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Behavioral Modelling on Bicycle Rider Characteristics in Indonesia (A Case Study of Malang Area)

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ABSTRACT

The use of bicycles as environmental-friendly modes of transportation should be paid more attention. Eventually, the use of bicycles could reduce the dependence on oil, environmental pollution, traffic jam and traffic accidents due to rapid use of motorization. In some developed countries, the use of bicycles could reach about 30% of the total trips, while for the developing countries (except China), bicycle users are less than 10%. This research on bicycle rider's behavior aims to determine the characteristics of bicycle riders and to model the bicycle usage. Data analysis in this study includes descriptive analysis and bicycle usage modeling by the method of Logit Regression Analysis. Descriptive analysis includes socio-economic aspects, movement and behavior characteristics of bicycle rider and accidents involving bicycles. Behavioral analysis with Logistic Regression is use to obtain bicycle rider preference in using bicycle lane models. The results of the analysis show that the bicycle rider needs the bicycle lane facilities, and there is a need of safety action program for bicycle rider.

Keywords: characteristics of bicycle rider, accident involving bicycle rider, bicycle usage model, Malang, Indonesia.

INTRODUCTION

New paradigm in traffic safety has been concluded that there is the need for increasing the safety for road users, especially for those who are vulnerable to accidents, e.g. pedestrians, bicycle rider and motorcycle riders [1]. The safety aspect for bicycle rider has to be paid attention, because the bicycle as a means of transport has several advantages, as a cheap means, it has a healthy and sport value, improving accessibility for poor people, and the best solution in dealing with existing environmental problems caused by motor vehicles [2]. Cycling is the most efficient transport mode for urban areas, in terms of economic (cost of maintenance and operations) and in terms of energy (efficient energy consumption). Historical developments have brought a bicycle-mechanic on the growth so as to increase the ideal efficiency mileage (from 0.4 km to 3.3 km). One of the previous research on bicycles have found that the bicycle rider has a speed limit of 15 kph, an average speed of 6 kph, the ideal trip distance 3.3 km, and the average trip distance of 2.8 km [3].

Malang is a city located in East Java Province, about 1000 km from Jakarta. In Malang City, especially in the eastern region, there is a large movement of the bicycle rider reaching about 450 bicycles at peak hours. It seems that bicycle riders are marginalized. Although majority of traffic accident in Malang Area was involving motorcycle rider [4], however data from Malang hospitals shows that in 2005, the number of bicycle rider involving in an accident is 4 to 14 people per month (1.5% of the total accident number). Data from Malang Police Office also shows that there is an increase in bicycle rider casualties from 2.6% in 2007 to 3.6% in 2008. This suggests that a study is needed to analyse and model the characteristics of bicycle riders to support the proposed bicycle safety action program.

So far, some researchers developed the understanding on the characteristics of bicycle users and bicycle lane in Indonesia [5], however very few study on accidents involving bicycle riders. In developed country many research has been done on bicycle accidents, including bicycle lane that affecting the accident [6]. To achieve these objectives in Indonesia, this research will observe the characteristics of bicycle rider, review on bicycle rider involvement in accident and develop a model for bicycle rider usage. It is expected that the results of this research will support the government policy in providing a bicycle lane facilities that likely will increase the number of bicycle rider, not only for the captive rider, but also for those choice rider.

MATERIALS AND METHODS

Research Location

This research has been conducted in the location of Pakis District in Eastern Region of Malang City (Figure 1).

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Data Needs

The primary data required in this study are:

- Bicycle rider characteristics collected with an interview survey.
- Accidents involving bicycle rider characteristics with an interview survey

While the secondary data such as number of accident and map are obtained from some agencies (police and hospital). In order to get the characteristics of bicycle rider, road-side interview survey has been conducted in 2009. The sampling method applied in this study is a combination of purposive sampling and accidental sampling. The variable and its indicator for descriptive analysis and behavioral modeling is listed in Table 1.

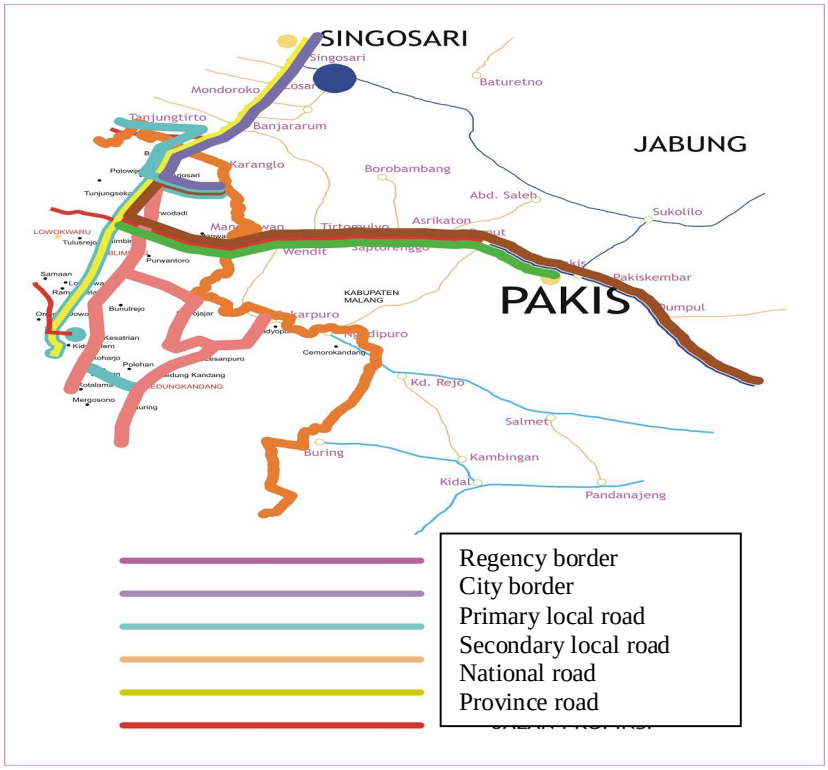

Figure 1 the Location of Study

Table 1 Variable and indicator for descriptive analysis and modelling

Objective (s)	Variable	Indicator
To observe the bicycle rider socio-economic characteristics	Sex	Sex (male or female)
	Age	Age class
	Educational grade	Final education level (elementary, junior, high school or above)
	Income level	Total income a month class
	Job	Job types
	Bicycle ownership	Bicycle ownership status (his own or borrowed/rent)
	The number of bicycle owned	Total number of bicycle owned by the user family
To observe the movement characteristics for bicycle usage modelling	Departure place	The departure place (home, school, etc.)
	Trip purpose	The purpose of trip (to work, to school, for sport/recreation or going home)
	Destination	Types of destination location
	Trip length	The length of trip distance
	Trip Routines	Frequency of using bicycle in a week
	Travel Time	Time spent in using bicycle

Method of Analysis

a. Analysis on characteristics of bicycle riders

The descriptive analysis has been done by categorized bicycle rider characteristics based on socio-economic conditions, trip movements, and bicycle rider behaviours, and experienced accidents.

b. Analysis on characteristics of accident involving bicycles
The descriptive analysis has also been done on accidents involving bicycles in terms of number of accident and condition of the victim (material damage, minor injuries, severe injuries, died), type of collision (single accident, double accident).

c. Modelling the usage of bicycles
The model will be made to determine the relationship between the usage of bicycle relating with social characteristics and trip movement characteristics of bicycle rider.

RESULTS AND DISCUSSION

Bicycle rider characteristics

Bicycle rider characteristics based on the results of the survey are grouped into socio-economic characteristics, movement, safety device completeness of bicycle, cycling behaviour, experiences and perceptions of cycling accidents by bicycle riders. Socio-economic characteristics of bicycle riders include gender, education, income, types of job, bicycles ownership status and the number of bicycles owned. Bicycle rider movement characteristics include the purpose of travel, travel time, trip routines and a few questions about the provision of bicycle lane. Safety device completeness of cycling is depend on the availability of several devices such as brake, taillights, headlights, bells, pillion seat, bicycle basket, mudguard, chain cover and standard. Bicycle rider behaviour includes before and while driving a bicycle. Finally, there are some questions about the experience and perception of cycling accidents by bicycle riders.

Socio-economic characteristics of bicycle rider's

a. Gender classification
Most bicycle riders are male (92.21%).

b. Educational classification
Result of survey in the area of study (Table 2) shows that the majority bicycle riders are SD / MI educated (43.16%). This lower education level certainly affects the types of their jobs.

c. Earnings classification
Level of education and employment affect income levels (Table 3), therefore in this study most bicycle riders earn less than Rp 500,000 (50.53%).

Table 2 Educational level of bicycle riders

No	Education Level	Number	Percentage
1	Uneducated	26	5,47
2	Unfinished Elementary School	34	7,16
3	Elementary School	205	43,16
4	Junior High School	133	28,00
5	Senior High School	68	14,32
6	Bachelor	9	1,89
	Total	475	100,00

d. Jobs classification
Types of work of the bicycle rider was influenced by the level of education, this can be explained from the results of the survey; the majority of the bicycle rider is less skill type of job, which is a construction worker 31,58% (Table 4)

Table 3 Income level of bicycle rider

No	Income Level	Number	Percentage
1	< Rp 500.000	240	50,53
2	Rp 500.000 - Rp 1.000.000	210	44,21
3	> Rp 1.000.000	25	5,26
	Total	475	100,00

Table 4 Job types of bicycle riders

No	Types of Job	Number	Percentage
1	Student	84	17,68
2	Farmer	26	5,47
3	Construction worker	150	31,58
4	Worker	36	7,58
5	Seller	35	7,37
6	Other	144	30,37
	Total	475	100,00

e. Ownership of Bicycle classification
The result of this study (Table 5) explained that the majority of bicycle riders have their own bicycle (95.16%). The lower level of income would affect the number of bicycles owned by bicycle riders, therefore most of the bicycle riders have one bicycle 64.42%.

Table 5 Bicycle Ownership of Working Day Bicycle Rider

No	Ownership	Number	Percentage
1	None	23	4,84%
2	1	306	64,42%
3	2	108	22,74%
4	>2	38	8,00%
	Total	475	100,00%

f. Trip purpose
Survey result shows that the majority of bicycle riders have the intention to travel in order to work (67.58%)

g. Trip length
The majority of bicycle riders coming from the eastern city of Malang leading to a distance of less than 5 km (43.79%)

h. Routines of trip
From the results of interviews, the majority of bicycle riders using the bicycle for routine activity in a week (86.95%), mostly because the need to save trip cost

i. Cycling while raining
Most bicycle riders cycling sometimes even when the rain (47.37%). Research in Hangzhou, China, shows that 85% of prospective bicycle user will use bicycle if it is not rain [7], therefore bicycle rider in Malang has better willingness to use bicycle although rain.

Accident Involving Bicycle

If it is observed from the number of accidents which occur on weekdays and holidays, it shows that the number of accidents which occur on weekdays (75%) was higher than on weekends (25%). A large number of events on the accident because the number of working days in a regular road users such as work or school, which is at peak hour of the road, when the traffic volume was high. In the other hand, during weekend, bicycle is used to do activities such as outdoor recreation.

Based on the gender of the bicycle rider and victims of accidents, the highest incidents of accident occurred on a number of men 80%. Total number of events in men is higher than women because most of the bicycle rider is male. With a larger population, then the statistical case of an accident, man will more often become victims in the event of an accident.

Psychologically, men are generally willing to take risks in driving, both in terms of speed (speeding), overtaking, and even driving in less fit conditions (drowsiness, illness, etc.). This is often the cause of the accident due to carelessness of drivers. The dominant accident victim age is more than 45 years, which is about 76% of the 276 incidents involving bicycle accidents. However, the dominant age of bicycle rider involving accident is the age group less than 17 years (36%).

The percentage of road users involved in accidents in the last six years for a single accident is 22% of the 276 accident. As for pedestrian accident is 1%, hit non motorized vehicles 1%, 56% hit motorcycles, hit cars 12%, 1% hit microbus, and hit trucks 2% of the 276 accident scene. The dominant vehicles involved in accident is motorcycle. More than 50% of bicycle accidents happened in the last six years involving motorcycles, this is because the number of motorcycles is higher than other road users.

The Model for Bicycle Usage

A. For Working days
All the remaining variables have been incorporated into the first step of the Backward Wald and assessment concludes step 7 for the estimated parameter values changed by less than 0.001. Log Likelihood value is basically aims to show how the weakness of the model in predicting the decision. The smaller the Likelihood statistic value, the better the model. In the last step Likelihood statistic values obtained about 414.43. Parameter assesment of logistic binary model of the routine use of bicycles in the work days shown below:
U = 3.042 -0.504 purpose of trips other than work-routine movements +0.388 other vehicles owned. R^2 = 18.6

a. Trip purpose
With the number of significance <0.05 (0.000) states that partially meet the age significantly.

negative value of ß means that respondents who had intentions other than the movement of work-routine will not use a bicycle (1 = working, 2 = meet a friend, 3 = shopping, 4=recreation, 5 = other).

b. Other vehicles owned
With the number of significance <0.05 states that other vehicle owned partially filled significantly. Positive value of ß means that respondents who had other vehicles will still use the bicycle for routine activities on weekdays

B. For Holiday
All the remaining variables have been incorporated into the first step of the Backward Wald and assessment concluded by the 11th step because the estimated parameter values are changed by less than 0.001. Log Likelihood value is basically aims to show how the weakness of the model in predicting the decision. The smaller the Likelihood statistic value, the better the model. In the last step Likelihood statistic values obtained for 117.77 Parameter assesment of logistic binary model of the routine use of bicycles on public holidays for the purpose of sport is shown below:
U = 0.373 - 0.46 income - 0.469 other vehicles owned with R^2 = 10.4

a. Income
With the number of significance <0.05 (0.000) states that partially meet the age significantly. Negative value of ß means that respondents who have a higher income will not routinely use bicycle for sport (1 = <1 million rupiah, 2 = 1-3 million rupiah, 3= 3-5 million rupiah, 4 = 5-7 million rupiah, 5 = 7 - 9 million rupiah, 6 = > 9million rupiah).

b. Other vehicles owned
with the number of significance <0.05 states that other vehicle owned partially filled significantly. Negative value of ß means that respondents who had other vehicles such as motorcycles or cars will not routinely use a bicycle for exercise purposes

Result of the analysis suggest that bicycle is still become the last option to be used if the government did not provide a better service for bicycle, therefore it is necessary to build bicycle infrastructure in urban area for improving the service to bicycle rider [8,9,10]. Improvement shall be done through providing bicycle lane priority in intersection [11], while decision on bicycle lane should use an advance technology such as GIS [12].

CONCLUSION

- The bicycle rider characteristics in study area shows that most of them are male, elementary school educated, lower income level and work as construction worker, have one bicycle, working trip purpose for less than 5 km trip distance, as a daily activity and use bicycle although it is rain.
- Most of the accident involving bicycle happened on weekdays, the victim is a male, more than 45 years old, while the bicycle rider who hit other is mostly those less than 17 years old. Most of the accident (56%) is between bicycle and motorcycle.
- The usage bicycle model found that factor affecting the use of bicycle during weekdays is trip purpose and the number of bicycle owned. While for weekend user, the factors are income and the number of bicycle owned.
- The use of bicycle will support of sustainable transportation, therefore there is a need for campaigning the use of bicycle, especially through providing bicycle lane in urban area.
- There is the need of action program for improving safety of bicycle rider.

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