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Original Article

Binomial Logistic Regression to Analyze the Factors that Influence People's Willingness to Cycle in the City of Banjarbaru, Indonesia

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Abstract - *The increase of public interest in cycling in Banjarbaru is a good moment to promote non-motorized transport. However, cycling is frequently done as a hobby. Meanwhile, people's enthusiasm for cycling for daily transportation is very lacking. The study was conducted to analyze the influence factors of the people's desire to cycle. Binomial logistic regression is used in analysis based on 154 questionnaires. Eighteen variables influenced cycling decisions from data processing results using SPSS. The most significant factors are human factors: cycle during the day time, travel time saving and bicycle path connection from residence to public places; facilities factors: availability of bicycle signs, bicycle lanes and CCTVs; environment factors: the traffic density and the existence of trees/green areas; safety and comfort factor: safer condition from crime; accessibility factors: the convenience of bringing a bicycle to public transport and short bike routes to public places; and distance factor: the distance between 2 and 2.5 km is favourable for cycling. It is figured out that the probability of people's willingness to cycle is currently only around 21%. However, when all the most important factors are fulfilled, the probability of people cycling can be raised to 70%.*

Keywords — *Cycling, Influence factor of cycling, Willingness, Binomial logistic regression.*

I. INTRODUCTION

Compared to other cities in the world, the use of bicycles in the City of Banjarbaru is still very lacking, while the use of private cars and motorbikes is very high. The same thing happened in other cities in Indonesia, including in several big cities such as Jakarta, Surabaya, Yogyakarta, Semarang, and Medan. As in the city of Solo, the proportion of bicycles is only approximately 1% of total vehicle use, while motorcycles account for 67% [1]. This is due to the lack of interest of the users themselves, facilities and infrastructure, and the safety of cycling. The particular case in Banjarbaru, from the user's interest, is still lacking because it is constrained by feeling lazy due to tropical weather with high humidity for daily bicycle use. However, some time ago, cycling activities suddenly became booming because of the popularity of various types of practical bicycles sold in the market, such as folding bicycles. However, these cycling activities are only limited to sports and recreational activities.

Several authors have analyzed the factors of people's willingness and aversion to cycling. According to the case study of bicycles and pedestrians from the FHWA [1], the factors influencing the desire to cycle are exercise, pleasure, environment; and cost savings. Several factors influence motivation and obstacles in using bicycles, including safety, convenience, interaction with motorized vehicles, integration of bicycles with other transportation, education and information about cycling, and physical factors. Meanwhile, the reasons people do not use bicycles include too long distances, dangerous risks, lack of facilities, bad weather, inadequate parking, bad road conditions, preference for using cars to work, lack of safe bicycle routes and paths, financial incentives, safe and convenient showers and bicycle storage and rising fuel prices [2]. Other studies reported the prominent factors for cycling route choice: motorized vehicles' speed and the number of heavy vehicles (trucks) in the traffic, traffic volume, security, and street lighting 0.

While research related to cycling in cities in Indonesia that has been carried out, among others, in the city of Solo, it is found that the lack of enthusiasm for cycling was caused by not having time for cycling, inadequate public facilities and bicycle lanes not yet available [3]. [4] Particularity investigated cycling facilities' quality, which mostly affects respondents' willingness to cycle, followed by reliability, convenience, accessibility, and security on campus in Depok. [5] identified bicycle safety factors, a parking lot protected from the weather and parking close to the college building as the reasons behind the willingness to cycle in the campus

environment in Surabaya. [6] found that lack of elements in mobility and accessibility, safety and security; comfort; and cycling infrastructure quality affect the reluctance of students in the city Yogyakarta to use bicycles for school trips. Meanwhile, [7] mentioned that people use bicycles influenced by accessibility, smoothness, safety, security and driving discipline.

This research was conducted to determine what factors influence people's desire to use bicycles in terms of facilities, infrastructure, security and comfort in Banjarbaru City. The logistic binomial regression modelling has been performed to investigate it based on the data from the respondents. Therefore, it is expected that with the identification of these factors, cycling activities will not only become a temporary activity for just hobbies and recreation, but cycling can also be used as a means of daily transportation.

II. METHODOLOGY

A. Dependent and Independent Variables

The data was taken from a questionnaire survey divided into two answers for the dependent variable, namely willingness (1) and reluctance (0). In contrast, the responses for the independent variables used a Likert scale. The questionnaire consists of 2 sets of questions. The first is the willingness to cycle with positive questions and options to answer on a Likert scale. The second one is a reluctance to cycle with negative questions and choices to answer in reverse order of the Likert scale being used in the first set. Modelling and analyzing data using the logistic binomial regression method with the help of IBM SPSS 25.0 Software. The independent variables are categorized into 5 groups of influence factors: human, facilities, environment, safety and comfort and distance factors. The correlation of dependent and independent variables is shown in Fig. 1. The list of independent variables can be seen in Table 1.

B. Data Collection Technique

To identify the factors that influence the willingness to use a bicycle, a quantitative study was conducted with data sources obtained from a random sample of 154 respondents from the population of Banjarbaru. Respondents consist of people of different ages, education, and occupation backgrounds. Data was collected by using a questionnaire survey. The research instrument applies a binomial answer of will (1) and not will (0) for the dependent variables and Likert Scale answer from 1 to 5 with scale values of 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree) for the independent variables respectively. The statements in the questionnaire were made to describe those 44 factors. Respondents must complete the entire list of questions in the questionnaire then return it to the researcher. Therefore, the total number of answers from the respondents is 308.

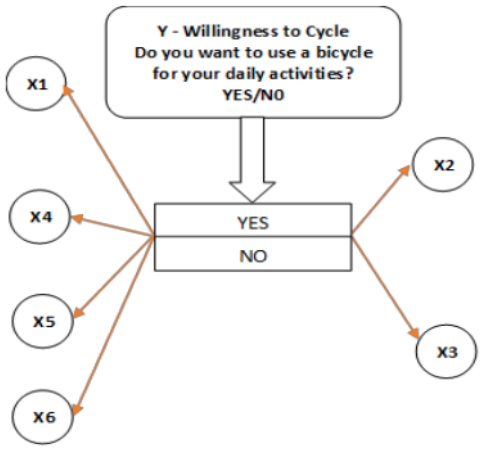

Fig. 1 Correlation of dependent and independent variables

Table 1. List of independent variables

HUMAN (X1)	regular daily cycling time available	X1.1
	bike price is affordable enough	X1.2
	a bicycle path connects the residence to a public place	X1.3
	not many places to go by bike	X1.4
	willing to ride a bicycle during the day	X1.5
	cycling only with a friend	X1.6
	no prestige (shy) for cycling	X1.7
	cycling if it saves travel time	X1.8
FACILITIES (X2)	smooth road route (no potholes)	X2.1
	CCTV available in crime-prone areas	X2.2
	enough road lighting for cycling at night	X2.3
	sufficient bicycle parking lots available	X2.4
	bike path in good condition	X2.5
	comfortable public bathroom available	X2.6
	bicycle signs available	X2.7
	bicycle rental in urban areas is available	X2.8
	a place to refill clean drinking water available	X2.9
	comfortable rest area available	X2.10
	wide dedicated bicycle lane available	X2.11
	dedicated bicycle crossing lanes available	X2.12
	bicycle repair shops available	X2.13
ENVIRONMENT (X3)	cycling only when the weather is sunny	X3.1
	cycling if the level of vehicle pollution is not high	X3.2
	cycling if not passing the crowds of pedestrians	X3.3
	cycling if the traffic is not too dense and not dangerous	X3.4
	lots of trees/green areas available	X3.5
	cycling if the terrain is flat	X3.6

SAFETY & COMFORT (X4)	cycling in Banjarbaru is quite safe from crime	X4.1
	cycling if it is safe from the risk of traffic accidents	X4.2
	cycling if the condition of the bike is comfortable to ride	X4.3
	cycling if bicycle safety equipment is adequate	X4.4
	cycling if free from the risk of harassment (verbal, physical)	X4.5
	bicycle parking is safe from theft	X.4.6
ACCESSIBILITY (X5)	bicycle paths do not interfere with pedestrians	X5.1
	bicycle routes integrated with public transport and P&R	X5.2
	bicycle lanes cover residential areas, offices and public places	X5.3
	the bike can be carried on the bus	X5.4
	short routes available to public places	X5.5
DISTANCE (X6)	willing to cycle with distance <500m	X6.1
	willing to cycle with distance 500m – 1000m	X6.2
	willing to cycle with distance 1000m – 2000m	X6.3
	willing to cycle with distance 2000m – 2500m	X6.4
	willing to cycle with distance 2500m – 5000m	X6.5
	willing to cycle with distance >5000m	X6.6

C. Binomial Logistic Regression Analysis

Decision making in the binomial logistic regression model is determined on a pair of discrete alternatives. The alternative to be chosen is the one that has the greatest utility. The utility, in this case, is seen as a random utility. Binomial logit, a logit model used to select two options, is often called a binary logit model. Binary logistic regression is a type of regression analysis where the dependent variable is a dummy variable (0 and 1) [8][11]0. Assumptions for a Logistic regression are that adequate sample size; absence of multicollinearity; no outliers; the statistic -2LogL (minus 2 times the log of the likelihood) is a badness-of-fit indicator (large numbers mean poor fit of the model to the data); and when taken from large samples, the difference between two values of -2LogL is distributed as chi-square 0.

It can be explained by the following equation:

$$ln\left[\frac{P}{1-P}\right] = a + b_1X_1 + \cdots + \ + b_nX_n$$

where $U = a + b_1X_1 + \cdots + \ + b_nX_n$

$$\frac{P}{1-P} = exp(a + b_1X_1 + \cdots + \ + b_nX_n)$$

$$P = \frac{exp(a + b_1X_1 + \cdots + \ + b_nX_n)}{1 + exp(a + b_1X_1 + \cdots + \ + b_nX_n)} = \frac{\exp(U)}{1 + \exp(U)}$$

Where: U_1 = utility function of choice 1

a, b_n = coefficients

X_n = utility factors

P_1 = probability of choice 1

In transportation studies, binomial logistic regression is frequently applied in transportation mode choice, for instance [13][14][15][16] and route choice [17][18][19]. However, not only limited to those utilizations, but it is also implemented for assessment of influencing factors, level of service, passengers '/users' perception, and decision in the selection of mode transports and parking. Some researchers reported the utilization of binomial logistic regression in cycling studies, for instance, for assessment of influence factors of user behaviour, infrastructure and perception in cycling [20], for analyzing important factors in cycling using panel data [21], for exanimating user characteristics of sharing bicycle trip [22], for evaluating factors affecting the tendency of bicycles use in a highly urbanized city [23] as well as cycling safety and cycling fatality [24][25].

D. Stages of Binomial Logistic Regression Analysis

The steps of analysis are described in Fig. 2. First of all, the data is collected from a questionnaire survey. Then the data is structured into pairs of independent variables (X_1 to X_j) and the dependent variable (Y) with all the answers symbolized in numerical values on an ordinal scale. And then, Binary Logistic Regression is performed in SPSS software. The important statistical indicators from the regression are R-Square, Percent Correct (Classification Table), and coefficients (B), Sig. (p-Value), odds-ratio (Exp B) from Variables in Equation table and Correction Matrix table. And then based on Sig. (p-value), each the significance of each variable X is assessed. The criterion is that variables with Sig. Less and equal to 0.05 is considered significant in the correlation to Y. Then, the X variables that are not significantly correlated with the Y variable are eliminated during the loop process until all the X variables fulfil the criterion. Last but not least, the final model is obtained, and then the Influence Factors are identified and analyzed its influence based on the coefficients (B) and odd-ratio (Exp B).

III. RESULTS AND DISCUSSION

The first iteration of binomial logistic regression of the complete variables can be seen in Table 2. From Table 2, it is found that there are 18 factors out of 44 factors that fulfil the criterion of Sig. or p-Value ≤ 0.05. This binomial regression model generates Nagelkerke R-square of 0.726 and an overall percentage correct estimation of 86.4%.

Next is to reduce the variables considered in a binomial logistic regression model to obtain the new model, which contains only the most significant factors. After 3 iterations, the final model is obtained, as shown in Table 3, from the value of Sig. It can be identified that all the selected factors

significantly influenced people's willingness to cycle. The final factors are slightly different from the results of the first iteration. The difference is that the X5.3 factor (bicycle lanes cover residential areas, offices and public places) is removed and replaced by the X4.1 factor (cycling in Banjarbaru is quite safe from crime).

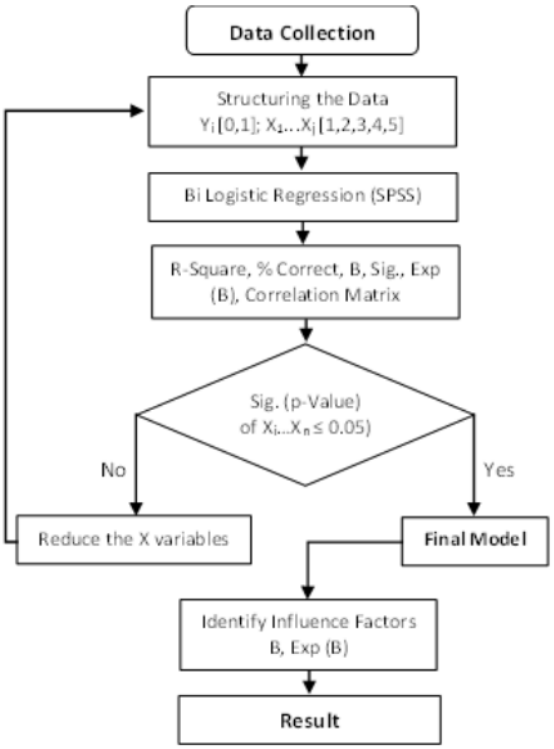

Fig. 2 Flowchart of analysis

Table 2. Complete result of analysis of influence factors of willingness to cycle

X	Description	B	Sig.	Exp(B)
X1.1	regular daily cycling time available	-0,114	0,723	0,892
X1.2	bike price is affordable enough	-1,257	0,000	0,285
X1.3	a bicycle path connects the residence to a public place	0,852	0,008	2,344
X1.4	not many places to go by bike	-1,095	0,001	0,334
X1.5	willing to ride a bicycle during the day	1,834	0,000	6,258
X1.6	cycling only with a friend	-0,253	0,361	0,777
X1.7	no prestige (shy) for cycling	-0,259	0,414	0,772
X1.8	cycling if it saves travel time	0,972	0,002	2,644
X2.1	smooth road route (no potholes)	-1,208	0,001	0,299
X2.2	CCTV available in crime-prone areas	1,169	0,004	3,220
X2.3	enough road lighting for cycling at night	0,140	0,688	1,151
X2.4	sufficient bicycle parking lots available	0,384	0,596	1,468
X2.5	bike path in good condition	0,413	0,616	1,511
X2.6	comfortable public bathroom available	-1,207	0,053	0,299
X2.7	bicycle signs available	2,041	0,017	7,702
X2.8	bicycle rental in urban areas available	0,346	0,465	1,414
X2.9	a place to refill clean drinking water available	-1,673	0,005	0,188
X2.10	comfortable rest area available	-2,190	0,007	0,112
X2.11	wide dedicated bicycle lane available	1,589	0,008	4,900
X2.12	dedicated bicycle crossing lanes available	-1,405	0,015	0,245
X2.13	bicycle repair shops available	0,652	0,238	1,919
X3.1	cycling only when the weather is sunny	-0,353	0,282	0,703
X3.2	cycling if the level of vehicle pollution is not high	0,283	0,453	1,327
X3.3	cycling if not passing the crowds of pedestrians	0,529	0,182	1,698
X3.4	cycling if the traffic is not too dense and not dangerous	0,668	0,039	1,950
X3.5	lots of trees/green areas available	0,989	0,022	2,689
X3.6	cycling if the terrain is flat	0,354	0,327	1,425
X4.1	cycling in Banjarbaru is quite safe from crime	-1,835	0,000	0,160
X4.2	cycling if it is safe from the risk of traffic accidents	0,104	0,757	1,110
X4.3	cycling if the condition of the bike is comfortable to ride	0,985	0,093	2,679
X4.4	cycling if bicycle safety equipment is adequate	0,627	0,088	1,871
X4.5	cycling if free from the risk of harassment (verbal, physical)	0,364	0,560	1,439

X	Description	B	Sig.	Exp(B)
X4.6	bicycle parking is safe from theft	-0,656	0,102	0,519
X5.1	bicycle paths do not interfere with pedestrians	-0,570	0,329	0,565
X5.2	bicycle routes integrated with public transport and P&R	0,802	0,088	2,231
X5.3	bicycle lanes cover residential areas, offices and public places	-1,328	0,019	0,265
X5.4	the bike can be carried on the bus	0,967	0,013	2,631
X5.5	short routes available to public places	-1,250	0,015	0,286
X6.1	willing to cycle with distance <500m	0,430	0,355	1,537
X6.2	willing to cycle with distance 500m – 1000m	0,060	0,930	1,062
X6.3	willing to cycle with distance 1000m – 2000m	-0,839	0,205	0,432
X6.4	willing to cycle with distance 2000m – 2500m	1,473	0,008	4,363
X6.5	willing to cycle with distance 2500m – 5000m	0,392	0,578	1,480
X6.6	willing to cycle with distance >5000m	-0,386	0,524	0,680
a	Constant	-4,332	0,002	0,013

The final model depicts the most significant factors, consisting of 5 factors of humans, 7 factors of facilities, 2 factors of environment, 1 factor of safety and comfort, 2 factors of accessibility and 1 factor of distance. This final model generates a Nagelkerke R-square of 0.618. The r-square is slightly reduced from the first model. However, the percentage correct of the final model is still quite acceptable (80.8%).

Table 3. The significant influence factors of willingness to cycle

X	Description	B	Sig.	Exp(B)
X1.2	bike price is affordable enough	-1,092	0,000	0,336
X1.3	a bicycle path connects the residence to a public place	0,527	0,011	1,694
X1.4	not many places to go by bike	-0,919	0,000	0,399
X1.5	willing to ride a bicycle during the day	1,378	0,000	3,965
X1.8	cycling if it saves travel time	0,898	0,000	2,455
X2.1	smooth road route (no potholes)	-0,672	0,004	0,510
X2.2	CCTV available in crime-prone areas	0,712	0,005	2,038
X2.7	bicycle signs available	1,672	0,006	5,323
X2.9	a place to refill clean drinking water available	-1,006	0,011	0,366
X2.10	comfortable rest area available	-1,291	0,007	0,275
X2.11	wide dedicated bicycle lane available	1,096	0,005	2,993
X2.12	dedicated bicycle crossing lanes available	-1,008	0,006	0,365
X3.4	cycling if the traffic is not too dense and not dangerous	0,742	0,001	2,099
X3.5	lots of trees/green areas available	0,839	0,002	2,314
X4.1	cycling in Banjarbaru is quite safe from crime	-1,624	0,000	0,197
X5.4	the bike can be carried on the bus	0,794	0,004	2,212
X5.5	short routes available to public places	-1,066	0,001	0,344
X6.4	willing to cycle with distance 2000m – 2500m	0,728	0,000	2,071
a	Constant	-1,994	0,019	0,136

The next step is to define the probability function of binomial logistic regression, which can be seen as follow:

$$U_1 = -1.99 - 1.09X_{1.2} + 0.53X_{1.3} - 0.92X_{1.4} + 1.38X_{1.5} + 0.89X_{1.8} - 0.67X_{2.1} + 0.71X_{2.2} + 1.67X_{2.7} - 1.00X_{2.9} - 1.29X_{2.10} + 1.09X_{2.11} - 1.00X_{2.12} + 0.74X_{3.4} + 0.84X_{3.5} - 1.62X_{4.1} + 0.79X_{5.4} - 1.07X_{5.5} + 0.73X_{6.4}$$

$$P_1 = \frac{\exp(U_1)}{1 + \exp(U_1)}$$

Where: U_1 = utility function of choice 1 (willingness)
$X_{i,j}$ = influenced factors
P_1 = probability of choice 1 (willingness)

The changes of probabilities based on different values of X variables, which are ranged from 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree) and the coefficient B can be seen in the Fig. 3.

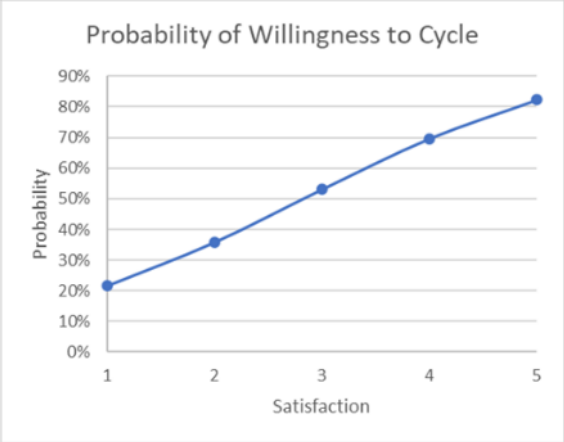

Fig. 3 Probability of willingness to cycle

Seeing from the Exp (B) value in Table 3, among the human factors, the X1.5, X1.8 and X1.3 factors respectively have the greatest value, which shows that people are willing to cycle during the day, if it saves travel time and if a bicycle path connects the residence to public places. Among the facilities factors, the X2.7, X2.11, and X2.2 factors have the greatest value, which shows that people are willing to cycle if bicycle signs are available, if wide dedicated bicycle lane available, and CCTV is available in crime-prone areas. Meanwhile, from the environmental factors, people want to cycle if cycling if the traffic is not too dense and not dangerous and lots of trees/green areas are available. Respectively for safety and comfort factors, people expect that cycling in Banjarbaru is quite safe from crime. However, seeing from the negative sign of B coefficient of this variable X4.1 demonstrates that people feel that cycling in Banjarbaru is not quite safe from their perspective. Seeing from accessibility factors, people are willing to cycle if the bike can be carried in the bus and if short routes are available to public places. Last but not least, according to the distance factor, people are mainly willing to cycle in the short distance between 2000m and 2500m.

IV. CONCLUSION

Cycling activities in the City of Banjarbaru is still very lacking. Based on this study, it is found that 18 significant factors influence people's willingness to cycle in Banjarbaru. The three most significant human factors are cycling during the daytime, travel time saving and bicycle path connection from residence to public places. The three most important facilities factors are bicycle signs, bicycle lanes and CCTVs located in crime-prone areas. Of the environmental factors, the most important factors are the density of traffic and the existence of trees/green areas. For safety and comfort factors, safer condition from crime is demanded.

Nevertheless, from the people's perspective, the safety condition for cycling in Banjarbaru needs to be improved. Seeing from accessibility factors, the convenience of bringing a bicycle to public transport and short routes to public places are required. Last but not least, a short distance between 2 and 2.5 km is favourable for cycling in Banjarbaru. At the current condition in Banjarbaru, it is estimated that the probability of people's willingness to cycle is only around 21%. When all the most important factors above mentioned are fulfilled, the probability of people to cycle can be increased up to 70%.

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GENERAL COMMENTS

Instructor

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