

Performance Analysis of Trans-Jakarta Bus Suburban Service Move-Across Greater Jakarta

ESW Tangkudung¹ and C Widyadayinta²

¹Universitas Indonesia, Kampus UI Depok 16424, Indonesia

²Universitas Indonesia, Kampus UI Depok 16424, Indonesia

E-mail: ellen@eng.ui.ac.id

Abstract. Trans-Jakarta have developed their services scope as Suburban Service or Feeder move-across service that operate from greater Jakarta into Jakarta central vice versa. One of the route is Ciputat – Bundaran Hotel Indonesia (Tosari) and integrated with corridor 1 (one) and 8 (eight). This service is not travel on the exclusive lane or bus-way. Objective of Government Jakarta to provide this service is to decrease private car to enter the central of Jakarta. The objective of this study is to find the performance of the service. Survey have conducted static and dynamic on work day to get variable of travel time and delay, waiting time of passenger at the bus stop, headway and ridership of the bus. Service Standard Minimum of Trans-Jakarta have compared with the result of variable headway, travel speed, and waiting time at bus stop as concern of all the passengers. Analysis use correlation test method and linear regression model have done. The performance of Trans-Jakarta bus suburban service, based on travel speed indicator is fairly bad, only 8.1% of trip could comply with Minimum Service Standard. Bus performance based on the indicator of density in the bus is good, where all points are below the maximum limit i.e. 8 people/m² at peak hour and 5 people/m² at off-peak hour.

1. Introduction

Bus is a public transportation that can accommodate large number of passengers that also have high accessibility compared to rail-based mass transportation. Therefore, it developed to a Bus Rapid Transit (BRT) as a public transport that offers fast, comfortable, and secure transport service, either from its infrastructure, vehicle and schedule. Trans-Jakarta is an implementation of BRT system in Jakarta, which has been operating officially since February 2004.

Based on data of BPTJ (Badan Pengelola Transportasi Jabodetabek) in 2015, the number of trips in Jabodetabek region reached 47.5 million trips per day. Of the many trips, 50 percent of the trip is done by people outside DKI Jakarta. In addition, based on statistic data of Dinas Perhubungan, there are only one-third of 25.7 million vehicles per day in Jakarta which are public transportation users and the rest are private vehicle users.

After 12 years, Trans-Jakarta develop its service coverage by creating Suburban Service. Since June 2016, Trans-Jakarta opening of new routes, serving not only in Jakarta, but rather provide the services from Greater Jakarta to Jakarta central and vice versa. One of the route is Ciputat – Bundaran Hotel Indonesia (Tosari) which integrated with corridor 1 (one) and 8 (eight). Objective of Government Jakarta to provide this service is to decrease private car to enter the central of Jakarta. These services are not travel on the exclusive lane or bus-way and there are no shelters, only stops, except in the corridor. So, performance analysis based on Minimum Service Standard (MSS) of Trans-Jakarta needs to be done to develop services for the people.



Minimum Service Standard of Trans-Jakarta given by the service provider should be accomplished as the minimum quality which will be received by the passengers. There are four substances of MSS, namely service reliability, safety and security, convenience, and comfort. Reliability and comfort partially affect passengers' satisfaction (Silaningsih, 2015). For each substance, there are several indicators. Headway, travel speed, density in the bus, and waiting time at bus stop as concern of all passengers, are the analyzed indicators in this paper.

2. Methodology

2.1. Preparation phase

This phase begins by conducting a study on the existing condition of the bus service. From the existing conditions, identification of problem formulation and goal setting, which is to analyze the performance of the bus. The literature study was conducted. At this phase also studied performance indicators and minimum service standards of Trans-Jakarta as a reference in conducting analysis.

2.2. Data collection phase

The required data are: 1) time and duration of survey, 2) departure and arrival time, 3) delay, 4) mileage, 5) number of passengers, 6) passenger waiting time at the bus stop, 7) bus arrival and departure time at the bus stop. Observations were made for approximately two months, in January to March. Observations are made on weekdays (Monday to Friday) at peak hours and off-peak hours.

Primary data collection:

- Dynamic survey: surveys conducted in a moving bus vehicle with the method of recording the travel time and the number of passengers boarding and alighting through a route. In this survey also recorded where and how long the vehicle stopped due to delay.
- Static survey: surveys conducted from outside the vehicle (at the bus stop). The information recorded is the passenger waiting time and arrival/departure time of the bus (headway).

2.3. Data processing phase

Data processing is done to compare the existing data with Trans-Jakarta Minimum Service Standard (MSS), with the help of Microsoft Excel software. Indicators of MSS used are travel speed, number of passenger in bus, passenger waiting time, and headway. Therefore, the data obtained is processed first to be able to compare its value with existing indicators.

- Travel speed is obtained by using the travel time obtained by founding the difference between the time of arrival and the departure time. Travel time is the time required by the vehicle to travel a certain distance or the total time used to serve a route in one way, including delay and dwelling time. The amount of travel speed then can be calculated by the formula

$$V = \frac{L}{T}$$

where V= travel speed (km/hour), L= distance (km), T= travel time (hour). Delay is the time the vehicle is in a state of stalled due to traffic conditions or others that causing the vehicle to stop.

- Density in the bus is obtained by using the ridership data (number of passengers per square meter). The number of passengers on the bus is obtained by adding and reducing the initial passenger with the boarding-alighting passengers. So to compare the field performance with the MSS, the number of passengers in the bus divided by the floor area of the bus.
- Waiting time at bus stop is the time required by the passenger to wait until he/she can get into the bus. The average waiting time for public transport can be measured from half of the headway, assuming random passenger arrival rate and public transport headways have normal distribution. If the waiting time is too long, it will reduce the interest of public transport users. The passenger waiting time at the bus stop can be directly compared with existing MSS.

- Headway is interval between two successive vehicles. Headway is obtained by viewing the bus arrival time at the bus stop.

Correlation test, using the help of SPSS software, will do to find the variable of performance as the base of priority to develop services for the people. Correlation is statistical method used to determine whether there is a relationship between variables. The correlation coefficient is a number indicating the direction and strength of the linear relationship between the dependent variable (Y) and the independent variable (X). Interpretation of correlation coefficient (Hasan, 2001) is as follows:

- If ρ (correlation coefficient spearman's rho) is positive, then the variables are positively correlated. The closer the value of this ρ to +1 the stronger the correlation, and vice versa.
- If ρ is negative, then the variables are negatively correlated. The closer the value of this ρ to -1 the stronger the correlation, and vice versa.
- If ρ is 0 (zero), then the variables do not show correlation.
- If ρ is either +1 or -1, then the variable shows a perfect positive or negative correlation.

2.4. Analysis and decision making phase

After doing data processing, field data can be compared with MSS. If the value obtained is still at the range (maximum or minimum) then the performance of Trans-Jakarta bus can be said good and vice versa. From the data, if there is 50 percent or more data that said the performance is good, then we can say the overall performance can be said good. Analysis with correlation test will result the relationship between variables and we can determine what variables or indicators that most influential on the performance, which is the parameter of travel time.

3. Results and Discussion

3.1. Transjakarta suburban service performance

- Travel speed

Figure 1 and Figure 2 show the travel time, where the red line indicates the maximum speed limit of 30 km/h while the green line shows the minimum speed limit of 18 km/h, according to MSS Transjakarta. From the Figures can be seen that only a few points are between the two lines. The percentage indicates good performance is only 7/62 or 11.3% at peak hour and 3/62 or 4.8% at off-peak hours, or overall only 10/124 or 8.1%. So it can be said that the performance of the bus based on travel speed indicator is fairly bad because it has not met the standard.

The performance based on travel time depends on the situation on the road, where this service is not travel on the exclusive lane busway. The bus must compete with other road users, ranging from private cars, motorcycles, urban transportation (angkot) to intercity buses. This route passes through markets and campuses that at certain hours will affect traffic flow. The study was conducted from January to March, at which time construction work was underway, one of which is MRT Jakarta. Other construction work at Pondok Indah area also take part of reducing the travel speed.

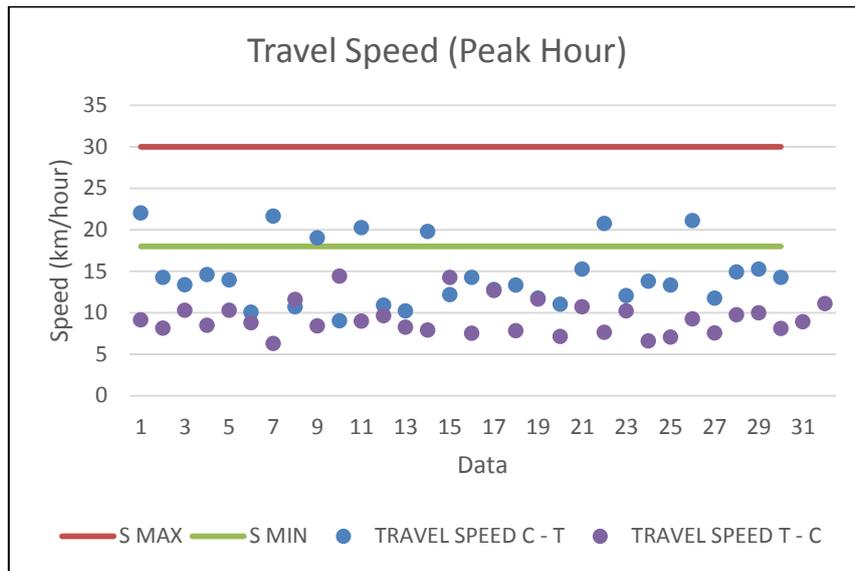


Figure 1 Travel Speed Data on Peak Hour

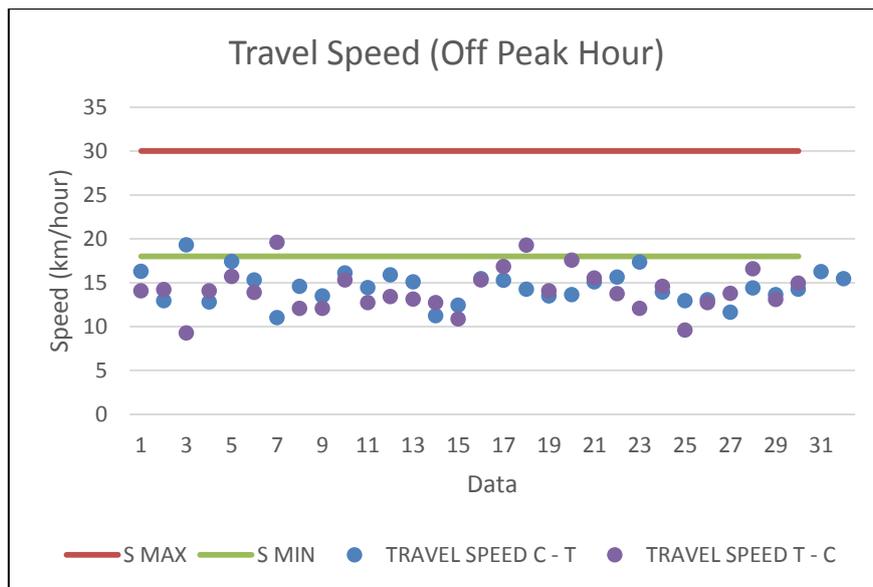


Figure 2 Travel Speed Data on Off-Peak Hour

- Density in the bus

From Figure 3 and Figure 4 can be seen that bus performance based on the indicator of density in the bus has met the standard, where all points are below the maximum limit of 8 people/m² at peak hour and 5 people/m² at off-peak hour. Although it still met the Minimum Service Standard of Trans-Jakarta, the density during peak hour can reach up to 5 people/m² or load factor of 121%, which is not acceptable for most passenger.

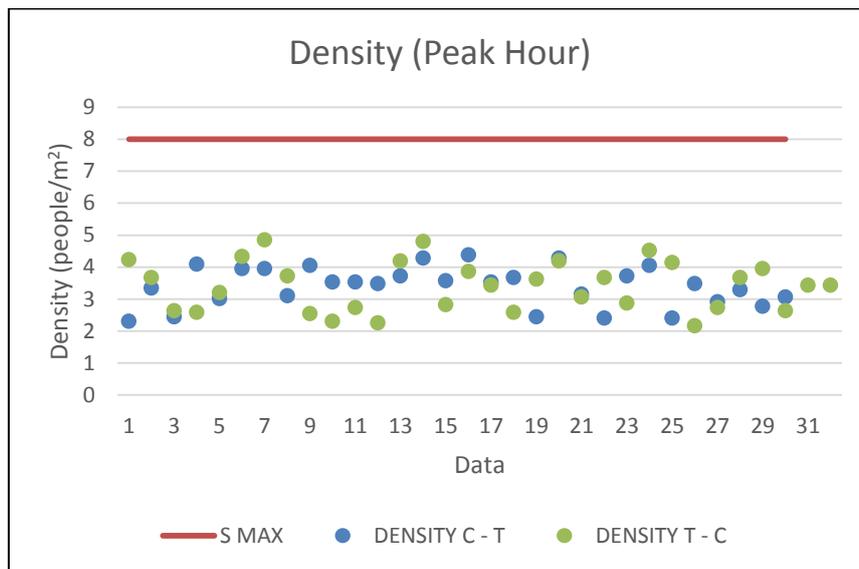


Figure 3 Density Data on Peak Hour

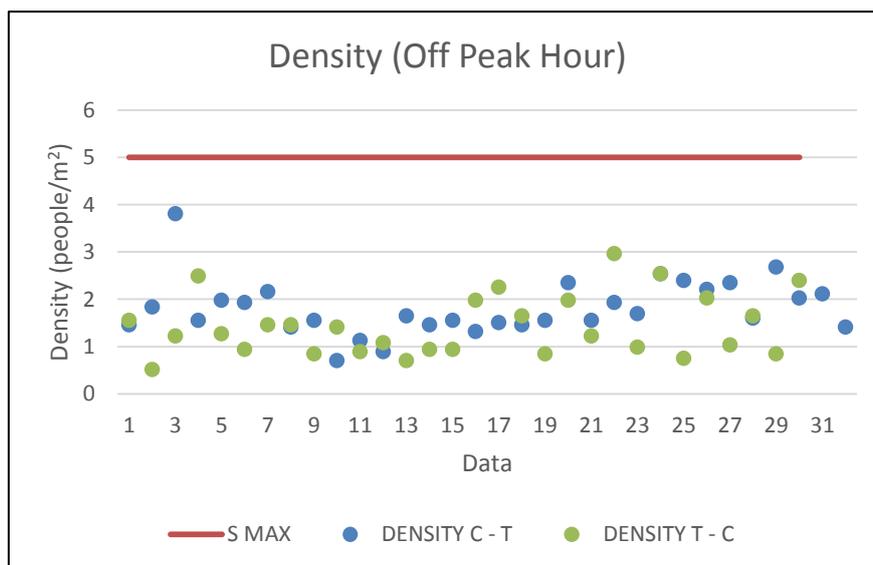


Figure 4 Density Data on Off-Peak Hour

- Waiting time at bus stop and Headway

The waiting time is calculated starting the moment the passenger arrives at the bus stop until he/she boards the bus. According to field observations, the waiting time for passengers varies, depending on the headway of the bus at that time, the density in the bus, where if it is too full, the passenger will be required to wait for the next bus, or the passenger personally, whether in a hurry, waiting for the next bus to get a seat (especially at the Tosari and Pool Ciputat). Headways at each stop will vary, especially when on a regular path, not in the main busway corridor. Maximum waiting time limit is 5 minutes during peak and 15 minutes during off-peak hour. While the maximum headway limit is 5 minutes during peak and 10 minutes during off-peak hour. From 20 bus stops that we observed, note that the performance is bad for headway and waiting time because they have not met the standards as seen from Table 1. Where, N =amount of all data, n =the amount of data that meets the standard, $\%$ =percentage of data that meets the standard.

Table 1 Performance Based on Headway and Waiting Time

		Standard (Peak Hour)	Standard (Off-Peak Hour)	N	n	%	Performance
Headway	P	≤ 5 minutes	≤ 10 minutes	21	0	0	X
	OP			9	1	11,1	
	T			30	1	3,33	
Waiting time	P	≤ 5 minutes	≤ 15 minutes	21	2	9,52	X
	OP			9	9	100	
	T			30	11	36,67	

The performance of the Trans-Jakarta Ciputat-Tosari based on the four MSS indicators above, is overall quite bad. Variable of speed, headway and waiting time show poor performance while passenger density shows good performance. Off-peak hour waiting time indicate good performance, especially at corridor stops that are also assisted by other buses that can serve the passengers..

3.2. Influence of variables on performance

Performance of a public transport service, at the most could viewed by the travel time indicator. Therefore, to find the most influential variable on performance, look for relationships between variables, where travel time becomes dependent variable and other variables become independent variables. Non-parametric tests are an option where normality and homogeneity assumptions are not met. So in this study, rank spearman correlation is used to find the relationship and test the significance of one dependent variable and one independent variable. Based on IBM SPSS output, we can see Correlation Coefficient and Sig value, at $\alpha=5\%$. In this correlation test, the variables tested include travel time, delay time, speed, density, headway and waiting time.

Based on the result, it can be seen that the travel time variables at most have a negative relationship with the variable speed and positive relationship with variable delay. For variable speed, spearman rho correlation value is all at interval 0.8 to 1 so it can be said a very strong negative relationship level. So, if the travel time is getting bigger then the speed will decrease, and vice versa. For variable delay, spearman rho correlation value varies on peak and off-peak hour. The rho value of 0.653 at peak hour indicates a strong level of relationship. The rho value of 0.450 in the peak hour of Ciputat direction indicates the moderate level of relationship. While the value of rho of 0.377 in off-peak hour direction of Ciputat shows a low level of relationship. Positive value indicates a positive-correlated variable, i.e. if the delay is shorter, the travel time will also shorter.

4. Conclusion

The Performance of Trans-Jakarta bus suburban service which move-across Greater Jakarta, on route Ciputat – Bundaran Hotel Indonesia (Tosari), based on travel speed indicator is fairly bad, only 8.1% of trip could comply with Minimum Service Standard. Bus performance based on the indicator of density in the bus is good, where all points are below the maximum limit of 8 people/m² at peak hour and 5 people/m² at off-peak hour.

For variable of speed, headway and waiting time show poor performance while passenger density shows good performance. Off-peak hour waiting time indicate good performance, especially at corridor stops that are also assisted by other buses that can serve the passengers.

References

- [1] Arifin AM 2015 *Analisis Tingkat Kepuasan Penumpang pada Fasilitas Pelayanan Bus Transjakarta Berbasis Standar Pelayanan Minimal (SPM)*
- [2] Bluman AG 2012 *Elementary Statics A Step By Step Approach Eight Edition*. New York: McGraw-Hill

- [3] BPS Provinsi DKI Jakarta 2016 *Statistik Transportasi DKI Jakarta 2015-2016*
- [4] Ceder A 2016 *Public Transit Planning and Operation, Modeling, Practice and Behavior*, 2nd Ed. CRC Press, Taylor and Francis Group, FL, pp 23-55
- [5] Giannopoulos GA 1990 *Bus Planning and Operation in Urban Areas: A Practical Guide*
- [6] Harinaldi 2005 *Prinsip-Prinsip Statistik untuk Teknik dan Sains*. Jakarta: Erlangga
- [7] Hasan I 2001 *Pokok-Pokok Materi Statistik 2 (Statistik Inferensif) Edisi kedua*. Jakarta: PT Bumi Aksara
- [8] Luthfiani A 2007 *Kenyamanan Pengguna Bus Rapid Transit (Studi Kasus: Koridor 1 Transjakarta)*
- [9] Nurvia I 2007 *Analisis Persepsi Penumpang Terhadap Tingkat Pelayanan Busway (Studi Kasus Koridor 1)*
- [10] *Pedoman Standar Pelayanan Minimal Transjakarta*. ITDP Indonesia, PT. Inresh Indonesia
- [11] Satyadi R 2016 *Evaluasi Standar Pelayanan Minimal Operasional Transjakarta Koridor 9 dan Koridor 12*
- [12] Silaningsih E 2015 *Transjakarta Company's Strategy and Minimum Service Standard to Raise Passengers' Satisfaction*