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Exploring Factors for Pedestrian Fatalities at Junctions in Malaysia

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ABSTRACT

Over the years, pedestrians are seen as one of the most susceptible road user groups in Malaysia, although their involvement in road accidents has decreased. Using the national accident data from 2009 to 2013, this study applies logistic regression model to explore the factors associated with pedestrian fatalities at road junctions. Among the four factors identified to be behind pedestrian deaths include age, injuries sustained to their head or neck, involvement of heavy vehicles, and location of accidents. Results of this study show that the likelihood of a pedestrian being killed in an accident may increase by 5.6 times when struck by a heavy vehicle. In addition, the probability of death increases to 8.7 times in the event a pedestrian sustains injuries to the head or neck following an accident.

Keywords: Pedestrian, accidents, logistic model, Malaysia

INTRODUCTION

Road accidents is a major public health concern in Malaysia where there had been a total of 66,296 fatalities from 2005 to 2014 (PDRM, 2014). Although various road users (car drivers, motorcyclists, pillion passengers, etc.) are involved in road accidents, pedestrians or people going on foot have been identified as the most vulnerable group of road users in the country. Travelling sans the protection of vehicle body or safety helmet can result in death or severe injury.

The severity of the injury sustained by a pedestrian depends on type of vehicle, impact speed, the size of vehicle, age of the pedestrian, as well as his/her height (World Health Organization, 2013). According to Rosén and Sander (2009), the risk of pedestrian death in an accident correlates

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with the vehicle impact speed. The probability of road fatality will also increase when a pedestrian is struck by a heavy vehicle (Aziz et al., 2013). But at the same time, even collision with small vehicles such as motorcycle may likely result in death to a pedestrian (de Vasconcellos, 2013).

Investigating the factors that lead to road fatalities remains a matter of national importance in Malaysia where the mortality rate of pedestrians is the third highest after motorcyclists and car drivers (PDRM, 2014). Existing accident record shows a decreasing trend from 2004 until 2014 (see Figure 1). As seen in the figure, the total number of pedestrian injuries in 2004 was 3980 to decline by 66% (1356) in 2014. Nevertheless, the number of pedestrian fatalities has shown little signs of improvement.

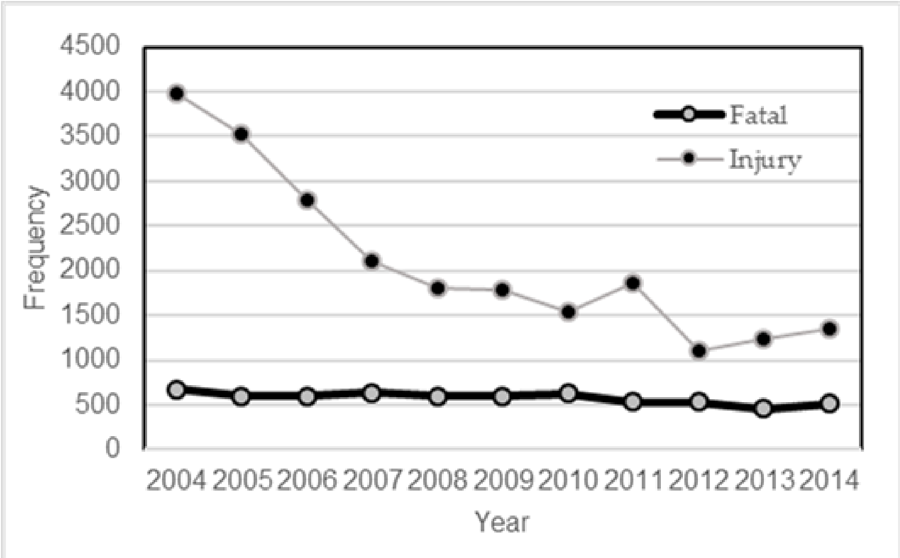

Figure 1. Pedestrian accidents in Malaysia
Source. PDRM (2014)

Analysing existing accident data using statistical method has been used by previous researchers to investigate the relationship between injury severity and its contributing factors. Kong and Yang (2010), and Sze and Wong (2007) have successfully applied the logistic model to analyse pedestrian injury severity in China, Hong Kong, and Washington. A study using the logistic model was done to analyse the effect of factors associated with risk among pedestrians (Olszewski et al., 2015; Rosén & Sander, 2009). This study aims to investigate the relationship between pedestrian fatalities in Malaysia and its influencing factors using accident data. The focus is on pedestrian accidents occurring at cross junction or T/Y junction types.

METHODS

Data

Data from 2009-2013 obtained from the MIROS Road Accident Database and Analysis System (MROADS) was used. The data consists of accident case, vehicle information, and pedestrian injury profile. The accident case data provided information on accident location, date, time, traffic system (one way or two ways), road type, control type, type of location (urban or rural) etc. Data on vehicle information provided information on the type of vehicles, model, ownership, manufactured year, driver information, license status and much more. While the injury profiles of pedestrian victims provided insights on demography, age, gender, part of body injured and severity.

The initial data was filtered to only include pedestrian accidents that occurred either at 3 or 4 legs junction. The 4 legs junction is referred as the cross junction, while the 3 legs junction is referred as T/Y junction. Data were excluded if the observed data was coded as 'damage only' case since pedestrian was not injured though was involved in the accident. Observations with inadequate variables used for the model and redundant coding were also excluded. This results in 325 observations of pedestrian accidents selected for the final dataset.

Statistical Model

Logistic regression was applied in this study to examine the relationship between pedestrian fatality and its associated factors. The method of maximum likelihood is used to estimate the parameters of the logistic regression (Kutner et al., 2005). This method was found to suit the data well, since the outcome of inspection will always be categorical, either pass or fail. In this content, the pedestrian fatality as the categorical dependent variable is measured on a dichotomous scale either 0 or 1, which indicate fatal or non-fatal.

When Y_i is binary, with probabilities of success, π and probability of failure is 1-π, then Y_i is a Bernoulli random variable with $E(Y_i)=\pi$. Since the distribution of the error term ε_i depends on Bernoulli distribution of the response Y_i, then the simple logistic regression takes the following form:

$$E\,(Y_i) = \pi_i = \frac{\exp(X'_i\beta)}{1 + exp(X'_i\beta)} \quad (1)$$

The relationship between pedestrian fatality as the dependent variable and its contributing factors as independent variables is estimated using logistic regression. Logistic regression models are a powerful, flexible tool to examine the range of different effects and conditions related to safety. The effect of each independent variable on the dependent variable is expressed as an odds ratio in logistic regression, analysed using IBM SPSS Statistics. The odds ratio is equal to the $Exp(\beta_i)$.

RESULTS AND DISCUSSION

Pedestrian Accidents at Junctions

Within a five-year period, a total of 325 pedestrian accidents at either cross of T/Y junctions were recorded. Table 1 provides the summary of pedestrian accidents at junctions in Malaysia with respect to the final dataset used in the model. About 25% of pedestrian accidents occurring at junctions were fatal. The incidence of pedestrian accidents at junctions was higher in the south and in Sabah/Sarawak/Labuan compared to other parts of the country. The proportion was higher during the day compared to night time with or without light and dry road conditions. Most of the pedestrian accidents at junctions are not hit and run cases, and the involvement of heavy vehicles is also low (10.8%). The occurrence of pedestrian accidents was higher at T/Y type junction, with the two-way flow, where the junction is signalised, and located in the rural area. A lower proportion of pedestrian accidents at junctions was observed among female pedestrians, and where a high percentage took place among pedestrians aged between 6 to15 years.

Model Results

To examine the relationship between pedestrian fatalities and contributing factors, the logistic model was fitted to the final dataset. The Hosmer-Lemeshow goodness of fit test indicates the model is satisfactory fit the observed data. A non-significant value of Hosmer-Lemeshow (in this study, $p = 0.193$, with degrees of freedom, d.f = 8), showed the model fits the data well. Another measurement, higher value of Nagelkerke R squared also indicates that model fits the observed data better, in this study the value is 0.423.

Table 1
Characteristic of pedestrian accidents at junctions (2009-2013)

Variables	Attributes	N	Percentage (%)
Injury	Fatal	84	25.8
	Non-fatal (serious and light injury)	241	74.2
Region	South	77	23.7
	North	60	18.5
	East	54	16.6
	Central	59	18.2
	Sabah/Sarawak/Labuan	75	23.1
Light condition	Day	237	72.9
	Night with light	67	20.6
	Night without light	21	6.5
Road surface condition	Dry	306	94.2
	Wet	19	5.8
Hit and run case	Yes	14	4.3
	No	311	95.7
Vehicle type	Heavy vehicles (bus and lorry)	35	10.8
	Others	290	89.2

Table 1 *(continue)*

Junction Type	Cross junction	105	32.3
	T/Y junction	220	67.7
Traffic flow	One way	55	16.9
	Two way	270	83.1
Junction Control type	Signalised	32	9.8
	Without signal	293	90.2
Junction Location	City/urban	94	28.9
	Built up area	75	23.1
	Rural	156	48.0
Gender	Male	211	64.9
	Female	114	35.1
Part of body injured	Head/neck	97	29.8
	Others	228	70.2
	0-5	21	6.5
	6-10	50	15.4
	11-15	30	9.2
	16-20	22	6.8
	21-25	19	5.8
	26-30	21	6.5
	31-35	15	4.6
	36-40	8	2.5
	41-45	17	5.2
	46-50	12	3.7
	51-55	17	5.2
	56-60	17	5.2
	61-65	15	4.6
	66-70	20	6.2
	71-75	14	4.3
	76-80	9	2.8
	81-85	12	3.7
	86-91	6	1.8

The effect of factors contributing to pedestrian fatality is measured by the odds ratio, where a value greater than 1 indicates that the concerned factor leads to higher risk of fatality. The fatality odds ratios calculated using a logistic model for each independent variable is listed in Table 2. Results indicated that 4 factors were statistically significant: pedestrian age, head and neck injury, and heavy vehicles at the $p<0.05$ and type of junction at the $p<0.1$.

Table 2
Odds ratio

Attributes	Reference category	Odds ratio (95% CI)
Night with light	Day	1.468 (0.449-4.803)
Night without light	Dry	2.152 (0.573-8.090)
	Wet	0.769 (0.210-2.811)
Hit and run case	Not hit & run	1.126 (0.224-5.663)
Heavy vehicle (bus and lorry)	Other vehicles	5.653 (2.198-14.541)**
Cross junction	T/Y junction	0.497 (0.243-1.014)*
One way	Two way	0.514 (0.206-1.278)
With Signal	No signal	0.911 (0.282-2.940)
City/urban	Rural	1.047 (0.482-2.277)
Built up area		0.472 (0.189-1.176)
Male	Female	1.643 (0.825-3.274)
Head/neck injury	Other body parts	8.697 (4.543-16.650)**
Age	-	1.033 (1.020-1.047)**

**Statically significant at 5% level
*Statically significant at 10% level

The odds of a fatal pedestrian accident occurring at night with or without light are higher than for the day (OR= 1.468, 2.152). Hit and run case also have higher odds (OR=1.126), and lower odds for dry road surface (OR= 0.769). All these variables were found to be statistically insignificant factors. The likelihood of fatality in an accident is significantly higher when a pedestrian is struck by a heavy vehicle (OR= 5.653). An accident that occurred at the cross junction, however, had lower odds (OR=0.497), compared to T/Y junction with regards to fatality.

Road characteristics had an insignificant effect on lower odds were the accident that took place in one-way traffic system (OR= 0.514), at the signalised junction (OR=0. 911), at built up area (OR=0. 472), but higher odds for an accident occurred in a city or urban area (OR=1.047).

With respect to pedestrian characteristics, ale males were found to have higher odds of being involved in a fatal accident than female pedestrians (OR=1.643). Odds of fatality among pedestrians who experienced either head or neck injury compared with other parts of the body was great (OR=8.697). In addition, pedestrians' age also affects the likelihood of fatal injury (OR=1.033).

DISCUSSION AND CONCLUSION

Analysis of existing data on accidents using a logistic model is one way to examine the effects of factors that contribute to serious accidents. In this study, the model shows four significant factors behind pedestrian fatalities at road junctions.

Age of pedestrians is identified as an individual factor for their fatality. Older pedestrians seem to be more vulnerable as their physical strength and ability deteriorates. Another significant factor leading to fatality is pedestrians who suffered head or neck injury, where may increase 8.7 times. A similar trend was found by Wong et al. (2007) where the pedestrian accidents with head injury are more likely to die by 3.82 times.

The likelihood of pedestrian fatality would increase by 5.6 times when he/she is hit by a heavy vehicle, compared to other types of vehicles. The deadly effect of heavy vehicles such as buses and trucks is consistent with findings of previous research (Lefler & Gabler, 2004), even to other road users such as bicyclist (Moore et al. 2011). The likelihood of fatal pedestrian accidents is lower at a cross junction compared to T/Y junction, probably due to the effect of signalization at cross junctions. An accident at T/Y junction may also be more severe to the drivers, compared with other types of junctions (Huang et al., 2008).

Exploration of pedestrian fatalities at junctions using a logistic model based on accident data from the year 2009 to 2013 highlighted four significant factors that can lead to fatalities among pedestrians at the $p<0.1$ are: the age of pedestrian, nature of injury, type of vehicle involved, and the type of junction. The outcomes of this study suggest that the heavy vehicles traffic flow entering an area with the higher volume of pedestrians should be controlled and reduced.

REFERENCES

Aziz, H. M. A., Ukkusuri, S. V., & Hasan, S. (2013). Exploring the determinants of pedestrian-vehicle crash severity in New York City. *Accident Analysis and Prevention, 50*, 1298–309.

de Vasconcellos, E. A. (2013). Road safety impacts of the motorcycle in Brazil. *International Journal of Injury Control and Safety Promotion, 20*(2), 144–51.

Huang, H., Chin, H. C., & Haque, M. M. (2008). Severity of driver injury and vehicle damage in traffic crashes at intersections: A Bayesian hierarchical analysis. *Accident Analysis and Prevention, 40*(1), 45–54.

Kutner, M. H., Nachtsheim, C. J., Neter, J., & Li, W. (2005). *Applied linear statistical models.* New York: McGraw-Hill Irwin.

Kong, C., & Yang, J. (2010). Logistic regression analysis of pedestrian casualty risk in passenger vehicle collisions in China. *Accident Analysis and Prevention, 42*(4), 987–993.

Lefler, D. E., & Gabler, H. C. (2004). The fatality and injury risk of light truck impacts with pedestrians in the United States. *Accident Analysis and Prevention, 36*(2), 295–304.

Moore, D. N., Schneider IV, W. H., Savolainen, P. T., & Farzaneh, M. (2011). Mixed logit analysis of bicyclist injury severity resulting from motor vehicle crashes at intersection and non-intersection locations. *Accident Analysis and Prevention, 43*(3), 621–630.

Olszewski, P., Szagała, P., Wolański, M., & Zielińska, A. (2015). Pedestrian fatality risk in accidents at unsignalized zebra crosswalks in Poland. *Accident Analysis and Prevention, 84*, 83–91.

Polis Diraja Malaysia [PDRM]. (2014). Malaysia Road Accident Statistical Report 2014. *Traffic Branch, Royal Malaysian Police*, Kuala Lumpur, Malaysia.

Rosén, E., & Sander, U. (2009). Pedestrian fatality risk as a function of car impact speed. *Accident Analysis and Prevention, 41*(3), 536–542.

Sze, N. N., & Wong, S. C. (2007). Diagnostic analysis of the logistic model for pedestrian injury severity in traffic crashes. *Accident Analysis and Prevention, 39*(6), 1267–78.

Wong, S. C., Sze, N. N., & Li, Y. C. (2007). Contributory factors to traffic crashes at signalized intersections in Hong Kong. *Accident Analysis and Prevention, 39*(6), 1107–1113.

World Health Organization. (2013). *Pedestrian safety: a road safety manual for decision-makers and practitioners.* Geneva.