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EVALUATION OF THE PROVISION OF SPECIFIC BICYCLE LANES IN THE MALANG CITY

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ABSTRACT

Even though special bicycle lanes have been provided, there are still many obstacles that make the provision of these lanes ineffective. Problem parking vehicles in bicycle lanes, as well as the lack of awareness of motorists who use special bicycle lanes, can threaten the safety of their users. Based on the results of the analysis using the IPA (Importance Performance Analysis) method, it is known that the highest service suitability level includes attractive bicycle path designs, harmonious land use and vegetation, and green or white colors on the bicycle lane symbol. The IPA method is divided into four quadrants where quadrant one has low satisfaction while the level of importance is high. There are signs for cyclists, command and prohibition signs, street lighting, backrests that allow bicycles to be locked, cyclists are prioritized over motorists, and height and pavement materials are safe for cyclists, therefore improvements need to be made to create special lanes a bicycle that can bring a sense of security and comfort to the user.

Keywords: *Bike Lane; Importance Performance Analysis Method; Evaluation*

1. Introduction

Complex problems due to the ever-evolving transportation, such as congestion that causes wasteful use of fuel, air and noise pollution which has an impact on reducing the quality of life caused by vehicle exhaust emissions, as well as the increasing occurrence of accidents on the highway. The losses from these problems have a major impact on economic and social problems [1].

One effort to reduce losses arising from problems on the highway requires a solution by implementing environmentally sustainable transportation (Environmentally Sustainable Transport). One of the components of sustainable urban transport in Transportation Demand Management (TDM) is maximizing the efficiency of the urban transportation system through unnecessary restrictions on private vehicles and encouraging more effective, healthy and environmentally friendly modes of transportation such as public transport and non-motorized vehicles such as bicycles [2]. Based on Putro's research, stated that one of the Smart City concepts implemented in Malang City is the application of Clean Transportation, which means reducing the use of motorized vehicles and replacing them with bicycles and the use of public transportation [3].

The physical characteristics of bicycles, which are different from those of motorized vehicles, require different levels of security and comfort from motorized vehicle drivers. Moreover, the conflict over the use of road space that occurs seems to be won by motorized vehicles, and this indicates that there is discrimination in the rights (right of way) of cyclists. Based on research conducted by Pulangasih, et al, cyclists experience discrimination where in D.K.I. Jakarta (as the study area), including signs that block bicycle lanes, then bicycle lanes are not feasible and there are bicycle lanes that are blocked by construction [4], and this certainly does not happen to motorized vehicle lanes in general. Even though special bicycle lanes have been provided, there are still many

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problems encountered so that rovision of these lanes becomes ineffective. Some of the problems include bicycle lanes being used for selling, parking, or the large number of motorized vehicles entering the lane making it dangerous for cyclists to pass through.

This statement is supported by research conducted by Apriastini, et al and Lazuardi, et al, where it was stated that accidents that occurred in big cities (in his research the City of Surabaya) involved 2 or more types of vehicles [5] and the most types of accidents were side and rear crashes [6]. Therefore, this study aims to analyze the level of user satisfaction for special bicycle lanes in Malang City using the IPA (Importance Performance Analysis) method so that all deficiencies can be used as an evaluation in order to create special bicycle lanes that are able to provide a sense of security and comfort for users.

This research is a continuation of previous research related to bicycle use in urban areas, studied by Musyafir Tajuddin and Baharuddin Wunas Hamzah in 2012 [2], to Nika Devi Permata Wijaya in 2018 [1], which examined priorities for the safety of cyclists in urban areas. Blitar, Malang and Surabaya. support the research conducted by Setiyono in implementing Green Infrastructure in Malang City Square, one of which is the determination of the green route concept to encourage people to walk and cycle [7].

2. Methods

2.1 Flow chart of research

The first step is to conduct a literature review that supports this research with predetermined objectives. Setting goals is expected to sharpen the desired results and not deviate from the discussion. After the first step is completed, it is followed by observations in the field to obtain data and make direct observations of special bicycle lanes as the object of research.

Primary data acquisition is obtained by distributing questionnaires to cyclists. While the secondary data, namely the general description of the study area, was obtained from the Regional Development Planning Agency (BAPPEDA) and special bicycle lane routes were obtained from the Road Traffic and Transportation Agency (DLLAJ).

Then primary data (questionnaire results), tested using validity and reliability tests, before being used in the Importance Performance Analysis (IPA) method. Secondary data is also processed and used as research support material. The next step is the results of data processing are analyzed and discussed and conclusions are drawn that will answer the objectives of the research. Obstacles and input can be included in suggestions with the aim of advancing and improving further research.

2.2 Number of samples

The population of this study is cyclists in the city of Malang, so there is no definite population limit, so the Cochran Equation is used [8]:

$$n = \frac{pq\ Z^2}{e^2} \quad (1)$$

Equation description :

n = Number of samples required
p = 50% chance of being right
q = 50% chance of being wrong
Z = The required confidence level in the sample is 95%.
e = Tolerable Margin of Error

The confidence level used is 95% and is obtained from the Z value table of 1.96. The total sample size in this study is as follows:

$$n = \frac{0{,}5\ x\ 0{,}5\ x\ 1{,}96^2}{0{,}1^2}$$
$$= 96{,}04\ responden$$

Based on these calculations, the minimum number of samples that must be used in research is 97 respondents.

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2.3 Validity Test

To test the validity of the instrument, the Product moment equation is used [9]. The instrument is said to be valid if the correlation value between each variable with a total score is ≥ 0.3 The following is the product moment equation:

$$r_{xy} = \frac{n\sum x_i y_i - (\sum x_i)(\sum y_i)}{\sqrt{(n\sum x_i^2 - (x_i)^2)(n\sum y_i^2 - (y_i)^2)}} \quad (2)$$

Equation description :
r_{xy} = Correlation coefficient
n = Number of respondents
Σx = The total score of the items
Σy = The total score
Σx^2 = The sum of the squares of the item scores
Σy^2 = The sum of the squares of the total score
Σxy = Total multiplication score

2.4 Reliability Test

To test the reliability of the instrument, the Cronbach's Alpha equation is used. Reliability testing can be measured by looking at the value of r_{11} and can be categorized in the table below. The following are the relationship level categories for the reliability test and the Cronbach's Alpha equation:

Table 1. Interpretation of the Correlation Coefficient

Coefficient Intervals	Relationship Level
0,00-0,199	Very low
0,20-0,399	Low
0,40-0,599	Currently
0,60-0,799	Strong
0,80-1,000	Very strong

Source : Ghozali, 2018 [9]

$$r_{11} = \left[\frac{K}{K-1}\right]\left[1 - \frac{\sum\sigma_b^2}{\sigma_T^2}\right] \quad (3)$$

Equation description :
r_{11} = Instrument reliability
$\sum\sigma_b^2$ = Number of item variances
K = The number of instrument items
$\sum\sigma_t^2$ = Total variance

2.5 Importance Performance Analysis Method

This method serves to present the correlation between satisfaction and the importance of using special bicycle lane user variables in Malang City, as well as user ratings of variables that have low performance values.

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In general, the IPA Importance Performance Analysis method needs to pay attention to several things, namely:

a. The scale used in weighting. The type of scale used in this study is the Likert Scale which is based on the beliefs/opinions/values given by respondents to the variables being assessed.

Table 2. Satisfaction and Importance Level Scale

Scale	Satisfaction Level	Importance Level
1	Very Dissatisfied	Very unimportant
2	Not satisfied	Not important
3	Less satisfied	Not too important
4	Satisfied	Important
5	Very satisfied	Very important

The Likert scale is used in the Importance Performance Analysis method with each weight. The three to five alternative models of the Likert scale are arranged in the form of a statement and the number chosen by the respondent becomes a scale. The basic principle of the Likert Scale is to determine the position of respondents in a continuum of attitudes toward variables, which are negative to positive [10]. This study uses a Likert Scale of 5 scales to describe the level of importance and satisfaction of the variables being assessed.

b. The level of conformity of each variable, related to the satisfaction and interests of the respondents describes the level of conformity between one respondent and another.

c. Cartesian diagram. In the Importance Performance Analysis method, the diagram is divided into 4 parts and has meaning in each quadrant.

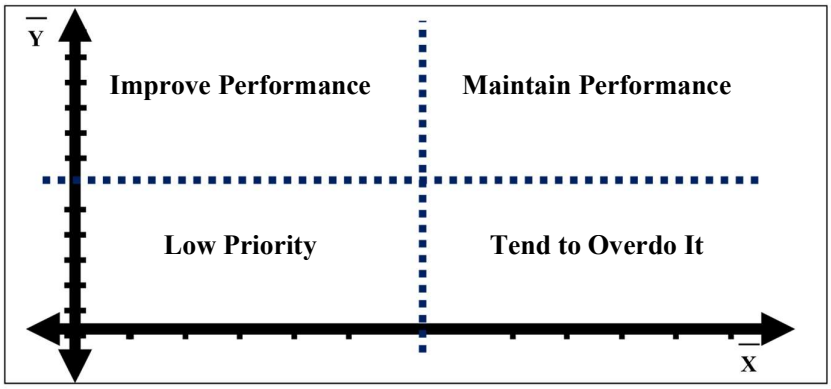

Figure 1. Cartesian Quadrant Classification in the Importance Performance Analysis Method

3. Result and Discussion

In this study, 20 variables willl be assessed by respondents using a questionnaire as an assessment instrument. These variables include completeness, minimum provisions, bicycle parking facilities, comfort for cyclists, safety for cyclists, fun for cyclists and attractive,ness for cyclists.

Table 3. Service Variables

No.	Variables	Service Aspects	Notation
1	Completeness	Sign warning lots of bicycle traffic	X_1
2		Do and don't sign for bicycles	X_2
3		Street lighting	X_3

No.	Variables	Service Aspects	Notation
4		Bicycle lane markings at signalized intersections	X_4
5		Bike lane colors and symbols	X_5
6		Cyclists crossing markings	X_6
7	Minimum Terms	For roads without traffic barriers, the minimum bicycle lane width is 1.2 m	X_7
8		The minimum width of bicycle lanes , if there is vehicle parking on the road, is 1.5 m	X_8
9	Bicycle Parking Facility	Ease of access, security, pedestrians are not disturbed by special lanes	X_9
10		Bicycle parking facilities and support are available	X_{10}
11	Convenience for Cyclists	The pavement is good and not damaged	X_{11}
12		Cyclists are given priority over motorists	X_{12}
13		Special lanes for bicycles are cleaned of garbage, puddles, etc	X_{13}
14	Safety for Cyclists	The level and pavement materials are safe for cyclists	X_{14}
15		Free from other vehicle drivers	X_{15}
16	Pleasure for Cyclists	An affordable distance between the destination and place of residence	X_{16}
17		The relationship between one land use and another land use	X_{17}
18		Provision of well-connected public transportation	X_{18}
19	Attraction for Cyclists	The harmonious arrangement of land use and vegetation	X_{19}
20		Attractive bicycle-specific lane design	X_{20}

3.1 Data Validity and Reliability Testing

Before entering into the Importance Performance Analysis analysis, validity and reliability tests were carried out on the data on the instrument (questionnaire) that was asked of the respondents. As described in Table 4 and Table 5, from 100 respondents, the results obtained were that the answers to the questions were stated to be valid because based on calculations, Rcount was obtained from the level of interest and satisfaction above the Rtable value. For reliability testing, the results also show that the instrument can be used (reliable) because the Rcount between the level of interest and satisfaction has a correlation interval between 0.60-1.00 (strong and very strong categories). From the results of the analysis of validity and reliability testing, it can be continued to the Importance Performance Analysis analysis stage from the results of the questionnaire.

Table 4. Data Validity Testing

No.	Service Aspects	R_{count}		R_{table}	Test results
		Importance	Satisfaction		
1	X_1	0,417	0,510	0,195	VALID
2	X_2	0,475	0,423	0,195	VALID
3	X_3	0,394	0,347	0,195	VALID
4	X_4	0,306	0,591	0,195	VALID
5	X_5	0,631	0,630	0,195	VALID
6	X_6	0,468	0,726	0,195	VALID
7	X_7	0,446	0,541	0,195	VALID
8	X_8	0,676	0,558	0,195	VALID
9	X_9	0,518	0,578	0,195	VALID
10	X_{10}	0,321	0,664	0,195	VALID

No.	Service Aspects	R_{count}		R_{table}	Test results
		Importance	Satisfaction		
11	X_{11}	0,689	0,444	0,195	VALID
12	X_{12}	0,648	0,458	0,195	VALID
13	X_{13}	0,512	0,475	0,195	VALID
14	X_{14}	0,524	0,459	0,195	VALID
15	X_{15}	0,529	0,301	0,195	VALID
16	X_{16}	0,666	0,671	0,195	VALID
17	X_{17}	0,328	0,284	0,195	VALID
18	X_{18}	0,368	0,479	0,195	VALID
19	X_{19}	0,496	0,723	0,195	VALID
20	X_{20}	0,604	0,634	0,195	VALID

Source : Analysis Results, 2022

Table 5. Data Reliability Testing

No.	Service Aspects	R_{count}		Test results
		Importance	Satisfaction	
1	X_1	0,701	0,725	Reliable
2	X_2			
3	X_3			
4	X_4			
5	X_5			
6	X_6			
7	X_7	0,798	0,708	Reliable
8	X_8			
9	X_9	0,771	0,711	Reliable
10	X_{10}			
11	X_{11}	0,821	0,775	Reliable
12	X_{12}			
13	X_{13}			
14	X_{14}	0,797	0,787	Reliable
15	X_{15}			
16	X_{16}	0,754	0,702	Reliable
17	X_{17}			
18	X_{18}			
19	X_{19}	0,743	0,733	Reliable
20	X_{20}			

Source : Analysis Results, 2022

3.2 Analysis with IPA (Importance Performance Analysis) Method

The results of the Importance Performance Analysis will show the performance variables for special bicycle lane services in Malang City related to completeness, minimum service provisions, bicycle parking facilities, comfort, safety, fun and attractiveness for cyclists who maintain existing performance and require performance improvements to determine appropriate performance improvement alternatives in specific bicycle lanes.

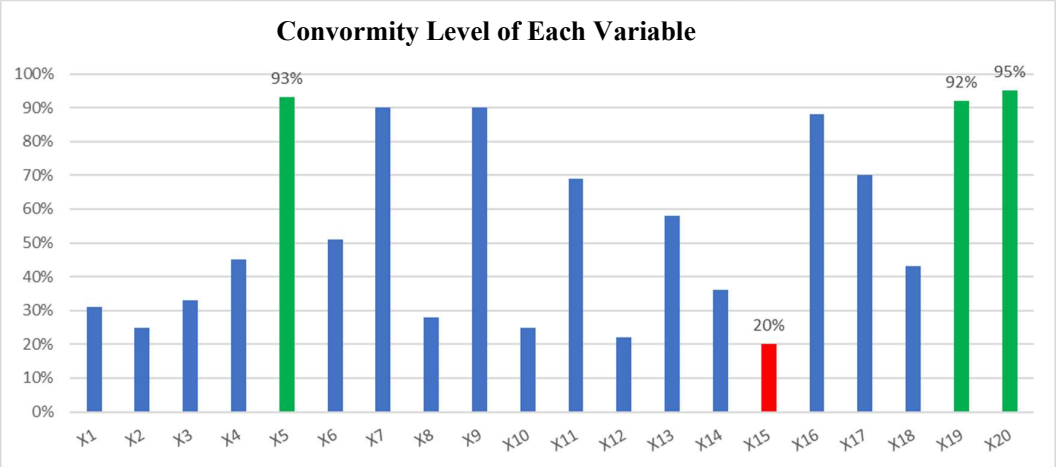

Figure 2. Parity Level of Each Variable

Based on Figure 2 above, the highest level of conformity is found in 3 aspects including: Design of attractive bicycle lanes, Matching land use and vegetation arrangements, as well as bicycle lane markings in the form of white and/or green bicycle images. The relationship between the level of satisfaction and the level of user interest in this variable is appropriate because the comparison of the level of interest and the level of satisfaction results in a value above 90%. For those with a low level of conformity, there are variables: Independent from other vehicle drivers, namely the value of the relationship between the level of satisfaction and the level of interest of 20%, which means that user satisfaction is still not appropriate (satisfaction level ≤ importance level).

Table 6. Level of Satisfaction and Interest of Cyclists in Special Bicycle Lanes in Malang City

No.	Service Aspects	Importance Level	Average of Importance Level	Satisfaction Level	Average of Satisfaction Level	Conformity Level
Completeness						
1	X_1	489	4,89	154	1,54	31%
2	X_2	451	4,51	115	1,15	25%
3	X_3	500	5,00	167	1,67	33%
4	X_4	500	5,00	223	2,23	45%
5	X_5	476	4,76	445	4,45	93%
6	X_6	489	4,89	251	2,51	51%
Minimum Terms						
7	X_7	468	4,68	422	4,22	90%
8	X_8	480	4,80	134	1,34	28%
Bicycle Parking Facility						
9	X_9	460	4,60	416	4,16	90%
10	X_{10}	472	4,72	119	1,19	25%
Convenience for Cyclists						
11	X_{11}	500	5,00	347	3,47	69%
12	X_{12}	500	5,00	110	1,10	22%
13	X_{13}	500	5,00	290	2,90	58%

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No.	Service Aspects	Importance Level	Average of Importance Level	Satisfaction Level	Average of Satisfaction Level	Conformity Level
Safety for Cyclists						
14	X_{14}	474	4,74	169	1,69	36%
15	X_{15}	500	5,00	100	1,00	20%
Pleasure for Cyclists						
16	X_{16}	454	4,54	399	3,99	88%
17	X_{17}	463	4,63	325	3,25	70%
18	X_{18}	468	4,68	200	2,00	43%
Attraction for Cyclists						
19	X_{19}	468	4,68	431	4,31	92%
20	X_{20}	490	4,90	467	4,67	95%

Source : Analysis Results, 2022

Based on Table. 6, the average level of importance ($\bar{Y}$) is 3.56, the average satisfaction level ($\bar{X}$) is 1.96, therefore the level of conformity is 0.55 <1. This value shows that the level of user satisfaction is still low with the existence of special bicycle lanes.

The results of the Importance Performance Analysis also produce an analysis obtained from dividing the quadrant into 4 parts which are divided by two interlocking lines (vertical and horizontal). The X axis is the value of the level of satisfaction with an average of 1.96 while the Y axis is the value of the level of importance with an average of 3.56. In Figure 3 there is a quadrant division of the evaluation variable for the provision of special bicycle lanes in Malang City into 4 quadrants. From Figure 3, based on the respondents' assessment, it can be seen that each variable is divided into four quadrants. In summary, it can be seen in Table 7.

Table 7. Summary of Cartesian Diagram Evaluation of Provision of Special Bicycle Lanes

Quadrant	Variable
I : High Priority	X_1,X_2,X_3,X_{10},X_{12},X_{14},X_{15}
II : Maintain Achievement	X_4,X_5,X_6,X_7,X_9,X_{11},X_{13},X_{16}, X_{17},X_{18},X_{19},X_{20},
III : Low Priority	-
IV: Excessive	X_8

From Table 7, which are included in the priorities for improving performance (Quadrant I), namely:

- Lots of bicycle traffic so a warning sign (X_1) is required
- Provided signs that can and cannot be done by cyclists (X_2)
- Bicycle lanes must be provided with sufficient lighting (X_3)
- Availability of bicycle parking facilities and support (X_{10})
- Rider a is given priority over motorbike riders (X_{12})
- Height and pavement materials safe for cyclists (X_{14})
- Free from other vehicle drivers (X_{15})

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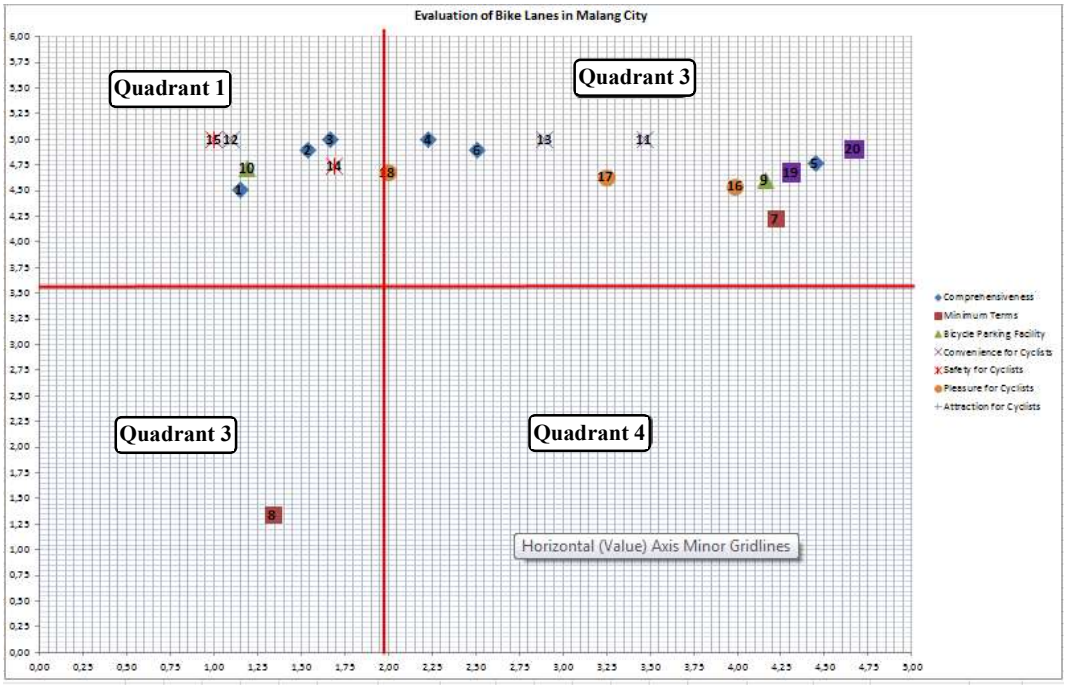

Figure 3. Cartesian Diagram Based on the Level of Satisfaction and the Level of Importance of Special Bike Lanes

3. Conclusions

Based on the results of the analysis using the Importance Performance Analysis method, the value of the degree of concordance between user satisfaction and interests for each variable is obtained. The highest level of suitability for variables that support bicycle lanes includes attractive bicycle lane designs, harmonious land use and vegetation arrangements, and bicycle lane markings in the form of white and/or green bicycle images with a satisfaction level value above 90% (satisfaction level and variable importance level is appropriate).

The Importance Performance Analysis method divides into quadrant areas which have their respective meanings, where specifically quadrant one is a priority for performance improvement because it has a high value of service importance but the service performance is still low, so that special bicycle lanes are created that are able to provide a sense of security and comfort for its users. These variables include:

- Signs warning a lot of bicycle traffic (X_1)
- Command and prohibition signs for bicycles (X_2)
- Street lighting lamps (X_3)
- There is a shelf, post or support that allows the bicycle to be locked or padlocked (X_{10})
- Cyclists are given priority over motorists (X_{12})
- Height and pavement materials safe for cyclists (X_{14})
- Free from other vehicle drivers (X_{15})

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