INFLUENCING FACTORS ON MOTORCYCLE ACCIDENT IN URBAN AREA OF MALANG, INDONESIA

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ABSTRACT

For the last decade, motorcycle has become the most popular transportation mode in Indonesia. As the result, motorcycle rider safety needs more attention. Thus, it is important to know the motorcycle rider characteristics that influenced the motorcycle accident in order to develop some action program for increasing motorcycle riders’ safety. This study is aimed to develop a probability model of motorcycle accident in urban area, with the case study of Malang City, using logistic regression method, thus the influencing factors on motorcycle accident can be identified. Direct interviews were conducted to 100 respondents in each research area. The motorcycle accident probability model development used the logistic regression method. The explanatory variables that significantly influenced the probability of a motorcycle rider get in an accident are gender, number of motorcycle owned, travel purpose, distance and riding knowledge.

Key words: influencing factors; motorcycle rider characteristics; motorcycle accident probability model; logistic regression

1. INTRODUCTION

For the last decade, motorcycle has become the most popular transportation mode in Indonesia. Lubis (2008) stated that in 2007, the population of motorcycle in Indonesia has reached 78.3% of total vehicle population or about 37 million units, with growth rate about 21.06% per annum [5]. Thus, it can be predicted that if the motorcycle population increase, the number of accident will also increase. Motorcycle accident must be noticed seriously, since 75% fatality victims of traffic accidents were motorcycle riders (GRSP, 2007) [3].

In 2003, 75.000 people died and 4.7 million people injured in the traffic crashes. This happened in ten ASEAN nations. The loss contributed by traffic accident has reached USD 15 billion, or equal to 2.2% Gross Domestic Product (GDP) of countries in ASEAN region. If this condition continues, the number of accident victims who died or injured and the material loss will significantly increase (ADB, 2004) [1]. In November 2004, ten ASEAN nations attended in a convention in Kamboja concerning about road safety problems in the region. This meeting resulted in some policies regarding with road safety programs, training, controlling, socialization, and coordination among the countries. One interesting outcome was the commitment from the nations to focus in the safety improvement for the most fragile road users, those are, pedestrians and motorcycle riders (ADB, 2004) [1].

Motorcycle rider safety, as other road safety, depends on some factors, namely, the rider himself and other road user, road and traffic condition, vehicle condition, and so on. Some studies have been accomplished in order to uncover some facts about the factors influencing motorcycle accidents. Road users are identified as the most responsible factor in motorcycle rider safety. Therefore, it is important to observe some internal factors of a rider that influence the rider involved in a motorcycle accident, by modeling the motorcycle-accident probability. This study is aimed to develop a probability model of motorcycle accident in urban area, with the case study of Malang City, using logistic regression method, thus the influencing factors on motorcycle accident can be identified.

The facts that motorcycle accident is the highest proportion of accident and that human factors dominate the factors influencing the accident have been proved by academic research all over the world, including in Indonesia. Some research concerning accident characteristics in some region in Indonesia have been accomplished. Indriastuti, et.al (2007) identified that motorcycle accident was the most frequent accident (340 of 607 incidents, or about 56% of all type of accident) occurred in Malang Municipality along years 2000 to 2005 [4]. Thus, the Directorate General of Land Transportation recorded that in 2007 there were 57,080 motorcycle accidents (about 68% of all type of accidents) all over Indonesia [2]. Suraji et.al (2007) declared that human factor become the major factor in the traffic accident, while other factors give less significant impact in the accident [6]. Ueds et.al (2005) explored the factors caused accident and found that the most influencing factor is tiredness on the rider [7].

Concerning the motorcycle rider and motorcycle accident characteristics would help the government in developing some action program in order to increase the safety of motorcycle rider, that suitable to each motorcycle rider socio-economic background.

Logistic regression is a development of the multiple linear regression method for the condition where the response variable (y) is a binary number, which is the number consisted between 0 and 1. As in the multiple linear regression method, the explanatory variables (x1, x2, ..., xn) can be categorical or continue, or even the combination of those types mentioned before.

The logistic regression method was developed in order to answer some problems that could not be solved by the multiple linear regression method, such as the abnormally distributed response variable that even more suitable to the binomial model. However, if the normal distribution is used for the binomial model, the variants of the response variable would not be constant for each data.
This model could properly explain the behavior in econometric and the risk factor modeling in epidemiology. In the context of choosing behaviour, this model is the development of the random utility theory.

The logit model development is based on the cumulative logistic probability function that specified as follow:

\[ P_i = F(\beta_0 + \beta_1 X_{i1}) = \frac{1}{1 + e^{-\beta_0 - \beta_1 X_{i1}}} \]

(1)

2. METHODS

The research was conducted in Malang City, East Java, Indonesia. Malang City is the second biggest urban city in East Java Province, after Surabaya City, which now is categorized as a metropolitan area. With the various motorcycle rider characteristics, this location is chosen to figure the condition of urban area in East Java.

Direct interviews were conducted to 100 respondents in each research area, as mentioned in Frænkel and Wallen, that minimum sample for a descriptive research is 100 respondents. The sampling method was Quota Sampling method. Respondents were chosen by accidental sampling method.

The motorcycle accident probability model used the logistic regression method. This model was applied since the multivariate distribution was not performed and the explanatory variable was the combination between continue variable and categorical variable.

The proposed model structure was:

\[ P(MCA) = \frac{1}{1 + e^{-\beta_0 - \beta_1 X_1 - \beta_2 X_2 - \beta_3 X_3 - \ldots}} \]

(2)

In which:

- \( P \) = probability of a motorcycle rider involving in an accident
- \( e \) = natural number
- \( \beta \) = coefficient of explanatory variable (predictor)
- \( X \) = explanatory variable (predictor)

Logistic regression was selected as this method has the probability value between 0 – 1. The outcome of the probability model is the odds that a motorcycle rider will involve in a motorcycle accident, based on the socio-economic characteristic, travel characteristic and riding behaviour.

Tabel 1. Explanatory variables for the motorcycle accident probability model

<table>
<thead>
<tr>
<th>Explanatory Variable (X)</th>
<th>Scale</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>Ratio</td>
<td>1. 18 – 21  2. 22 – 30  3. 31 – 40  4. 41 – 50  5. 51 – 60  6. 61 – 70</td>
</tr>
<tr>
<td>Gender</td>
<td>Nominal</td>
<td>M  F</td>
</tr>
<tr>
<td>Income (Rupiah)</td>
<td>Ratio</td>
<td>1. &lt; 1,000,000  2. 1,000,000 – 1,500,000  3. &gt; 1,500,000</td>
</tr>
<tr>
<td>Number of Motorcycle owned</td>
<td>Continous</td>
<td>1. 1  2. 2  3. 3</td>
</tr>
<tr>
<td>Machine Capacity</td>
<td>Ordinal</td>
<td>1. &lt; 100 cc 2. 101 – 250 cc 3. 251 – 300 cc 4. &gt; 300 cc</td>
</tr>
<tr>
<td>Motorcycle Colour</td>
<td>Nominal</td>
<td>1. Dark 2. Light</td>
</tr>
</tbody>
</table>

3. RESULTS AND DISCUSSION

Model Variables

Data for the model was obtained from the questionnaire given to some respondents. The questionnaire consists of three parts, namely, socio-economic background, travel characteristics, and riding behaviour. Altogether, the questionnaire contained nine questions to obtain information on respondent’s background, three questions about travel characteristics, and three sets of questions about riding attitude. The questions about motorcycle rider background are age, gender, education, occupation, income, motorcycle ownership, motorcycle type, machine capacity, and colour. Travel characteristics that were questioned are travel purpose, road type and distance. Whilst, riding behavior that were explored are driving license acquiring procedure, riding knowledge, and the attitudes before and after riding a motorcycle. Table 1 shows the explanatory variables of the model.
The respondents of the probability model is the experience of a motorcycle rider involved in an accident. A motorcycle rider who was involved in a motorcycle accident was symbolized by the number 1, on the contrary a motorcycle rider who never been involved in a motorcycle accident was symbolized by the number 0.

**Motorcycle Accident Probability Model**

Motorcycle accident probability model in Malang City is:

\[ P(mca) = \frac{1}{1 + e^{-(0.40+1.07x_{2}+0.21x_{6}-0.70x_{10}+0.15x_{12}+0.74x_{12.3}+0.91x_{12.4}+0.58x_{12.5}+0.87x_{12.6}+0.31x_{14.1})}} \]  

(3)

In which:

- \( X_{2} \) = Gender
- \( X_{6} \) = Number of motorcycle owned
- \( X_{10} \) = Travel purpose
- \( X_{12} \) = Distance
- \( X_{14} \) = Riding knowledge

According to the Goodness-of-Fit Test, this model is feasible, since from the Hosmer's-Lemeshow test, the significant value is 0.254 (> 0.10), although the Nagelkerke R-Squared value (\( R^{2} \)) is only 0.087. From the correlation test, there is no serious multicollinearity value among the explanatory variables, as shown the correlation value that is below 0.8. The predicting capability of this model are good, with the confidence level is about 72.5%, where 13.9% probability of not involving in an accident and 97.6% probability of involving in an accident can be predicted well.

According to the Wald criteria, the “male” explanatory variable \( X_{2} \) can be expected to predict the motorcycle accident occurrence, with the Wald value 3.835 (sig 0.05). The odds ratio of 2.928 shows that there will be a considerable change in the accident probability if the unit number of “male” motorcycle rider change.

From the model above, it is found that besides the “male” variable, the increase of motorcycle ownership \( X_{6} \), middle-class of distance \( X_{12.3} \), and the less riding knowledge \( X_{14.1} \) effect on the higher probability for a motorcycle rider in Malang City to get in an accident. On the contrary, the more motorcyclists go with the purpose of social activities \( X_{10} \), the less possibility is expected to be involving an accident.

Below is the explanation of why each of the variable significantly that is effected on the probability a motorcycle rider involve in an accident.

**Gender**

In the urban area, a male motorcycle rider has big impact on the increasing of motorcycle accident probability. This condition can be happened, since a man is psychologically more emotional and challenging. In example, when a man riding a motorcycle is overtaken by other motorcycle rider, he will emotionally increase his speed and try to re-overtake.

A man also dares to estimate a condition in a very short time, and take the quick chance. This can be seen in the road when there is a small gap, a man usually take the risk to overtake, without considering the safety.

Two reasons exposed are supported by the condition of the urban area where more than 70% of the responden are male, with age ranges between 17 – 22 years old. In this segment of age, a man is psychologically in an unstable emotional condition and still highly influenced by his environment. Moreover, in urban areas there more traffic conflicts and challenges.

**Number of Motorcycle Owned**

The increase of motorcycle ownership indirectly related with the experience, ability and self-reliance in riding motorcycle, but sometimes the higher self-reliance will cause less awareness of safety while riding. Owning more motorcycles could support a motorcyclist to do more journeys, even the very short-distance journeys. The more frequent a motorcyclist being in the road, the more possibility he will involve an accident. Other explanation about motorcycle ownership is that sometimes a motorcyclist collects more than one type of motorcycles. Different types of motorcycle have different characteristics, means that different riding techniques required. Thus, if a motorcyclist is not used to or not too expert in riding more than one types of motorcycles, this condition will bring him to an accident risk.

**Travel Purpose**

The travel purpose to routine activities (work and education) are found to expand the probability of a motorcycle rider get involve in an accident significantly, due to the urban community traveling custom. Urban traveler are used to start their journey of their routinity close to the beginning time of the activities, thus they must move in rush to get to their destination, and sometimes they do not aware to their safety. Meanwhile, for social activities, the accident probability is less, since they do not have to husten.
Distance

Based on the model developed, it can be seen that the riders who travel further distance could increase the risk of accident occurrence. This condition can be explained with the physical condition of the rider. The more distance they travel, means the more time they need. Riding a longer distance need more concentration, more strength and more composed emotion, since most of the traffic condition in urban area is usually uncontrollable. With low concentration, strength, and uncomposed emotion, the accident risk will increase.

Riding Knowledge

The rider with less knowledge will increase the risk to be involved in an accident. It is understandable since the rider may not familiar with same traffic rules or in some case the rider may be confused what to do in certain conditions. This will conduct the wrong action that leads motorcyclist in traffic accident. Thus, the riding knowledge must be supported by the riding attitude.

4. CONCLUSIONS

In the urban areas, which are represented by Malang City, the explanatory variables that significantly influenced the probability of a motorcycle rider get in an accident are gender, number of motorcycle owned, travel purpose, distance and riding knowledge. Male rider with travel purpose of routine activities (education, work) in further distance will increase the probability of a motorcycle rider involved in a motorcycle accident. The higher number of motorcycle ownership shows the same result. Whilst, the lower riding knowledge rise the accident risk.

REFERENCES