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Identification of The Effectiveness of Trans Metro Bandung (TMB)

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ABSTRACT

One of the most acute problems for some big cities is traffic jams. Many of the factors that cause this problem to arise are the inadequate public transport system. The public transportation system itself is believed to be one of the solutions to urban transportation problems that support environmental sustainability. As one of the big cities in Indonesia, Bandung also experienced this congestion problem; therefore Transit Bus Rapid Transit (BRT) Trans Metro Bandung (TMB) system in Bandung City was presented to overcome the problem. However, the operation of Trans Metro Bandung is considered to not fully run according to plan and is effectively used by the community. The purpose of this research is to identify the level of effectiveness of TMB transport system. In the process to get answers to the level of effectiveness is calculated the effectiveness of TMB transport performance measured based on several indicators that include; load factor, speed, and passenger waiting time, headway, frequency, and safety and security aspects of user side. The indicators are analyzed by using statistical descriptive analysis method, which is then comparted with comparative descriptive analysis method to specified public transport standard. In addition, it was also assessed by the user perception of TMB transport to the existing performance of transportation. Based on the results of the analysis conducted then obtained a result that TMB transportation currently operating is still not effective if judged from the side of quantitative. However, the results of this quantitative analysis contrast with what is perceived by users who mostly have a positive perception of the existing performance of TMB transport. The whole conclusion that can be taken is that the mass transportation mode of the TMB transport still does not have a good performance effectiveness due to the poor performance of transportation compared with the existing standard.

Keywords: *Trans Metro Bandung, performance, perception, effectiveness*

1. INTRODUCTION

The city of Bandung is one of the major cities in Indonesia, which is an attractive destination for migrants from rural areas as part of the ongoing process of urbanization. The impact of this phenomenon of urbanization is the increasing growth and population density in the city of Bandung, causing various impacts, one of which is the increasing level of congestion.

Based on data obtained from the Bandung Central Bureau of Statistics (2016), the population of Bandung City at the end of 2015 was 2,481,469 people with a growth rate of 0.72% in 2010−2015 or less than half the national growth rate of 1.4%. Although the rate of population growth in the city of Bandung is still below the average national growth rate, this still needs to be anticipated given the ever-increasing rate of population growth in the city of Bandung every year.

The high rate of population growth in the city of Bandung is directly proportional to the growth rate of private vehicles. The growth of private vehicles in the city of Bandung in the past five years is 60,000 units per year or around 11% annually. While the growth rate of the city of Bandung is much smaller, only around 5% per year (Eri, 2013), so that congestion on road segments is inevitable.

Another effort that can be made by the government in overcoming congestion in addition to adding roads is to create a reliable public transportation system. At present the number of public transport in the city of Bandung is quite a lot but still cannot be relied on by the community. This is evidenced by the fact that there are still many people who prefer to use private vehicles rather than using public transportation. Many factors cause the lack of public interest in using public transportation as a mode of transportation, including the still not optimal service system that is owned by Bandung City public transport at this time.

Referring to the conditions that occur, the government strives to provide a mass transit system that has better service than the existing public transportation. The manifestation of the government's efforts is the procurement of the Bus Rapid Transit (BRT) transport system in Bandung which has the name Trans Metro Bandung or commonly known as TMB.According to the definition proposed by Wrightand Hook (2007), a conclusion can be drawn if the BRT transportation system is a mass transit system that is fast moving and inexpensive. The existence of this TMB is expected to be a means of public transportation that can serve the needs of the people of Bandung.

The TMB transport system operated for the first time on December 22, 2008. Currently there are three service corridors for the TMB transport system that have been operating serving the people of Bandung City. The corridors are; Cibeureum−Cibiru corridor, Cicaheum−Cibereum corridor, and Cicaheum−Sarijadi corridor. The three corridors are served by buses with a capacity of 80 passengers, totaling 30 fleets with 10 fleet details in each corridor.

Based on the results of observations that have been made, facts are found regarding the operationalization of TMB. These facts include; not yet integrated TMB transport system with undisciplined city public transport operation of TMB transport, there is no special route for TMB transportation, timelines that are not precise, and still unsatisfactory conditions and services for TMB transport system stops. However, there are still those who think that this transportation system is one of the government programs that can be appreciated. With a new fleet of buses that are comfortable to ride, many people do not think of any negative issues that exist and continue to make TMB transportation a mode of transportation because they are interested in the convenience of the transportation offered.

The results of the observations made above provide an illustration of the unclear effectiveness of the TMB transport system as a solution to congestion in the city of Bandung. This is what requires the need to study the level of effectiveness of TMB transport performance as a solution to the congestion problems that occur in the city of Bandung.

2. METHODOLOGY

2.1. Research Approach

The research approach carried out in this study is to use a mixed approach or commonly known as mixed method research. Mixed research is a research approach that combines qualitative research with quantitative research (Creswell, 2003). The mixed methods approach used in this study is by using sequential mixed methods. The sequential mixed methods method combines gradual qualitative and quantitative data; data search is done by looking for quantitative data and analyzing it first then proceed with conducting qualitative data collection and analysis (Creswell, 2003). In this study the qualitative data in question is the perception data of TMB transport users obtained using the method of distributing questionnaires. While the quantitative data is the TMB transport performance data obtained from the results of field observations.

2.2. Method of Collecting Data

The method of data collection carried out in this study is divided into two parts; primary and secondary surveys. The primary survey included field observations and questionnaires.

2.2.1. Secondary Survey

Secondary surveys were carried out at the Bandung City Transportation Agency to obtain preliminary data regarding the TMB transport system.

2.2.2. Primary Survey

The primary survey conducted is divided into two parts, namely observation and distribution of questionnaires. Observations were made to obtain the existing conditions of TMB transport performance measured based on five parameters; load factor, speed, passenger waiting time, headway, and frequency of transport carried out at three times; morning rush time (peak morning 06.30−08.30 WIB – *Waktu Indonesia bagian Barat*), excluding rush hour (off peak 10.30−12.30 WIB), and at afternoon rush hour (peak afternoon 15.30−17.30 WIB). The distribution of questionnaires was conducted to determine the perceptions of the people of Bandung City regarding the performance of the TMB transport system. The questionnaire distribution technique used is a non-probability sampling approach with random sampling techniques. The number of respondents needed is 100 respondents based on the results of the Lemeshow (1991) sample calculation technique.

2.3. Data Analysis

Analysis of the data carried out in this study consisted of; calculation of transport performance parameters based on the equations issued by Director General of Land Transportation of the Republic of Indonesia (2002), comparative descriptive analysis, and analysis of perception of TMB transport users.

2.3.1. Calculation of Transport Performance

The calculation of TMB transport performance is based on the 5 following equations:

1. Load Factor Analysis (Load Factor)
Factor load is the ratio between the capacity sold and the capacity available in one trip of the public transport fleet which is usually expressed as a percentage (%). To get the load value for this factor, use the formula at **Equation 1** as follows:

$$LF = \frac{(\sum Pnp_{km})}{[(\sum Bus_{km}) \times K]} * 100\% \qquad \dots (1)$$

Information:
LF = Load Factor,
Pnp_{km} = the number of passengers multiplied by the length of the route,
Bus_{km} = the number of trips multiplied by the length of the route in a given unit of time,
K = Vehicle Capacity.

2. Transport Frequency Analysis
Frequency (f) is the number of departures of transport vehicles that pass at one particular point (bus stop) in units of time, in the frequency system (vehicles/hours). The frequency is determined by the calculation formula at **Equation 2** and **Equation 3** as follows:

$$F = \frac{Number\ of\ Passengers\ in\ one\ hours}{LF \times Vehicle\ Capacity} \qquad \dots (2)$$

or, same with

$$F = \frac{60\ Minutes}{Headway} \qquad \dots (3)$$

Information:
F = Frequency,
LF = Load Factor.

3. Headway Analysis
Headway is the time interval between vehicles on the path of the same road. The smaller the headway value indicates the higher the frequency of the vehicle so that it will cause a low waiting time, this is a favorable condition for passengers, but on the other hand it will cause traffic disruption. To get a headway value, was done by looking at the intervals of the intervals on each hour.

4. Analysis of Passanger Waiting Time
Waiting time is the time when a public vehicle stops at the origin or destination. Calculation of transport waiting time can be measured by the following formula (**Equation 4**):

$$T = \frac{1}{2} \times H \qquad \dots (4)$$

Information:

T = Waiting Time,
H = Headway.

5. TMB Transport Speed Analysis
The speed of an urban bus describes the distance travelled that can be reached in certain time units. In general, the performance will be good if the travel speed is faster. To get the speed value of a transport can be measured by the following formula (**Equation 5**):

$$V = \frac{Distance\ Travelled}{Time} \quad \dots (5)$$

Information:
V = Speed.

2.3.2. Comparative descriptive analysis.

To find out whether the transport performance that has been obtained has been said to be effective or not, a comparative analysis of the performance of existing TMB transports on public transport standards is derived from standards by the Director General of Land Transportation of the Republic of Indonesia. The data in the following **Table 1** is the public transport standards used in this study.

Table 1. Standard of Urban Public Transport Performance

No.	Parameter	Unit	Standard
1	Load Factor	%	70
2	Headway	minute	10–20
3	Frequency	vehicle/hours	3–6
4	Waiting Time • Average • Maximum	minute	 • 5–10 • 10–20
5	Speed	km/hours	10–12

(Source: Directorate General of Land Transportation, 2002)

2.3.3. Analysis of Perception of TMB Transport Users

The perception of transport users obtained was analyzed using a Likert scale with a scale of 1–4 which indicates that the greater the number the better the perception of the transport users of the intended performance. The results of the Likert scale analysis are then compared with the cumulative assessment that has been determined based on the quartile theory as follows (**Table 2**):

Table 2. Guidelines for Qualitative Comparative Analysis Assessment

Criteria	Score
Good	16 – 20
Average	10 – 15
Bad	5 – 9

3. DISCUSSION AND RESULT

Based on the results of the survey that has been carried out the following is the result of the TMB transport performance analysis:

3.1. Quantitative analysis

The quantitative analysis carried out is an analysis of the measured performance of TMB transport which includes; load factor, speed, headway, passenger waiting time, and frequency of transportation.

3.1.1. Load Factor Analysis.

Overall, the value of TMB transport load factor does not meet the prescribed standards. In other words, if the load factor is reviewed, TMB transport is still not effective. **Table 3** follows the comparison of the average load factor of TMB transport between corridors.

Table 3. Average Load Factor in 3 TMB Transport Corridors

Name of Corridor	Average LF [%]	Highest LF by Time	Highest LF by Day in A Week
Corridor 1	13.38	Afternoon peak	Beginning of the week
Corridor 2	19.84	Afternoon peak	Beginning and end of the week
Corridor 3	19.96	Morning peak	Beginning and middle of the week

3.1.2. Speed Analysis.

The speed of urban bus vehicles that are standardized by the Director General of Land Transportation as one measure of performance is 10−12 km/hour. The average speed of TMB transport based on the results of field observations is as follows (**Table 4**):

Table 4. Average Travel Time and Speed of TMB

Name of Corridor	Average of Speed (km/jam)			Average
	Morning Peak	Off Peak	Afternoon Peak	
Corridor 1	11.86	12.57	10.68	12.29
Corridor 2	11.46	12.49	10.41	11.45
Corridor 3	19.50	16.02	12.33	15.95
Average	14.27	13.69	11.14	13.23

Analysis Results From the bus speed table above, it can be concluded that the TMB transport speed is faster than the standard speed, so the performance is good.

3.1.3. Headway, Waiting Time and Frequency Analysis

The average TMB Bus headway is 30−40 minutes, because the arrival of passengers is based on random (random), then the calculation of passenger waiting time is equal to half (0.5) of the headway while the calculation of transport frequency is done by counting the number of transports that pass on every hour. Based on the standards set, the transportation system can be said to be effective if the frequency of transportation passing every hour is 3−6 vehicles per hour. Comparison of the performance conditions in question can be considered in detail in the following **Table 5**.

Table 5. Comparison of Frequency Conditions, Headways and Waiting Times Between the TMB Transport Corridors

Name of Corridor	Frequency [vehicle/hours]	Headway [minutes]	Waiting Time [minutes]
Corridor 1	1	42.50	21.25
Corridor 2	2	32.50	16.25
Corridor 3	1	35.83	17.92
Average	1	36.94	18.47

The standard issued of the effective headway of urban public transport is 10−20 minutes. While the standard passenger waiting time issued is 5−10 minutes for the average waiting time for transportation, and 10−20 minutes for the maximum allowable limit for transport performance to be considered effective. Based on the existing conditions that have been obtained, conclusions can be drawn if the TMB transport headway conditions have not been ideal because they are still above the existing performance standards of 36.94 minutes for the overall TMB freight headway performance. Waiting time TMB is currently within the existing standard ideal range of 18.47 minutes overall.

3.1.4. Comparative Existing Transport Performance Against Urban Public Transport Standards

The **Table 6** following is a comparative condition of the existing performance of TMB transports against established urban public transport standards.

Table 6. Recapitulation of TMB Transportation Performance

<table>
<tr><th rowspan="2">No</th><th rowspan="2">Parameter</th><th colspan="3">Corridor</th><th rowspan="2">Performance Standard</th><th rowspan="2">Conclussion</th></tr>
<tr><th>1</th><th>2</th><th>3</th></tr>
<tr><td>1</td><td>Load Factor [%]</td><td>13.4</td><td>19.8</td><td>20</td><td>70</td><td>Overall, the load factor performance of TMB transport is below 70% so that it can be stated that demand for TMB transport is currently very low.</td></tr>
<tr><td>2</td><td>Headway [minutes]</td><td>42.5</td><td>32.5</td><td>35.8</td><td>10–20</td><td>Overall, the TMB transportation headway performance is below the standard so that it can be stated that overall the TMB transport performance in its availability is still very minimal.</td></tr>
<tr><td>3</td><td>Frequency [vehicle/ hours]</td><td>1</td><td>2</td><td>1</td><td>3–6</td><td>Performance of the TMB transport frequency is below the existing standard, indicating that the availability of TMB transportation is minimal.</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Waiting Time [minutes]</td><td rowspan="2">21.2</td><td rowspan="2">16.2</td><td rowspan="2">17.9</td><td>Average: 5–10</td><td rowspan="2">Passenger waiting time in corridor 1 is not in accordance with the existing standard, which is above 20 minutes. While the condition of passenger waiting time in corridors 2 and 3 has met the maximum standard of existing waiting time.</td></tr>
<tr><td>Maximum: 10–20</td></tr>
</table>

Table 6. Recapitulation of TMB Transportation Performance (continuance)

No	Parameter	Corridor 1	Corridor 2	Corridor 3	Performance Standard	Conclussion
5	Speed [km/ hours]	12.3	11.4	15.9	10–12	Overall, the condition of the speed of TMB transportation in each corridor can be said to be ideal for areas that are crowded with traffic conditions that are included in the mix traffic category. The entire performance of TMB corridor 1 to 3 transport speeds is in accordance with the existing standards of 10-12 km/hour.

Based on the results of the assessment that has been carried out, a result is obtained that overall the TMB transport performance is still not effective. This is evidenced by the fact that there are still a lot of transport performance that are below the appropriate standards so that they require further improvements.

3.2. Qualitative Analysis

Qualitative analysis was conducted to find out how well the TMB transport performance currently operates based on the perception of transport users. Based on the results of the survey that has been carried out the following is the perception of TMB transport users on the performance of the transport currently operating (**Figure 1**).

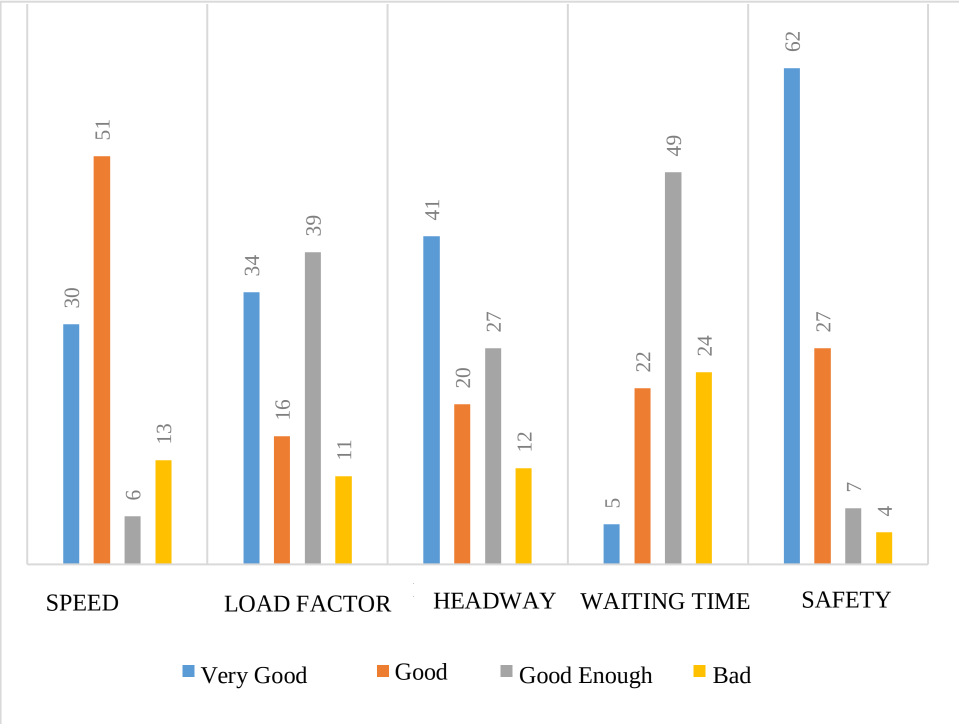

Figure 1. Perception of TMB Transport Users

Based on the data above, the following is an assessment of the performance of TMB transportation based on user perceptions **(Table 7)**.

Table 7. TMB Transport Performance Assessment Based on User Perception

No.	Parameter	Performance	
		Score	Criteria
1	Load factor	3	Good
2	Speed	2	Good Enough
3	Headway	4	Very Good
4	Waiting Time	3	Good
5	Safety	4	Very Good
	Overall Performance		**Good**

Based on the results of the analysis that has been carried out, it can be concluded based on the perception of TMB transport users, overall the TMB transport performance is considered to have been good by transport users. This is evidenced by the total performance appraisal value of 16 so that it falls into the fairly good category. Whereas if viewed in detail, the majority of transport users feel that the performance of the headway and transportation security is the performance with the highest level of satisfaction.

3.3. Linkages of Quantitative and Qualitative Analysis

Based on the conclusions from each of the quantitative and qualitative analyzes that have been carried out, it can be seen that the results of quantitative and qualitative analysis contradict each other. Quantitative analysis, which is a measured analysis with comparative performance on transport standards, which is the basis, shows that TMB transportation is still not effective as mass transportation. While the qualitative analysis, which is the assessment of transport performance based on user perceptions, shows that the majority of TMB transport users currently feel that the performance of existing transportation is good.

The **Table 8** following is an explanation of the existing achievements of TMB transport in the perspective of transport users.

Table 8. Linkage of TMB Transport User Perception to TMB Performance

Para-meter	Corridor			Standard	Effectiv-eness	Users Percep-tion	Linkage of User Perception to TMB Performance
	1	2	3				
Load Factor [%]	13.4	19.8	19.9	70	Achieved	Good	The user feels that the performance of load factor is good. The condition of the existing load factor transport is considered comfortable as expected
Headway [minute]	42.5	32.5	35.8	10–20	Not Achieved	Good	Majority of transport users consider headway of TMBis good, even though the existing headway conditions of TMB transport are currently below the existing transport standards.

Table 8. Linkage of TMB Transport User Perception to TMB Performance (continuance)

Para-meter	Corridor			Standard	Effectiv-eness	Users Percep-tion	Linkage of User Perception to TMB Performance
	1	2	3				
Waiting Time [minute]	21.2	16.2	17.9	Average: 5–10	Not Achieved	Good Enough	TMB transport users have felt that the current waiting time is good. Although actually an increase is needed from the government considering the waiting time of TMB transport passengers is currently in the maximum range which is actually quite too long compared to the waiting times of other public transportation.
				Max: 10–20	Achieved in Corridor 2 and Corridor 3		
Speed [km/hour]	12.3	11.4	15.9	10–12	Achieved	Good Enough	Actually the speed of TMB transport currently meets the existing standards, but it seems that according to most transport users the current transportation speed performance still needs to be improved again.

Based on the table above, the condition of load factor is very low (<70%) which indicates that the demand for TMB transportation is still very low. At present,the condition can be caused by several things.

1. The poor level of availability of transportation, which is indicated by the performance of the TMB transportation headway that is far below the standard, allows people to prefer to use other modes of transportation that have the same travel route and have a better level of availability.
2. The poor level of availability of TMB transport causes long passenger waiting times. The waiting time is worse than the waiting time for other public transports that have the same travel route. Both of these can be the possibility of low demand for current TMB transport. In addition, by obtaining a fact where the majority of users still feel that the TMB transport system has quite good performance, it can be seen that the community standards of Bandung City are still low on their perceptions of good mass transportation. This is certainly not a good condition considering that community participation in monitoring the government-run programs is very important. The large number of users who do not yet know how the BRT transport system actually works should have a negative impact on the supervision of the management of the transportation system in general, which has implications for the stagnant progress of the transportation system, especially in the city of Bandung.

4. CONCLUSION AND SUGGESTION

4.1. Conclusion

Based on the study findings that have been obtained, the following are conclusions that can be drawn from this study.

1. Overall the performance of TMB transport when compared to the established public transport standards is below the standard. Based on these conditions, the overall performance condition of TMB transport in the city of Bandung is currently not effective.
2. In the perception of transport users, the condition of TMB's current transportation performance is considered good and the majority of transport users appreciate its existence as a reliable means of public transportation. This condition explains that the actual demand for TMB transport actually exists and has the potential to become the main public transportation for the people of Bandung City if it can be improved even better.
3. Lack of fleet numbers has limited the availability of TMB transport. The low headway value of TMB transport at this time can be a big problem to attract people to choose TMB transportation as their mode of transportation. This is because with the minimum level of availability of TMB transportation, transport users have no other choice but to use other public transport modes such as ANGKOT (small public transportation) which have the same route.
4. The existence of other mass transportation modes also causes low TMB transport load factor values. However, this can be overcome if TMB transportation has advantages that other modes of transportation do not have, such as priority lines.

4.2. Suggestion

Based on the studies that have been conducted, the following recommendations can be submitted to the Bandung City Government in improving TMB transportation performance.

1. Making strategic travel routes that are able to accommodate overall community movements. Three corridors are still limited to make people make TMB transportation as their primary mode of transportation.
2. Provision of priority lines to improve the speed of transportation performance that currently exists besides the priority lane is also one of the main characteristics of the BRT transport system. Therefore, due to the unavailability of priority lanes for TMB transport, it cannot be distinguished between the TMB BRT transport system and the city buses provided by DAMRI.
3. Creating a public transport system that is synergized with each other. The large number of ANGKOT, DAMRI, and added TMB operating in the city of Bandung was deemed ineffective and even a cause of congestion for some circles. The government is deemed necessary to make an integrated transportation system that is clear where transportation operates on the main road and which one is the feeder.

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