The Influence of Accident Related Factors on Road Fatalities Considering Bali Province in Indonesia as a Case Study

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Abstract: This study investigates the influence of accident related factors on road fatalities using logistic regression technique. Logistic Regression models were separately developed for fatal accidents considering motorcycles and all vehicles including motorcycles using Bali in Indonesia as a case study. Based on the State Police of Bali Province accident data, seven predictor variables were employed in the developed models. The study found that the odds of fatal accident due to male motorcyclists and motorists at fault were 0.3 and 0.4 respectively lower than for females. Thus, the probabilities of female motorcyclists and motorists were about 79% and 72% respectively contributing more on motorcycle and motor vehicle fatal accidents than males. In addition, age was also significant to influence all vehicle fatalities. Age was accounted for about 50% to influence all vehicles fatalities.

Key Words: *Fatal Road Accidents, Motorcycle, Logistic Regression*

1. INTRODUCTION

The motorcycle is the most popular mode of transportation in Indonesia including Bali Province. Motorcycle has an average annual growth rate of approximately 11% and is accounted for almost 85% of the total registered vehicles in Bali. The census data showed that there were 1,166,694 motorcycles of the total 1,377,352 registered vehicles in 2007 (Statistics of Bali Province, 2008). In the capital city of Denpasar, the number of registered motorcycles was 390,000 of the total number of 457,000 registered vehicles in 2007. Furthermore, during the daytime on weekdays, the number of vehicles tends to be doubled about 800,000 units considering trips make by commuters and students to and from Denpasar (Statistics of Bali Province, 2008).

Motorcycles in Bali are typically small-sized vehicles with engine capacity ranges between 100-150cc so that a motorcycle has high mobility on the road. People use motorcycles for many purposes including work, shopping, leisure, and education either for short or long distance trips. For instance, students use motorcycles during weekdays for 55km-a return trip between the capital city of Denpasar and a university in Jimbaran, Southern Bali. This is mainly due to poor quality of the current public transport services. On the other hand, a motorcycle is more practical to cope with traffic congestion and more efficient in comparison to either private cars or public transport.

In Bali, three main modes including private cars, heavy vehicles (bus and truck) and motorcycles share together the roadways including arterial roads. Commuters use the arterial roads, which connects the capital city and the surrounding areas. Consequently, all these roads passed daily high traffic flows on which approximately 70% of the road users ride a motorcycle for their trip.

As there are no special lanes dedicated to motorcycle travel in Bali, there are always conflicts on the road amongst the three modes, Moreover, the behaviour of motorcycle users such as speeding and manoeuvring among vehicles to get ahead worsened traffic condition is not favourable in terms of road safety. This may lead to high proportion of motorcycle accidents and casualties. In fact, during period 2003-2007 there were 4489 road accidents and 8498 casualties in Bali in which almost 60% involving killed and seriously injured casualties. Of these road accidents, on average there were 70% motorcycle accidents (State Police of Bali Province, 2008). A motorcyclist in Bali, therefore, could be regarded as a vulnerable road user.

Study on fatal road accidents is essential not only to prevent them but also to reduce fatal injuries. This paper aimed at investigating several accident related factors influencing motorcycle and motor vehicle (all modes including motorcycles) fatalities in Bali. As the accident factors were obtained from the local police accident reports, the analysis will be limited only to these secondary data. Two continuing arterial roads including bypass Ida Bagus Mantra and bypass Ngurah Rai were chosen as the case studies.

2. LITERATURE REVIEW

2.1 Previous Studies

Many studies have been carried out to estimate motorcycle and motor vehicle accidents in both developed and developing countries. In this section, the review is more on motorcycle than motor vehicle because there are significant differences between motorcyclists in developing and developed countries. For example, pillion passengers are very uncommon in western countries. In developing countries, however, it is common to see a family, for instance including two adults and two children, rides on a motorcycle. In addition, motorcycles in developing countries are more popular for commuting or utilitarian trips as opposed to recreational trips (Quddus, et al., 2002).

A study conducted by Clarke, et al. (2004) in the UK described that the increase in scooter and motorcycle sales has caused a corresponding increase in deaths and serious injuries caused to motorcyclists following a period of relative decline. Scooters had a 16% rise in sales between 2002–2003. The recent vehicle licensing records, larger motorcycles (above 500cc engine capacity) have accounted for around half of all registered motorcycles, in which this pattern seems to continue further. Furthermore, significant differences were found in the sample with respect to the types of accidents involving motorcyclists (and their blameworthiness). The study concluded that, firstly there seems to be a particular problem surrounding other road users' perception of motorcycles, particularly at junctions. Such accidents often seem to involve older drivers with relatively high levels of driving experience who nonetheless seem to have problems detecting approaching motorcycles. Secondly, motorcyclists themselves seem to have far more problems with other type of accidents, such as those on bends, and overtaking or 'filtering' accidents. Thirdly, there have been two main groups of riders that interventions should be focussed on. They included young and inexperienced riders of smaller capacity machines such as scooters, and older riders who were more experienced riders of higher capacity machines. Both the skills and attitudes of these riders need to be addressed.

Meanwhile, a study conducted in the UK focusing on motorcyclist' behaviour and accidents (Elliot, et al., 2004). The study found that speed behaviour was significantly related to involvement in a 'blame' accident. In addition, errors and not violations were the dominant predictors of motorcyclists' accident-involvement. This situation was a reverse to car accident-involvement. The explanation for this difference might be that riding a motorcycle is more demanding than driving a car, thus motorcyclists may be more prone to making errors when riding than are car drivers when driving. More importantly, given the dynamics of motorcycling, the commission of an error when riding is likely to have more severe consequences than making an error when driving. For example, it is quite possible for a car driver to recover from making an error without losing control of the vehicle. However, the recovery from an error when riding a motorcycle is potentially more difficult due to the relative instability of a two-wheeled vehicle compared with a four-wheeled vehicle.

Elliot, et al. (2004) suggested that to reduce motorcyclists' accident involvement is to reduce the number of behaviour errors being made, for instance, change rider style by being more careful and safe, and improve control skills by having proper training. Campaigns to make riders aware of the potential risks in motorcycling and, in particular, to emphasise the importance of errors can only be beneficial and may encourage riders to adopt safer riding styles and undertake further training. Furthermore, any interventions targeting the performance of stunts, the use of protective equipment and, particularly, speed violations can only be desirable from a road safety point of view. Other related studies, however, were much concerned on helmet and motorcycle accidents and casualties, for instance a study by Ichikawa, et al. (2003) in Thailand and Keng (2005) in Taiwan.

Another study conducted by Al-Ghamdi (2002) applied logistic regression to investigate the influence of accident factors on fatal and non fatal accidents for motor vehicle in Saudi Arabia. The study found that accident location and cause of accident significantly associated with fatal accidents. Accident factors used in the study including accident location, accident type, collision type, accident time, accident cause, driver age at fault, vehicle type, nationality and license status.

Furthermore, logistic regression has been considered as an appropriate method of analysis in a study conducted by Dissanayake (2004) to compare severity of affecting factors between young and older drivers involved in single-vehicle crashes. The study findings informs that almost all the common identified factors influenced both driver groups in the same manner except in the case of alcohol and drug usage in the case of crash severity of older drivers. Speeding and non-usage of a restraint device were the two most important factors affecting towards increased crash severity for both driver groups at all severity levels. Additionally, ejection and existence of curve/grade were determinants of higher young driver crash severity at all levels. For older drivers, having a frontal impact point was a severity determinant at all levels.

In this paper, Logistic Regression model is employed as to deal with the binary nature of dependent variables such as fatal and non fatal accidents.

2.2 Logistic Regression Model

Logistic regression is useful for predicting a binary dependent variable as a function of predictor variables. The goal of logistic regression is to identify the best fitting model that describes the relationship between a binary dependent variable and a set of independent or explanatory variables. The dependent variable is the population proportion or probability (P) that the resulting outcome is equal to 1. Parameters obtained for the independent variables can be used to estimate odds ratios for each of the independent variables in the model (Washington, 2003).

The specific form of the logistic regression model is:

$$\pi(x) = P = \frac{e^{\beta_o + \beta_1 x}}{1 + e^{\beta_o + \beta_1 x}} \tag{1}$$

The transformation of conditional mean π(x) logistic function is known as the logit transformation. The logit is the *LN* (to base *e*) of the odds, or likelihood ratio that the dependent variable is 1, such that

$$\text{Logit (P)} = LN\left(\frac{P_i}{1-P_i}\right) = B_o + B_i.X_i \tag{2}$$

Where:

B_o	:	the model constant
B_i	:	the parameter estimates for the independent variables
X_i	:	set of independent variables (i = 1,2,.........,n)
P	:	probability ranges from 0 to 1
$\left(\frac{P_i}{1-P_i}\right)$	:	the natural logarithm ranges from negative infinity to positive infinity

The logistic regression model accounts for a curvilinear relationship between the binary choice Y and the predictor variables Xi, which can be continuous or discrete. The logistic regression curve is approximately linear in the middle range and logarithmic at extreme values. A simple transformation of equation (1) yields

$$\left(\frac{P_i}{1-P_i}\right) = \exp^{B_o + B_i.X_i} = \exp^{B_o}.\exp^{B_i.X_i} \tag{3}$$

The fundamental equation for the logistic regression shows that when the value of an independent variable increases by one unit, and all other variables are held constant, the new probability ratio $[P_i/(1-P_i)]$ is given as follows:

$$\left(\frac{P_i}{1-P_i}\right) = \exp^{B_o + B_i(X_i+1)} = \exp^{B_o}.\exp^{B_i.X_i}.\exp^{B_i} \tag{4}$$

When independent variables X increases by one unit, with all other factors remaining constant, the odds $[P_i/(1-P_i)]$ increases by a factor $\exp^{B_i}$. This factor is called the odds ratio (OR) and ranges from 0 to positive infinity. It indicates the relative amount by which the odds of the outcome increases (OR>1) or decreases (OR<1) when the value of the corresponding independent variable increases by 1 unit.

There is no true R^2 value in logistic regression, as there is in Ordinary Least Squares (OLS) regression. Alternatively, Pseudo R^2 can be a proxy of an R^2 including Cox & Snell Pseudo-R^2 and Nagelkerke Pseudo-R^2 (Charnkol, et.al, 2007).

$$\text{Cox \& Snell Pseudo-}R^2 = R^2 = 1 - \left[\frac{-2LL_{null}}{-2LL_k}\right]^{2/n} \quad (5)$$

The null model includes only the constant while the *k* model contains all explanatory variables in the model. Cox & Snell R^2 value cannot reach 1.0, so that Nagelkerke is used to revise it.

$$\text{Nagelkerke Pseudo-}R^2 = R^2 = \frac{1-\left[\frac{-2LL_{null}}{-2LL_k}\right]^{2/n}}{1-(-2LL_{null})^{2/n}} \quad (6)$$

A Hosmer-Lemeshow Test is used to carry out the goodness of fit measure. The null hypothesis for this test is that the model fits the data, and the alternative is that the model does not fit. The test statistic is conducted by first breaking the data set into roughly 10 (g) groups. The groups are constructed by ordering the existing data by the level of their predicted probabilities. The data are ordered from least likely to most likely for the event. The equal sized groups are formed. From each group, the observed and expected number of events is computed for each group. The test statistic is,

$$\hat{C} = \sum_{k=1}^{g} \frac{(O_k - E_k)^2}{v_k} \quad (7)$$

Where:

$\hat{C}$ = The Hosmer-Lemeshow test (H-L test)
O_k = Observed number of events in the k^{th} group
E_k = Expected number of events in the k^{th} group
v_k = Variance correction factor for the k^{th} group

If the observed number of events differs from what is expected by the model, the H-L test will be large and there will be evidence against the null hypothesis.

3. CASE STUDY AREA AND DATA DESCRIPTION

3.1 Case Study Area

Province of Bali has an area of 5,634.40 km^2 and a population of about 3.4 million. The capital city Denpasar is located in the southern Bali. The island is widely known as a tourist destination. Most of popular tourist destinations are located in southern areas including Kuta, Sanur, and Nusa Dua. Therefore, these areas are the most densely populated than any other parts of Bali.

At present, total arterial road length in Bali is 199.63 km (Statistics of Bali Province, 2008). Two of these arterial roads are bypass Ida Bagus Mantra and bypass I Gusti Ngurah Rai. A single carriageway bypass Ida Bagus Mantra has been operated since 2003 stretching about 23km connecting between Kusamba (in eastern Bali) and Tohpati. A double carriageway

Bypass Ngurah Rai connects between Tohpati and Nusa Dua stretching about 30 km and has been operated since 1981. The continuing arterial roads are shown in Figure 1.

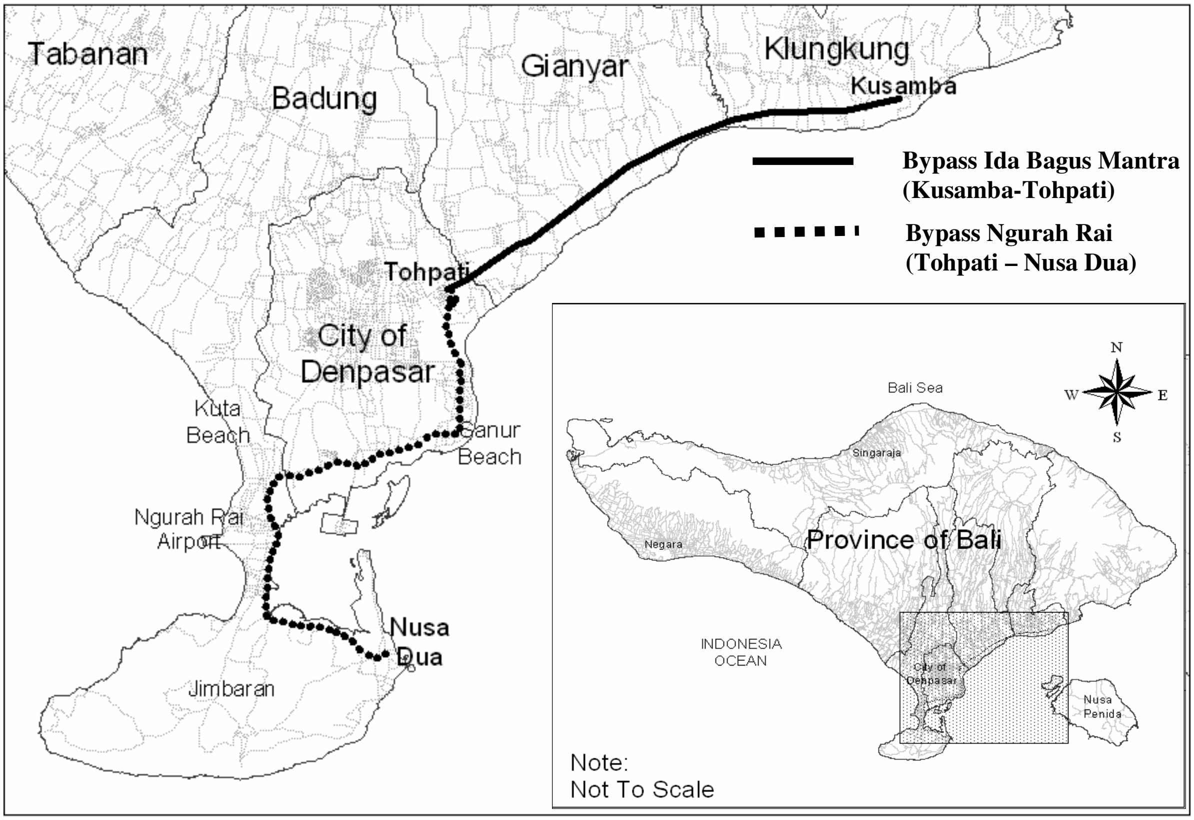

Figure 1 Case study area

3.2 Data Description

Comparison between motor vehicle (all modes including motorcycles) accidents and motorcycle accidents during period 2004-2007 along the two arterial roads are presented in Figure 2. It shows that the number of accidents increased slightly from 2004 to 2005 and from 2006 to 2007. The number of accidents, however, increased dramatically from 2005 to 2006 by more than 2 folds. This situation was because the rise of fuel price in Indonesia in 2005 which in turn increasing the motorcycle ownership. From the figure, it is also shown that motorcycle accidents were accounted for almost 85% of total accidents on these roads. During this period in total there were 240 motorcycle accidents and 318 accidents (all motor vehicles).

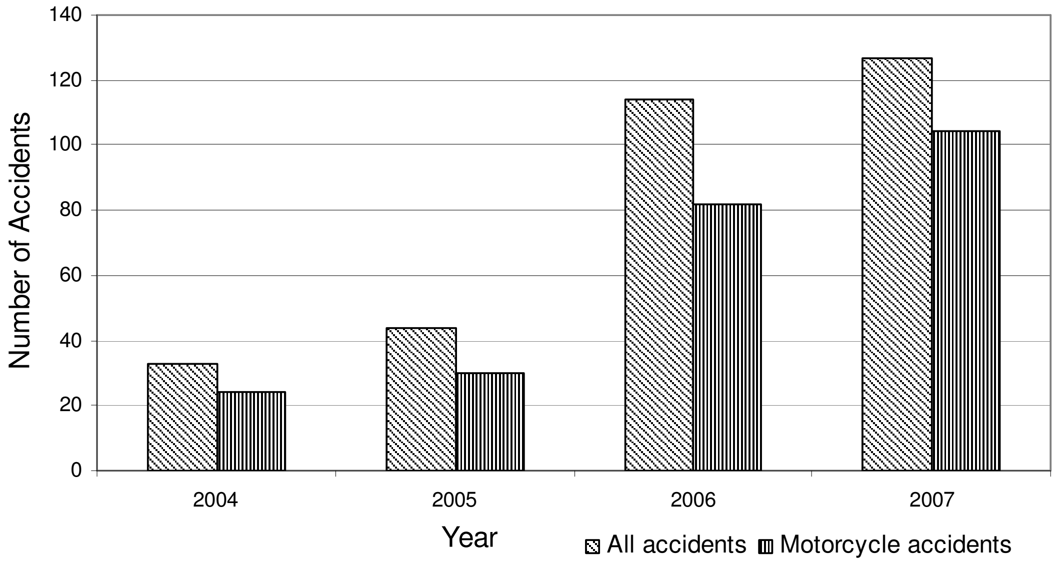

Figure 2 Road accidents based on modes of transport

4. MODEL DEVELOPMENT

Some of accident related factors were employed as the predictor variables in this study, following the method used by Al-Ghamdi (2002). These variables are used to analyse both fatal motor vehicle accidents (including motor vehicle) and motorcycle fatal accidents. Motorcycle or motor vehicle fatal accident is defined as at least one motorcyclist or motorist died on the event of road accidents.

Data availability have also been primary considered in determining predictor variables for this study. All variables mentioned in Table 1 were available from the police. These were also used as a basis for constructing the classification for predictor variables including for collision types and accident cause. This study, however, attempted to consider all relevant factors which influencing fatal accidents, despite the shortcoming of existing accident data in Bali.

Following suggestions from previous studies (Kockelman and Kweon, 2001; O'Donnel and Connor, 1996), age and gender have long been a high priority in accident risk assessment. Therefore, age and gender of driver or motorcyclist at fault were considered as predictor variables. Response variable is fatal accidents, which is binominal in nature. All independent variables are categorical, but age which is a continuous variable. In order to represent categorical variables, dummy variables are created following the coding system in SPSS, software used in this study. Study variables and their coding are shown in Table 1.

Table 1 Variables selected for the study

No.	Variable Type	Classifications and Coding	Variable Title
1.	Fatal Accidents	0 = Non Fatal Accidents 1 = Fatal Accidents	Fatal
2.	Accident type	0 = with fixed object 1 = overturned 2 = with vehicles	Atyp
3.	Collision type	0 = Out of Control 1 = Right Angle, 2 = Side Swipe 3 = Rear End 4 = Head On	Ctyp
4.	Vehicle type (at fault)	0 = Heavy vehicle 1 = Light vehicle 2 = Motorcycle	Veh
5.	Accident cause	0 = Others 1 = Speeding 2 = Run red light 3 = Follow too close 4 = Wrong way 5 = Failed to yield	Caus
6.	Accident Location	1 = Link 0 = Junction	Loc
7.	Time of accident	1 = Day time 0 = Night time	Time
8.	Gender (of driver/motorcyclist at fault)	1 = Male 0 = Female	Gender
9.	Age (of driver/ motorcyclists at fault)	Year	Age

According to data related statistics shown in Table 2, some variable classifications can be neglected because of their small proportion. The hypothesis testing technique for proportions was used in this study to decide whether a classification could be reduced. The following typical test was used:

$$H_0: p_i = 0$$
$$H_a: p_i \neq 0$$

Where, p_i is the proportion of a variable classification.

Table 2 Hypothesis testing: data statistics (motorcycle fatal accidents)

Description	X	N	P-value	95% Confidence level	
				Lower	Upper
Accident Type					
With fixed object *	9	240	0.038	0.0	0.1
Overturned	31	240	0.129	0.1	0.2
With vehicles	200	240	0.833	0.9	0.9
Collision Type					
Out of control	45	240	0.188	0.1	0.2
Right angle	51	240	0.213	0.2	0.3
Side swipe	24	240	0.100	0.1	0.1
Rear end	63	240	0.263	0.2	0.3
Head on	57	240	0.238	0.2	0.3
Vehicle Type (at fault)					
Heavy vehicle	21	240	0.088	0.1	0.1
Light vehicle	56	240	0.233	0.2	0.3
Motorcycle	163	240	0.679	0.6	0.7
Accidents Cause					
Others	52	240	0.217	0.2	0.3
Speeding*	7	240	0.029	0.0	0.1
Run red light*	3	240	0.013	0.0	0.0
Follow too close	60	240	0.250	0.2	0.3
Wrong way	67	240	0.279	0.2	0.3
Failed to yield	51	240	0.213	0.2	0.3
Gender (of driver at fault)					
Male	210	240	0.875	0.8	0.9
Female	30	240	0.125	0.1	0.2
Location					
Link	202	240	0.842	0.8	0.9
Junction	38	240	0.158	0.1	0.2
Time of Accident					
Day time	121	240	0.504	0.4	0.6
Night time	119	240	0.496	0.4	0.6

* Statistically insignificant at the 5% level; the 95% confidence limits include 0.
where: X = number of classification (yes=1), N = sample size

Based on the test, for motorcycle fatal accident analysis, there were three accident factors excluded from the model development stage, for example 'accident type-with fixed object', 'accident due to speeding' and 'run red light'. This exclusion is carried out with merging and putting these classifications as reference for the rest of classification within each variable. For instance, within the accident cause factor, 'speeding' and 'run red light' were merged and generated a new classification called 'speed&rrl'. Following the same procedure, for the purpose of fatal road accidents analysis, which includes motor vehicle also yield the same result.

The entry method of logistic regression was followed using SPSS version 15. The Omnibus Tests of both motorcycle and motor vehicle fatal accidents model coefficients is analysed in order to assess whether data fit the model as shown in Table 3. It shows the Chi-square difference tests for the specified model relative to a null model which contains only an intercept and no independent variables. In Table 3, the specified model is significant ($p < 0.05$) so it is concluded that the independent variables improve on the predictive power of the null model.

Table 3 Omnibus tests of model coefficients

	Motorcycle fatal accidents		Motor vehicle fatal accidents	
	Chi-square	Sig.	Chi-square	Sig.
Step	36.895	.002	27.668	.035
Block	36.895	.002	27.668	.035
Model	36.895	.002	27.668	.036

Table 4 contains the two pseudo R^2 measures that are Cox and Snell and Nagelkerke. The former measure frequently does have a maximum less than one. It is therefore usually better to assess Nagelkerke's measure as this divides Cox and Snell by the maximum to give a measure that really does range between zero and one. In this example, the motorcycle and motor vehicle fatal accident models explain 19% and 11% respectively of the variance in the dependent variable. In addition, in Table 4 Hosmer-Lemeshow (H-L) test shows the significance of both developed logistic regression models (p-value > 0.05).

Table 4 Goodness of fit (pseudo R^2 and H-L test)

Pseudo R^2 Test			
Fatal Accidents Model	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
Motorcycle	295.666	.142	.190
Motor vehicle	412.368	.083	.111
Hosmer and Lemeshow Test (H-L Test)			
	Chi-square	df	Sig.
Motorcycle	1.627	8	.990
Motor vehicle	3.957	8	.861

Table 5 gives the overall percent of cases that are correctly predicted by the full model. For motorcycle and motor vehicle fatal accidents, the percentages have increased from 51.3 and 52.5 respectively for the null model to 65.8 and 61.9 respectively for the full model.

Table 5 Classification accuracy

Motorcycle Fatal Accidents		Predicted		Percentage Correct
Observed		Non Fatal Accidents	Fatal Accidents	
Null Model	Non Fatal Accidents	123	0	100.0
	Fatal Accidents	117	0	0.0
			Overall Percentage	51.3
Full Model	Non Fatal Accidents	90	33	73.2
	Fatal Accidents	49	68	58.1
			Overall Percentage	65.8
Motor vehicle Fatal Accidents		Predicted		
Observed		Non Fatal Accidents	Fatal Accidents	Percentage Correct
Null Model	Non Fatal Accidents	167	0	100.0
	Fatal Accidents	151	0	0.0
			Overall Percentage	52.5
Full Model	Non Fatal Accidents	117	50	69.5
	Fatal Accidents	68	83	53.6
			Overall Percentage	61.9

5. RESULTS AND DISCUSSIONS

The model results as shown in Table 6 indicate that accident because motorists failed to yield and other factors were negatively related to motorcycle fatalities. This indicated that failed to yield and other factors were less likely to influence motorcycle fatal accidents than speeding and run red light (Cause(0)). The odd that an accident will be fatal due to failed to yield and other factors were about 20% and 30% respectively lower than for speeding and run red light. Motorcycle collided with other vehicles also was about 20% less likely than motorcycle colllided with fixed object (Atyp(0)) to influence motorcycle fatal accident. In addition, the probabilities of failed to yield, accident because of others, and motorcycle collided with other vehicles were 17%, 22% and 18% respectively to influence motorcycle fatalities.

Table 6 Model results

Motorcycle fatal accidents				Motor vehicle fatal accidents		
Variables	B	Sig.	Exp(B)	B	Sig.	Exp(B)
Location(1)	.427	.300	1.532	.210	.557	1.234
Atyp(1)	-.150	.872	.861	-.051	.924	.951
Atyp(2)	**-1.525***	.195	.218	.176	.805	1.193
Ctyp(1)	-.697	.458	.498	**-1.067***	.154	.344
Ctyp(2)	-.549	.569	.578	**-1.195***	.137	.303
Ctyp(3)	-.497	.592	.608	-.898	.218	.407
Ctyp(4)	-.348	.702	.706	-.511	.504	.600
Time(1)	.073	.802	1.076	.036	.883	1.037
Cause(1)	**-1.261***	.175	.283	.256	.680	1.291
Cause(2)	-.493	.565	.611	.442	.486	1.555
Cause(3)	-.963	.235	.382	-.014	.983	.986
Cause(4)	**-1.600****	.063	.202	-.618	.331	.539
Age	.002	.877	1.002	**.019***	.136	1.019
Gender(1)	**-1.331*****	.006	.264	**-.952*****	.015	.386
Veh(1)	.110	.845	1.116	.162	.734	1.176
Veh(2)	-.382	.462	.683	.144	.748	1.155
Constant	**3.604*****	.018	36.727	.331	.744	1.392

Bold figures are significant as follows:
*** Significant at 95%, ** Significant at 90% , * Significant at 80%.

Where

1.	Location(1)	=	Link	9.	Cause(1)	=	Others
2.	Atyp(1)	=	Overturned	10.	Cause(2)	=	Follow too close
3.	Atyp(2)	=	With vehicles	11.	Cause(3)	=	Wrong way
4.	Ctyp(1)	=	Right Angle	12.	Cause(4)	=	Failed to yield
5.	Ctyp(2)	=	Side Swipe	13.	Gender(1)	=	Female (at fault)
6.	Ctyp(3)	=	Rear End	14.	Veh(1)	=	Light vehicle
7.	Ctyp(4)	=	Head On	15.	Veh(2)	=	Motorcycle
8.	Time(1)	=	Night Time	.			

The large constant coefficient in motorcycle fatal accidents model indicated that there will be some other factors, for instance road infrastructure or road surface condition related factors that may be impacted on motorcycle fatalities.

In the motor vehicle fatalities model, right angle and side swipe accidents were negatively related to fatalities. They were about 30% less likely than accidents due to out of control to influence all vehicle fatalities. Thus, the probabilities of right angle and side swipe accidents were 25% and 23% respectively to contribute all vehicle fatalities.

Meanwhile, age of motorist was positively related to all vehicle fatalities and the probability was 50% to contributed all vehicles fatalities.

Female at fault (gender(1)) was less likely than male to influence both motorcycle and motor vehicle fatal accidents. The value of Exp(β) for dummy variables Gender (1), indicating the odds that an accident will be fatal because of female motorcyclist and motorist at fault were 30% and 40% respectively lower than for male. Thus, the probabilities of female motorcyclist and motorist were about 21% and 28% respectively contributing on motorcycle and motor vehicle fatal accidents. In other words, the probabilities of male motorcyclist and motorist were about 79% and 72% respectively contributing more than for female on motorcycle and motor vehicle fatal accidents.

Based on the mode results, gender were found to be significant indicating its contribution on both motorcycle and motor vehicles fatalities, while age is significantly influenced all vehicles fatalities. These are consistent with past studies findings that road user attributes such as gender and age should be considered in accident risk assessment (Al-Ghamdi, 2002, Dissanayake, 2004).

6. CONCLUSIONS

This study applies logistic regression technique to investigate the influence of accident factors on motorcycle and motor vehicle fatal accidents on arterial roads in Bali. Based on the State Police of Bali Province accident data, seven predictor variables were employed in the model development. The analyses show that the odds of fatal accident due to female motorcyclist and motorist at fault were 30% and 40% respectively lower than for male. Thus, the probabilities of male motorcyclist and motorist were about 79% and 72% respectively to contribute more on motorcycle and motor vehicle fatal accidents. In addition, age was also significant indicating its influence on all vehicle fatalities. The probability of age was 50% to influence all vehicles fatalities. These are consistent with past studies findings that road user attributes such as gender and age should be considered in accident risk assessment (Al-Ghamdi, 2002, Dissanayake, 2004).

Further research on age division on male/female and age of motorist should be conducted. The result would be expected to develop strategies to prevent and reduce fatal accidents in particular for motorcyclists in Bali.

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