

Model of cyclist accident characteristics in the city of Malang and Blitar

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Abstract. Utilization of bicycles as an environmentally friendly mode of transportation is re-concerned as the development of sustainable transportation programs. The use of bicycles in some developed countries such as the Netherlands is 27 per cent of total travel, while for developing countries such as Indonesia, cyclists are less than 1% of total travel with low educated characteristics (65 per cent) and low income (48 per cent). Cyclist reduces dependencies on petroleum and environmental pollution as well as lessen the occurrence of congestion and traffic accidents involving motor vehicles. It was necessary to know the behavior and interaction of bicycle riders with other vehicle users in a heterogeneous traffic flow. The main purpose of the research is to create a model of bicycle accidents to increase the road traffic safety in Malang city and Blitar city. The research used analyses of frequency, the road's level of service, and multiple linear regression. The results showed that there was a need for a development basis of a special lane for bicycle. It aims to reduce the level and number of cyclist accidents and to achieve transportation safety as well as to raise public awareness in traffic safety.

Keywords: bicycle, road traffic safety, traffic accidents, sustainable transportation

1. Introduction

The development of transport is currently very rapid since the needs of the community are increasing, directly proportional to the needs of transportation modes to support their activities. According to [1], the development of vehicles as a means of transportation brings a positive impact on the fulfilment and improvement of human welfare, especially as a means of mobilization in order to facilitate daily activities but it was also accompanied by the emergence of some undesirable negative effects such as congestion and the increasing number of traffic accidents. Based on [2] regulates non-motorized vehicles, stating that the government must provide facilities for cyclists in traffic. Cyclists are entitled to have the right to facilities supporting security, orderliness, fluency, and safety in traffic. Based on the regulation of the Local Government in Malang and Blitar City, bike paths have been constructed to provide comfort and flexibility for cyclist.

Accidents are triggered by several aspects, including human factors, vehicle features, road factors, and environmental aspects. Accidents due to human factors are influenced by the individual characteristics of the riders. Vehicle factors are affected by the reliability of the components in the vehicle to maneuver when it is moving. Road factors are influenced by the condition of road infrastructure that ought to support comfort, safety, and security in driving, while environmental factors are affected by the bad weather around the crash site that sways the driver's visibility in driving [3], [4].



Malang is the second largest city in East Java Province which has transportation problems such as congestion and a high rate of accidents which is increasing annually. There were 330 cases took place on highways in 2015, increased by 66 per cent compared with the year of 2014 where there were only 199 cases of accidents. This number of accidents continued to rise by 8 per cent in 2016 of 356 cases causing 82 deaths and 428 minor injuries. The total loss caused by accidents in Malang City in 2016 reached Rp 245,905,000.00. As for accidents involving cyclists in Malang, there are 4 cases in 2014–2015, and it declined to 3 accidents in 2016. In general, accidents involving bicycles in the City of Malang occurred on the road that does not have a particular bike lane. Based on the statistics, bicycle accidents have happened at almost all road functions such as arterial, collector, and local roads [5].

2. Research Method

2.1. Location

The study locations for this research were Malang and Blitar City. Questionnaires were distributed in both cities to cyclist respondents who had been cycling during the last six months at the minimum and had passed the path along arterial, collector, and local/neighborhood roads in Malang and Blitar with or without particular bike lanes. Road segments used as the location to collect data on road geometric characteristics in this research were those with frequent bike accidents based on the police data from 2014–2016. Consideration was made that each road function is represented by two different road locations (Table 1, Table 2, and Figure 1).

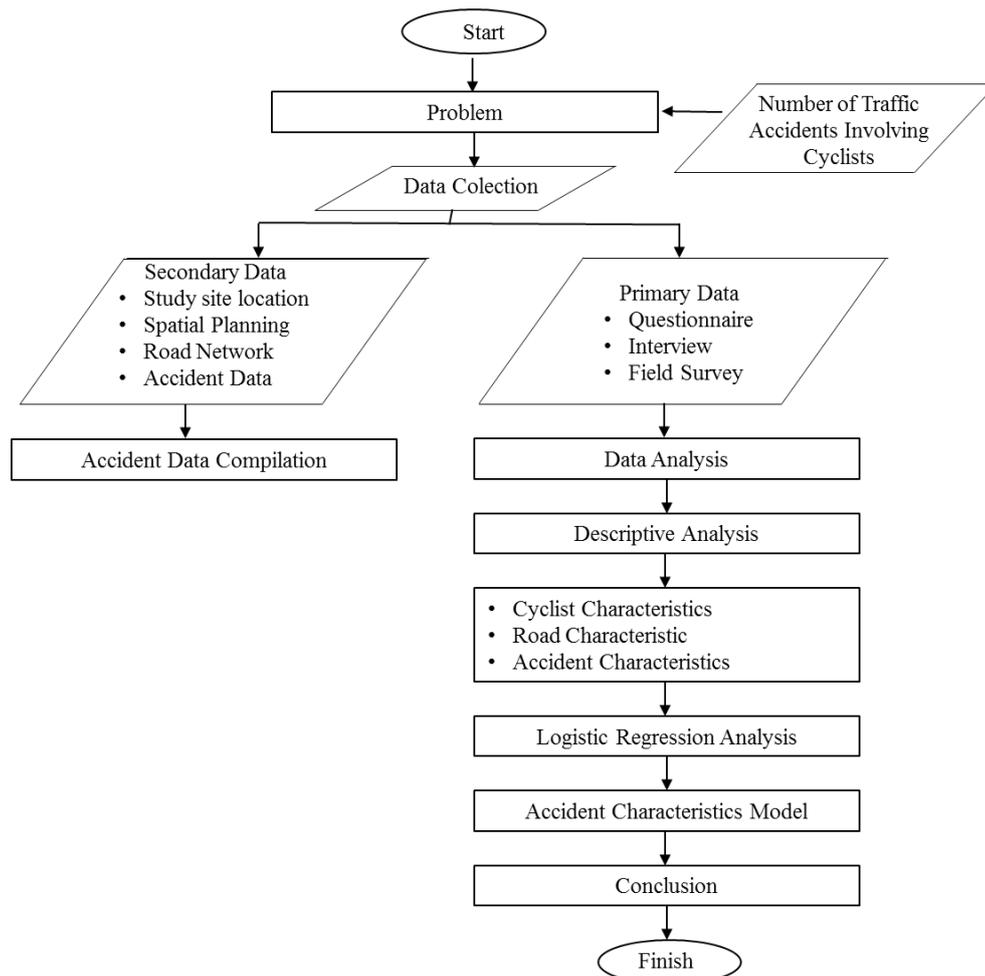


Figure 1. Research framework.

2.2. Types and sources of data

The required data are statistics related to the main purpose of this study, i.e., the characteristics of the drivers, road geometric, and accidents as well as the model of cyclist accidents probabilities in both cities. The study used primary data (obtained directly from the survey) and secondary data.

Table 1. Survey locations of road geometry in Malang City.

No.	Location	Road Function
1	Ahmad Yani	Arterial
2	Borobudur	Arterial
3	Pattimura	Collector
4	Jenderal Basuki Rahmat	Collector
5	Sawojajar	Local
6	Ikan Tombro	Local

Table 2. Survey locations of road geometry in Blitar City.

No.	Location	Road Function
1	Tanjung	Arterial
2	Raya Kediri – Blitar	Arterial
3	Bengawan Solo, Pakunden Sub-district, Sukorejo Sub-district	Collector
4	Raya Pakisrejo Village, Srengat Sub-district	Collector
5	Tawangrejo Village, Wonodadi	Local
6	Simpang 4 Selokajang Village	Local

The data obtained were then processed and analyzed by SPSS program to create a model of accident characteristics that can occur to cyclists based on the road function. Secondary data were gathered indirectly by the researchers from some relevant agencies to support the primary data analysis.

2.3. Data Collection

The data collected in this study were in the form of interviews and questionnaires as well as direct surveys in the field:

- An interview is a conversation conducted by two parties the interviewer and the interviewee with a specific intention. In this research, the interviewee is a cyclist who had been in an accident. Interviews with cyclists are intended to explore more information about the experienced accidents.
- A questionnaire is an attempt to collect certain information by submitting a number of written questions to be answered in writing by the respondent. Respondents from this questionnaire are cyclists who had been active for at least six months. The purpose of collecting questionnaires in this study is to obtain information regarding the research variables such as the rider characteristics and accident details.
- Field survey is an attempt to gather further information about the object to be assessed through direct action to see and measure conditions in the field. In this study, a field survey was used to gather information about the road geometric characteristics, the volume of traffic, and the speed of the vehicle.

The sampling technique used the proportionate stratified random sampling. According to [6], this approach is applied when the population has members/elements that are not homogeneous and stratified professionally. Determination of the number of samples was calculated using the method of time linear function because the population of cyclists is very dynamic, especially those who use not only a bike but also a motor vehicle as a mode of transportation. Here is the sample calculation formula with time linear function method [7]:

$$n = \frac{T-t_0}{t_1} \quad (1)$$

N = minimum sample size; T = time available for research; T₀ = sampling time; T₁ = time spent by respondents to fill out the questionnaire/interview

$$n = \frac{225-180}{0.25} = \frac{45}{0.25} = 180 \text{ respondents} \quad (2)$$

2.4. Descriptive analysis

Questionnaires data in the form of cyclists characteristics, road geometric characteristics, and accident characteristics in the study area were then analyzed using the frequency analysis. This method was chosen because compared with other analysis, it has advantages of being easily and quickly comprehended through its data arrangement in the form of diagrams [8], [9].

2.5. Statistics logistic regression

In this study, accident model was developed to determine the probability of cyclists experiencing accidents by predicting the rider's behavior, accident characteristics, and road geometric characteristics. The logistic regression method was employed because a multivariate normal distribution could not be fulfilled and the explanatory variables were a mix between continuous and categorical variables. Another account of this choice is that the probability values were in the range 0–1, distinguishing this approach from the usual linear regression where the value of the response variable (dependent) is less than 0 or more than 1.

According to [10,11], the formation of a log it model is based on a cumulative logistics opportunity function which is specified as follows:

$$P_i = F(\beta_0 + \beta_1 X_{1i}) = \frac{1}{1+e^{-z}} = \frac{1}{1+e^{-(\beta_0+\beta_1 X_{1i})}} \quad (3)$$

P (BA) = chance of a bicycle accident occurrence; e = natural number (2.71828); β = explanatory variable coefficient (predictor); X = explanatory variable (predictor)

3. Results and Discussion

3.1. Location characteristics

The continuously increasing number of motor vehicles, uncompensated by the infrastructure development, leads to the aggravating transportation problems including the number of accidents. There were at least 356 cases of accidents in Malang City in 2016 which only about 1 per cent or 3 cases of them involving bicycle users as victims and 165 accidents in Blitar with 3 cases resulting in cyclists as victims [5].



Figure 2. Mixed traffic condition between motorized and non-motorized vehicles.



Figure 3. Bicycle path condition used for other activities.

Figure 2 shows the mixed traffic condition between motorized and non-motorized vehicles where all types of vehicles move together in the same lane (not separated). Figure 3 shows that many of currently operating trails do not conform to the hierarchy of road functions, especially for bike lanes that are often used by motor vehicles and used for other activities.

The study locations are Malang and Blitar. Both were chosen considering that Malang is the second largest city in East Java Province representing a medium town and Blitar portrays a small town. The selected road segments were those with arterial, collector, and local roads function in Malang and Blitar, with and without the existence of particular bike lanes.

3.2. General Conditions

Malang is one of the cities in East Java Province located on the plateau and is + 90 km south of Surabaya. Based on BPS data of Malang City, its population in 2015 is 851,298 inhabitants comprising 419,713 males and 431,585 females (Figure 4).

Blitar City is one of the small towns in East Java Province. It lies on the coordinates of 112.014°–112.028° East Longitude and 8.02°–8.08° South Latitude with an altitude of +156 m above the sea level. According to Blitar BPS data, its male and female ratio of population is 99.15 per cent. Its total population is 146,155 inhabitants consisting of 54,193 people in Sananwetan District, 49,783 residents in Sukorejo District, and 42,179 people in Kepanjenkidul District (Figure 5).

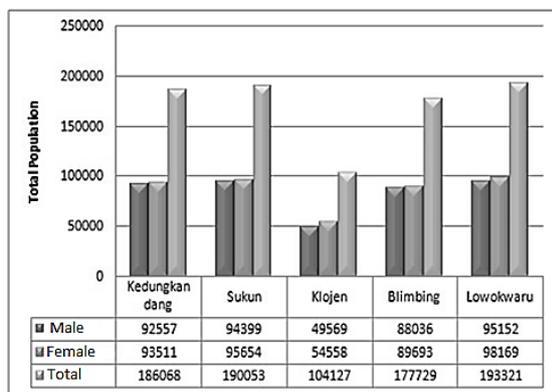


Figure 4. Total population of Malang City in 2015.

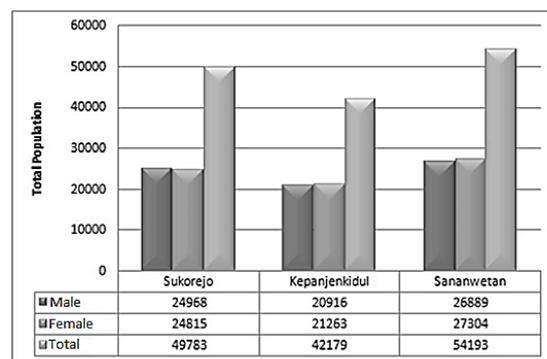


Figure 5. Total population of Blitar City in 2015.

3.3. Cyclist characteristics

3.3.1. Socioeconomic aspect

The majority of bicycle users Malang and Blitar city is the male gender of 73 per cent and 68 per cent, respectively. This gender domination is related to the age of respondents in the study area, proven by the value of chi-square test between those two variables of 0.004 (Table 3).

Table 3. Socioeconomic aspect recapitulation of cyclists.

Variables	Malang	Blitar
Gender	Male	Male
Age	15–25 years old	15–25 years old
Education	Senior high school	Senior high school
Job	Student	Entrepreneur
Income	IDR 1,000,000 – IDR2,000,000	< IDR 1,000,000

3.3.2. Movement characteristics

The majority of cyclists in Malang City use bikes with the intention to exercise of as much as 28 per cent since the bicycling movement there is only crowded on the weekend, indicated by the uncertain intensity. On the other hand, the majority of cyclists in Blitar use bicycle with the purpose to go to work of as much as 27 per cent because they are mostly self-employed and routinely do this.

3.3.3. Behavioral characteristics

Cyclists in Malang tend to never check the condition of the bicycle lights before driving, but always check the brakes, tires, and sometimes check the bike chain. They have the habit of not using safety tools such as helmets, gloves, as well as knee and elbow protectors while driving. Their other behavioural traits are that they sometimes wear light-coloured clothing, never ride or walk in groups, never joke on the street, never go through red lights, never carry overloaded items, occasionally be prepared for vehicles from the right direction, always give a sign when they will turn right, and sometimes keep on going under the rain.

Similarly, the cyclists in Blitar tend to never check the condition of bicycle lights before driving, but always check the brakes, tires, and sometimes check the bike chain. They also do not wear safety equipment such as helmets, gloves, and knee and elbow protector while driving. As for the other behaviors, they sometimes wear light-colored clothing, never ride but sometimes walk in groups, never joke on the street, never go through red lights, never carry overloaded goods, sometimes be prepared for vehicles from the right direction, always give a sign when they will turn right, and sometimes keep on going under the rain.

3.3.4. Accident characteristics

The percentages of respondents having experienced an accident in Malang and Blitar are 61 per cent and 44 per cent, respectively. Accidents involving bicyclists in Malang are caused by slippery or damaged road conditions of 36.07 per cent, while the account of bike accidents in Blitar based on the respondents' experiences is their own mistakes such as drowsiness, daydreaming, and joking of as much as 29.55 per cent.

4. Conclusion

The majority of bicycle accidents in Malang and Blitar occurred in the afternoon with a percentage of 39.34 per cent and 36.36 per cent, respectively. Accidents involving bicycle users in Malang are caused by slippery or damaged road conditions, while the account of bike accidents in Blitar is the bicyclists' own mistakes such as drowsiness, daydreaming, and joking. The respondents of both Malang and Blitar cities have also expressed the need for bike lanes on the road that is usually passed by cyclists. Hence, the development of special lanes for bicycles is necessary to reduce the level and number of bike accidents and to achieve the transportation safety as well as to raise public awareness regarding traffic safety.

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