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Availability Model of Bicycle Path Due to the Perception of Cyclist or non-Cyclist in East Java Province of Indonesia

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ABSTRACT

The understanding of cyclist characteristic and transportation availability of bicycle path are as initial step towards sustainable transport. Malang was as student city, so there is very important to study about economical social characteristic (ESCh), traveling characteristic of cyclist (TCh) and non cyclist, and availibility model of bicycle path dua to the perception of cyclist and non cyclist (PBP). This study intended: 1) to investigate ESCh, bicycle ownership (BO), TCh, and PBP; 2) to observe how far ESCh variable affect PBP; and then 3) to build the perceptional model of bicycle path for cyclist and non cyclist. Location of study included Malang, Jember, Lamongan, and Tulungagung. By randomly interviewing of 934 respondents and using the Structural Equation Modeling (SEM) and Partial Least Square (PLS), results showed that 1) ESCh variable was very dominant and education was as the very significant influenced indicator of ESCh; 2) moving aim was as very significant influenced indicator of PPS and moving aim included the activity to work location and pcking up children to school; and 3) perception model of PBP (cyclist) = 0,731 ESCh + 0,099 BO + 0,039 TCh (R^2=0,634) and PBP (non cyclist) = 0,385 ESCh + 0,411 BO + 0,891 TCh + 0,064 MVO (R^2=0,854). The results can be used as the consideration of local government to be able to build special path for cyclist in order to decrease air pollution.

Keywords: economical social characteristic (ESCh), traveling characteristic (TCh), bicycle ownership, bicycle lane, cyclist perception, non cyclist, Structural Equation Modeling (SEM), Partial Least Square (PLS)

INTRODUCTION

Traffic pattern of Indonesia mainly in East Java Province are generally as the mix traffic between motor and non motor vihicle, and the same vihicles such as motor cycle, public car, bus, and truck which all of them are in the same path and not separated path. This condition happens in city as well as among the cities and cause a possibility to create the variety of velocity, vihicle manuver pattern, and it will build the potency of accident . Nowadays, the usage of bicycle as a friendly environment transportation tool and supporting the healthy is nacessary to be consideration again. Bicycle has recreational value and may also be used by anyone as transportation tool suvh as to go working or learning to school by student. Laws of Indonesia No. 22 of 2009 about traffic and road transportation has regulated non motor vehicle. In this law, government has to give ease for bicycle traffic. Cyclist has a supported facilities right of secure, orderly, and smoothy on trafficing. In addition, local government can determine the usage type of non motor vehicle in their region due to the characteristic and regional demand. Therefore, in determining design of bicycle path, it is nacessary to know about the characteristic of cyclist in the stusy location. Then it eas also menrtioned that motor driver in road way obliged to emphasize the secure of walking people and cyclist.

Moda of bicycle is as an accurate solution in solving motor burning material (fuel) price which has unstable trend and causes environmental problem of air pollution and traffic stucking. Rapid development of transportation technology and demand give an impact for cyclists are less. In addition, cyclists with low speed is assumed to disturb the motor users.Cyclists are frequently accepting the discriminative treatment drom the motor users when thet drive together in the road. Generally, cyclists are as low income of society group because not the whole people can have or enjoy car and the other kind of motor. According to Tamin Raad [1], most of society have low income in the developed countries and more than half of them walk and the other using public transportation or non motor trnasportation like bicycle. Based on the initial observation, on the peak hour (morning time), there are more cyclist from boundary area towards city centre for working as employer, labourer as well as student that goes to school. The cyclists also need mobility and they are not naturally discarded and missing of right to move in road. Therefore, the suitable facility which can give secure and does not cause conflict with motor vehicle is very needed by the cyclists. Some researchs about bicycle path have been carried out in Bandung, Jogjakarta, and Semarang, but almost all of the researchs have not solved the demand and supply the bicycle main path.

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The understanding about cyclist characteristic and transportation availability like bicycle path are just as initial step towards sustainable transport. Government support by supplying bicycle path has a chance to increase the quantity of cyclists, to decrease the noisy and air pollution, and it can guarantee the secure, orderly, and smoothy of traffic. Therefore, it is needed the study about usage characteristic, bicycle moving, and investigation of bicycle path availability due to the perception of cyclist and non cyclist in East Java Province.

MATERIALS AND METHODS

Location of study included Malang, Jember, Lamongan, and Tulungagung. Primary data was used in this study and it was directly obtained by distributing questionaire to respondents. Method of finding sample was probability sampling by using simple randomly sampling therough the purposive approach. The methodology of this study was as follow:

1. To prepare questionaire as the tool or instrument of research.
2. To carry out dESCHhriptive analysis.
3. To control the validity and reliability of questionaire by using Confirmatory Factor Analysis (CFA) in order to be able to measure the validity and reliability of research variables.
4. Analysis of Structural Equation Modeling (SEM) by using Partial Least Square (PLS) with the steps were as follow:
   - Test of autor model that included:
     - Vailidity test by using: a) convergent validity, this value can be seen from loading factor result, the indicator is valid if the value > 0.5; b) discriminant validity, this value can be seen from cross loading result, the indicator is valid if the value of each indicator in measuring constructive variable dominantly higher than the other constructive variable
     - Reliability test by using: a) composite reliability, constructive variable is rleiable if the value > 0.6; b) AVE, constructive variable is reliable if the value of AVE > 0.5
   - Inner Model
     Test of result can be seen from the value of inner weight which carries out the test of research hypothesis and the goodness of fit of model. Model can be expressed to have gooness of fit if the value of R-Square > 0.

Characteristic

Characteristic is as the psychologies, morals or natural ability which differentiates a person to another like character, nature, and special character. Characteristic has special quality due to the certain characteristic [2]

- Characteristic of economic social
  Economic socisl characteristic of cyclist has influence in bicycle ownership, characteristic of traveling, and behaviour of cyclist. Characteristic of economic socisl in this study included age, sex, education, type of work, income, bicycle ownership, and number of bicycle.
- Characteristic of moving
  Characteristic of moving depends on human demand for moving from one place to another. Moving in city has some characteristics that are the same although every city in some countries generally are different in tipology and morphology. This characteristic is the base principle which becomes as the reference point of transportation study [1]. In the relation with bicycle traveling, generally in developed country, traveling with bicycle was carried out by the poor society which is captive to the moda, especially it is carried out to work, while in advanced country, the usage of bicycle is carried out as the baiter of society public transport [3].
- Perception of cyclist to the bicycle lane
  Perception is meant as direct response (acception) from a process that a [person knows something through fie senses [2], but according to Indonesian Wikipedia, perception is a process when an individu regalate and interpretate sensor traces in giving meaningful for the environment. Individual behaviour is often based on the perception about reality and not on the reality itself (http://id.wikipedia.org/wiki/).

Response or perception due to the availability of bicycle path is very influenced by personal or individual characteristic. It means that when somebody gives response to something, it is certainly very close with the behaviour or character condition. Generally, perception is based on the individual experience such as bicycle path as in this study.

Structural Equation Modelling(SEM) with Partial Least Square (PLS)

Structural Equation Modelling (SEM) is one of the multi-variate methods which is allowed the researcher to test the relation among complex variables. SEM is as integrated approach among factor analysis, structural model, and path analysis. SEM is also mentioned as co-variant Structure Model or LISREL Model (Linear

Structural Relationship) [4]. In addition, SEM is also as integrated approach between data analysis and conceptual construction. In structural model, there is known two variables such as exogyn and endogyn. Exogyn variable is a variable with the value is determined outside the model such as dependent and instrument variable. By the available limitation, because the assumption of sample quantity is big, data has to be multi-variate normally distributed, indicator has to be in reflective form, model has to be based on theory and by being available of indetermination, so now there are some persons use SEM based on the component or variance of Partial Least Square (PLS).

Partial Least Square (PLS) is a multi-variate statistical technique which can solve some respon and explanatory variables as well as PLS is as a good alternative for analysis method of doublr regression and main component regression because PLS method is more ribust. It means that parameter of model is more changed when new sample is taken from total of population [5]. At first, PLS was developed in 1960 by Herman O. A. Wold in econo-metric field. PLS is as a predictive technique which can solve more independent variable even though there happens multi-co-lineality among the variables [6].

Analysis of multi regression can be used when there are more predictor variables. Therefore if the variables are more over such as more than observation number, it can be obtained model that fits with sample data but it will fail to predict new data. This phenomenon is called as overfitting. In this case, although there are manifested variables, there may be only less latent variable that can explain the variation in response. The base idea of PLS is to extract the latent factors which explain the manifested variable as more as possible when modelling the respon variables.

PLS is as free distribution, it means that it does not assume the data is in the certain distribution, it can be as nominal, category, ordinal, interval, and ratio. In the beginning, PLS is given the name of NIPLAS (nonpathar iterative least square). According to Wold [7], NIPALS is more general than the other approach especially maximum likelihood because it worBO with a little number of assumption., zero intercorrection among residual variable. Therefore, NIPALS approach gives model which has closer fit to observation result. Base model of PLS has been finished in 1977 [7].and then it was developed by Lohmoller [8][9] and Chin *et.al.* [10] in the form of SmartPLS software.

RESULTS AND DISCUSSION

Analysis of data included descriptive statistic, validity, and reliability, and model of structural equation for perception of bicycle lane provision (PBP) for cyclist and non cyclist. Detailly, it was presented as follow:

Validity and Reliability

Validity test intended to know how far the questions in questionaire are representative enough. Validity test was carried out by using analysis of confirmatory factor in each latent ariable such as economic social characteristic (ESCh) and traveling characteristic (TCh), and Perception of bicycle lane provision (PBP) through SmartPLS.

- **Convergent Validity**

  Measuring model test through loading factor was carried out for knowing indicator validity by seeing the convergent validity value of the indicators in model. Each indicator in model had to be more than 0.5. Table 1 and 2 presented convergent validity on ESCh, TCh, and BO of Bootstrap sample of cyclist and non cyclist.

Table 1 Convergent Validity on ESCHH, TC, and BO Boptstrap Sampel (B=500) of Cyclist

Variable	Indicator	Cyclist		
		Loading original	Bootstrap B=500 loading	T-test
Economic social characteristic (ESCh)	age (X1.1)	0.711	0.713	36.511
	sex (X1.2)	0.774	0.775	102.055
	work (X1.3)	0.902	0.902	184.015
	income (X1.4)	0.866	0.866	172.725
	education (X1.5)	0.926	0.926	208.022
Traveling characteristic (TCh)	time of pass (X3.1)	0.867	0.867	111.132
	distance (X3.2)	0.945	0.945	348.473
	rutinity (X3.3)		0.678	31.004
Perception of bicycle lane provision (PBP)	Moda move to motor cycle if income has increased (Y1), remain using bicycle if there was available main path (Y2)	0.958	0.958	185.391
		0.956	0.956	174.959

Table 2 Convergent Validity on ESCh, TCh, and BO Bootstrap Sampel (B=500) of Non Cyclist

Variable	Indicator	Non Cyclist		
		Loading original	Bootstrap B=500	
			loading	T-test
Economic social characteristic (ESCh)	age (X1.1)	0.967	0.967	488.104
	sex (X1.2)	0.861	0.860	67.619
	work (X1.3)	0.942	0.942	275.048
	income (X1.4)	0.902	0.902	305.185
	education (X1.5)	0.958	0.958	270.520
Traveling characteristic (TCh)	traveling aim (X4.1)	0.939	0.939	176.734
	Time of travel (X4.2)	0.900	0.899	90.897
	distance (X4.3)	0.918	0.917	94.161
	time starting activity (X4.4)	0.891	0.892	55.094
	rutinity (X4.5)	0.912	0.912	149.990
Perception of bicycle lane provision (PBP)	secure (Y1)	0.616	0.615	20.968
	safe (Y2)	0.768	0.767	40.265
	orderly (Y3)	0.854	0.854	69.489
	smoothy (Y4)	0.904	0.904	177.858
	comfortability (Y5)	0.908	0.908	201.586

Discriminant Validity

Test of discriminant validity intends to investigate the validity of indicator block. Test of discriminant validity to indicator can be seen on the cross loadings between indicator and construct. AVE intends to determine that construct variable has good discriminant validity. AVE is satisfy if the value > 0.5. Test result of AVE was presented as in Table 3 below.

Table 3 Discriminant Validity of ESCHH, TC, PPS

Variable	Value	
	Average Variance Extracted	
	Bycicle	Non Bicycle
Economic social characteristic (ESCh)	0.705	0.859
Traveling characteristic (TCh)	0.701	0.832
Availability perceptioan of bicycle path (PBP)	0.912	0.668

Test of reliabilitas intends to investigate the reliability of construct variable by using composite reliability. Composite reliability is satisfy if the value > 0,6. Value result of composite reliability was presented as in Table 4. It indicated that all of indicator block that measure the beginning construct of Economic social characteristic (ESCh), Traveling characteristic (TCh) and Perception of bicycle lane provision (PBP) had composite reliability > 0.6.

Table 4 Composite Reliability of ESCHH, TC, PPS

Variable	Value	
	Average Variance Extracted	
	Cyclist	Non Cyclist
Economic social characteristic (ESCh)	0.922	0.968
Traveling characteristic (TCh)	0.874	0.961
Perception of bicycle lane provision (PBP)	0.954	0.908

Model of Structural Equation

Test of structural model (Inner Weight) was showed through the result of structural path coefficient. Result of structural path coefficient (Inner Weight) and completed significant value of cyclist and non cyclist was presented as in Table 5 and 6 below.

Table 5 Inner weight test on perception of bicycle lane provision (PBP) with bootstrap sample of cyclist

Influence of variable	Original coeff	(Bootstrap B=100)		(Bootstrap B=200)		(Bootstrap B=300)		(Bootstrap B=500)	
		coeff.	t-Test	Coeff.	t-Test	Coeff.	t-Test	Coeff.	t-Test
Economic social characteristic (ESCh) → Perception of bicycle lane provision (PBP)	0.731	0.703	3.876	0.719	5.480	0.734	6.967	0.731	13.252
Bicycle ownership (BO) → Perception of bicycle lane provision (PBP)	0.097	0.101	1.674	0.096	2.160	0.099	2.663	0.099	4.877
Traveling characteristic (TCh) → Perception of bicycle lane provision (PBP)	0.039	0.066	0.199	0.051	0.281	0.035	0.358	0.039	3.001

Table 5 Inner weight test on perception of bicycle lane provision (PBP) with bootstrap sample of non cyclist

Influence of variable	Orginal coeff.	(Bootstrap n=100)		(Bootstrap n=200)		(Bootstrap n=300)		(Bootstrap n=500)	
		coeff.	t-Test	Coeff.	t-Test	coeff.	t-Test	coeff.	t-Test
Economic social characteristuc (ESCh) → Perception of bicycle lane provision (PBP)	0.384	0.389	2.827	0.387	4.159	0.378	5.150	0.385	7.003
Motor vehcle ownership (MVO) → Perception of bicycle lane provision (PBP)	0.065	0.060	1.417	0.063	2.272	0.064	2.625	0.064	3.506
Bicycle ownership (BO) → Perception of bicycle lane provision (PBP)	0.408	0.422	4.554	0.418	6.489	0.410	7.945	0.411	10.655
Traveling characteristic (TCh) → Perception of bicycle lane provision (PBP)	0.889	0.896	8.762	0.895	11.994	0.897	15.085	0.891	20.084

After being carried out the test of validity and reliability on the whole latent variables, then it was controlled by SmartPLS program. Validity and reliability test of bootstrap sample (B = 500) indicated significant result. Test result of complete model as above by using SmartPLS program could be seen from R-Square value which illustrated goodness of fit of a model. Recommended R-Square value was more than zero. Table 7 presented R-Square of research result due to SmartPLS program.

Table 7 Goodness of Fit of R-Square

Respons variable	R-Square	
	Cyclist	Non Cyclist
Perception of bicycle lane provision (PBP)	0.634	0.854

Table 7 presented that support or proportion of economic social characteristic (ESCh), bicycle ownership (BO), and traveling characteristic (TCh) in explaining the variation surround the variable of Perception of bicycle lane provision (PBP) for cyclist was 0.634 0r 63.4 %, but for non cyclist was 0.854 or 85.4 %.

Structural equation for the perception of cyclist and non cyclist was as follow:

PBP Cyclist = 0,731 ESCh + 0,099 BO + 0,039 TCh

PBP Non Cyclist = 0,385 ESCh + 0,064 MVO + 0,411 BO + 0,891 TCh

Table 8 presented test of path coefficient on the perception of cyclist.

Table 8 Test result of path coefficient on bicycle path availability perception model of cyclist

Variable	Coefficient	T-statistic	T table	Note
Economic social characteristic (ESCh) → Aailability perception of bicycle path (PBP)	0.731	13.252	1.96	Significant
Bicycle ownership (BO) → Perception of bicycle lane provision (PBP)	0.099	4.877	1.96	Significant
Traveling characteristic (TCh) → Perception of bicycle lane provision (PBP)	0.039	3.001	1.96	Significant

Table 8 showed that inner weight between the variables were as follow:

- Economic social characteristic (ESCh) had positive and significant influence to the perception of bicycle lane provision (PBP). It was indicated from positive path coefficient of 0.731 with T-statistic value of 13.252 which was more than T-table of 1.96. Therefore, economic social characteristic (ESCh) directly influenced perception of bicycle lane provision (PBP) of 0.731, it meant that every increaning of economic social characteristic (ESCh) would increase the perception of bicycle lane provision (PBP) of 0.731.
- Bicycle ownership (BO) had positive and significant influence to the perception of bicycle lane provision (PBP). It was indicated from positive path coefficient of 0.099 with T-statistic value of 4.877 which was more than T-table of 1.96. Therefore, bicycle ownership (BO) directly influenced perception of bicycle lane provision (PBP) of 0.099, it meant that every increasing of bicycle ownership (BO) would increase the perception of bicycle lane provision (PBP) of 0.099

- Traveling characteristic (TCh) had positive and significant influence to the perception of bicycle lane provision (PBP). It was indicated from positive path coefficient of 0.039 with T-statistic value of 4.877 which was more than T-table of 1.96. Therefore, traveling characteristic (TCh) directly influenced perception of bicycle lane provision (PBP) of 0.039, it meant that every increasing of traveling characteristic (TCh) would increase the perception of bicycle lane provision (PBP) of 0.039

Table 9 presented test of path coefficient on the perception of non cyclist.

Table 9 Test result of path coefficient on bicycle path availability perception model of non cyclist

Variable	Coefficient	T-statistic	T-table	Note
Economic social characteristic (ESCh) → Perception of bicycle lane provision (PBP)	0.385	7.003	1.96	Significant
Motor vehicle ownership (MVO) → Perception of bicycle lane provision (PBP)	0.064	3.506	1.96	Significant
Bicycle ownership (BO) → Perception of bicycle lane provision (PBP)	0.411	10.655	1.96	Significant
Traveling characteristic (TCh) → Perception of bicycle lane provision (PBP)	0.891	20.084	1.96	Significant

Table 9 showed that inner weight between the variables were as follow:

- Economic social characteristic (ESCh) had positive and significant influence to the perception of bicycle lane provision (PBP). It was indicated from positive path coefficient of 0.385 with T-statistic value of 7.003 which was more than T-table of 1.96. Therefore, economic social characteristic (ESCh) directly influenced perception of bicycle lane provision (PBP) of 0.385, it meant that every increasing of economic social characteristic (ESCh) would increase the perception of bicycle lane provision (PBP) of 0.385
- Motor vehicle ownership (MVO) had positive and significant influence to the perception of bicycle lane provision (PBP). It was indicated from positive path coefficient of 0.064 with T-statistic value of 3.506 which was more than T-table of 1.96. Therefore, motor vehicle ownership (MVO) directly influenced perception of bicycle lane provision (PBP) of 0.064, it meant that every increasing of motor vehicle ownership (MVO) would increase the perception of bicycle lane provision (PBP) of 0.064
- Bicycle ownership (BO) had positive and significant influence to the perception of bicycle lane provision (PBP). It was indicated from positive path coefficient of 0.411 with T-statistic value of 10.655 which was more than T-table of 1.96. Therefore, bicycle ownership (BO) directly influenced perception of bicycle lane provision (PBP) of 0.411, it meant that every increasing of bicycle ownership (BO) would increase the perception of bicycle lane provision (PBP) of 0.411
- Traveling characteristic (TCh) had positive and significant influence to the perception of bicycle lane provision (PBP). It was indicated from positive path coefficient of 0.891 with T-statistic value of 20.084 which was more than T-table of 1.96. Therefore, traveling characteristic (TCh) directly influenced perception of bicycle lane provision (PBP) of 0.891, it meant that every increasing of traveling characteristic (TCh) would increase the perception of bicycle lane provision (PBP) of 0.891

CONCLUSION

Based on statistical analysis as above, it could be concluded as follow: 1) For cyclist: the variable of economic social characteristic (ESCh), bicycle ownership (BO), and traveling characteristic (TCh) very influenced the perception of bicycle lane provision and ESCh variable was very dominat, but indicator that very influenced ESCh variable was education with the value of 92.6 %, it meant that the more increasing of educational status would cause cyclist had more conciousness to maintain environmental continuity by using non pollusion vehicle like bicycle and it needed the availibility of bicycle path for the safe and secure; 2) For non cyclist: the dominant variable of traveling characteristic (TCh) was moving aim with the value of 93.9 %, it meant that moving aim of non cyclist very influenced perception of bicycle lane provision (PBP). The moving intended for activity to work place and picking up children to school. Therefore, the availability of bicycle path was percepted would cause the traffic was better; and 3) Model of perception of cyclist (PBP) was 0,731 ESCh + 0,099 BO + 0,039 TCh (R^2=0,634) and PBP for non cyclist was 0,385 ESCh + 0,411 BO + 0,891 TCh + 0,064 MVO (R^2=0,854)

SUGGESTION

For cyclist, if local government prepares bicycle path, by more increasing of educational level will increase the attention of environment so that they will be remained for bicycling although their income have

increased and have the ability of buying motor cycle. Thus for non cyclist, they express willing to bicycling when they start working in the morning although there is far distance, they will feel secure, safe, orderly, smooth, and comfortable if there is available bicycle path. Therefore, it is suggested to goverment for immediately building the path especially for bicycle with separated line of permanent concrete marca in the available road body, but it is followed by the usage limitation policy of private motor vehicle like road tax, fuel tax, expensive parking rate, etc.

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