038	.446	.007	1	.932	.963	.401	2.308
	raining	.433	.474	.833	1	.361	1.541	.609	3.902
	Time of collision								
	am peak (6:30-9:30)	-1.017	.591	2.964	1	.085	.362	.114	1.151
	pm peak (3:00-7:00)	.436	.516	.714	1	.398	1.546	.563	4.248
	Day of week								
	weekend	-.053	.392	.018	1	.893	.948	.440	2.045

Source: No (2) Office of Traffic Police (Yangon) (2015-2019)