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A REVIEW OF BUS PERFORMANCE IN BANDAR LAMPUNG

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Abstract: There are tendencies of over supply in bus number. This condition is responsible for the excessive queuing time at terminals; struggling of bus crews to get passengers and limited revenue which results in premature demand for fare increase. This research aims to discuss bus performance compared to the standard set up by World Bank. Data was collected through service frequency and passenger surveys in terminals and roads passed by the bus routes. Results of the analysis show average headway of 5-22 minutes (standard 1-12 minutes); travel distance per bus per day (126-243 km) well below standard (230-260 km); lost time due to queuing 16-43% and number of operating buses well above required number for healthy operating condition. Therefore the government as regulator of the bus operation should be careful in setting the ceiling number for the benefit of all.

Key Words: performance analysis, public transport, Bandar Lampung

1. INTRODUCTION

There are tendencies of over supply in the number of operating buses either in city or intercity routes. This condition is responsible for the excessive queuing time at the terminals; the struggling of the bus crews to get sufficient number of passengers; and the limited revenue per bus per day which finally results in premature demand for fare increases. Previous researches by Arintono (2001, 2003) on mikrolet service (mikrolet is a minibus with 10-16 seating capacity serving urban routes of 6-10 kilometre long without schedule and is usually operated by drivers as independent contractor) shows the evidence. He said, if mikrolet number could be adjusted to a reasonable level, service frequency can be maintained as required and the operators still enjoy profit even in economic crisis condition without fare increase. What happened was, the tariff has increased many times, from Rp350 in year 1997 becoming Rp500 (1998); Rp800 (1999), Rp1,000 (2001) and finally Rp1,200 since 2005.

In his research in mikrolet operation on the route of Tanjung Karang – Rajabasa he found these facts: the average number of operating mikrolet per day is 394 while the required number is only 150; travel times between terminals are 10 minutes (minimum), 27 minutes (maximum) with an average figure of 15 minutes and cycle time of 71 minutes. The reasonable cycle time based on the normal travel and lay-over times is 35 minutes. It shows that the excessive number of mikrolet causes lost time due to queuing nearly 50%.

In this research what will be discussed is the operating performance of public transport vehicles on other routes consisting of city and intercity buses. Some of the performance indicators will be compared to the World Bank standards for viable bus operation. The purpose of this research is to provide references for public transport operators to arrange their operating strategies and for the government to decide policies on public transport management.

In practice, there is some standard for viable bus operation which consists of mainly travel distance per bus per day, number of passengers per bus per day and load factor, leading to computation of the operating ratio (revenue over operating costs). The World Bank standard may not be fully applied to every country depending on the operating costs and tariff. However, it may be used as a general guidance to judge viability of the bus operation.

2. RESEARCH METHODOLOGY

Data for the analysis was collected through a series of direct field observation consisting of service frequency and passenger surveys on the routes of Tanjung Karang – Korpri (DAMRI buses, state-owned); Rajabasa – Panjang (private city buses) and Rajabasa – Metro (private intercity buses).

On the service frequency survey, observers were located on road sides to record bus numbers and the times the buses passed the observation points. The observation was conducted from early morning until afternoon while the buses were operating (normally from 06:00 to 18:00) for a minimum of 2 days representing weekdays and weekend. Unlike mikrolet, buses do not have numbers on the doors. Therefore, the police registration numbers were recorded instead, as the bus identity. Since the bus frequency is not high (once every a few minutes), one observer was capable of recording bus movements in 2 directions. However, 2 observers were located in each observation point to prevent data lost when one of the observers was, for some reasons, temporarily not available.

On the passenger survey, the bus routes were divided into sections of 0.50 – 2.00 km long. Control points were located between sections whose locations were chosen following observation of passenger movements, indicating the locations of passenger boarding and alighting points. The observers were onboard the buses recording the number of passengers boarding or alighting at or between control points, but he did not need to record himself as passenger. This task was conducted repeatedly between the two terminals (start and end points) as long as the buses were operating, but the observer did not need to take the same bus. Since city buses have 2 doors for passengers getting in and out, therefore 2 observers were required each was located in the front and rear door, respectively.

3. RESULTS OF THE ANALYSIS

From the service frequency survey some bus performance indicators are computed including time headway; cycle time; number of trips and travel distance per bus per day. From the passenger survey, the following indicators become available: number of passengers carried per trip; average travel distance per passenger and the load factor. And finally, the number of passengers carried per bus per day can also be computed.

Some parts of the World Bank standard are used for comparison as shown in Table 1. It should be noted here that the standard applies particularly to city buses. For intercity buses some of the standard may not apply, for instance the total number of passengers carried per bus per day, since on city buses passenger turn over occur at high frequencies (travel distance is relatively short) and, on the other hand, on intercity buses this frequency is low. And so on intercity buses the number of passengers carried per bus per day tends to be lower.

Table 1: World Bank Standard for Bus Performance

Parameters (units)	Standard
Headway (minutes)	1-12
Travel distance (km/bus/day)	230-260
Number of passengers (pax/bus/day)	440-525
Load factor (%)	70
Availability (%)	80-90

Source: Sulistyorini (1997)

3.1. Time Headway

Generally, the total number of bus-trips per day is higher on weekdays than on the weekend. The analysis is mainly based on weekday performance of the buses. The time headway is directly computed from the service frequency, i.e. if the service frequency is 4 buses per hour then the time headway (shortly called headway) is 15 minutes. Table 2 shows headway comparison among the bus routes.

Table 2: Headway Comparison Among Routes

Route	Headway (minutes)		
	Minimum	Maximum	Average
Tanjung Karang-Korpri	15	30	20
Rajabasa-Panjang	3	15	5
Rajabasa-Metro	4	60	22
Rajabasa-Metro (AC)	7	19	10

Source: Budianto (2004); Nurcholis (2004); Setiawan (2004); Widodo (2003)

Tanjung Karang-Korpri is an intracity bus route which usually has a high service frequency (short headway). In fact, its headway (20 minutes) falls below World Bank standard (1-12 minutes). On the other hand, Rajabasa-Metro is an intercity bus route which usually has lower service frequency. However, the service frequency of the Air-Conditioned (AC) buses is high enough to fit into the standard (headway = 10 minutes). The route of Tanjung Karang-Korpri is so far monopolized by DAMRI, which may intend to maximize the profit by minimizing the service frequency to target maximum number of passengers per trip. Meanwhile Rajabasa-Metro is opened for competition resulting in high service frequency which is beneficial to the users, particularly of the AC buses.

3.2. Number of Trips and Travel Distance per Bus per Day

Since there are differences in route length, the number of trips per bus per day is not applicable to compare bus performance. Instead, it is more appropriate to compare the travel distance per bus per day. For this purpose it is necessary to know the number of trips per bus per day to calculate the number of passengers carried and the travel distance per bus per day. The number of trips and the travel distance per bus per day are shown in Tables 3 and 4, respectively.

Table 3: Number of Trips per Bus per Day

Route	No. of trips/bus/day		
	Minimum	Maximum	Average
Tanjung Karang-Korpri	8	14	11.63
Rajabasa-Panjang	2	9	5.58
Rajabasa-Metro	2	6	4.00
Rajabasa-Metro (AC)	2	10	6.07

Source: Budianto (2004); Nurcholis (2004); Setiawan (2004); Widodo (2003)

Table 4: Travel Distance per Bus per Day

Route	Travel Distance (km/bus/day)		
	Minimum	Maximum	Average
Tanjung Karang-Korpri	104.80	183.40	152.35
Rajabasa-Panjang	45.20	203.40	126.11
Rajabasa-Metro	80.00	240.00	160.00
Rajabasa-Metro (AC)	80.00	400.00	242.80

Source: Budianto (2004); Nurcholis (2004); Setiawan (2004); Widodo (2003)

As seen from Table 4 only the AC bus route of Rajabasa-Metro whose travel distance per bus per day (242.60 km) fits the World Bank standard (230-260 km), while all remaining 3 routes fall well below the standard. The reason behind this is that Rajabasa-Metro is an intercity route that the average speed is higher, and especially the AC buses is well demanded, therefore the average travel distance is higher. Meanwhile the Non-AC buses on this route face severe competition from the other Non-AC buses operating on the Rajabasa-Metro corridor whose number is abundant, and so the travel distance per bus per day is limited.

3.3. Cycle Time

Cycle time is the time difference between 2 consecutive appearances in an observation point of the same vehicle in the same direction of movement. At bus terminals, cycle time is computed from the time difference between 2 consecutive departures or arrivals of the same bus. Table 5 shows cycle times for buses operating on the 4 routes, as a result of field observation. In addition, cycle time can also be computed from the total travel time (round trip between 2 terminals) plus lay-over time which is normally 10-15% of the total travel time. Table 6 shows cycle times calculated based on this assumption.

Table 5: Observed Cycle Times

Route	Cycle Time (minutes)		
	Minimum	Maximum	Average
Tanjung Karang-Korpri	74	141	98
Rajabasa-Panjang	141	333	175
Rajabasa-Metro	174	355	266
Rajabasa-Metro (AC)	113	339	202

Source: Budianto (2004); Nurcholis (2004); Setiawan (2004); Widodo (2003)

Table 6: Calculated Cycle Times

Route	Cycle Time (minutes)		
	Minimum	Maximum	Average
Tanjung Karang-Korpri	60	140	82
Rajabasa-Panjang	86	180	135
Rajabasa-Metro	128	180	152
Rajabasa-Metro (AC)	104	132	115

Source: Budianto (2004); Nurcholis (2004); Setiawan (2004); Widodo (2003)

Comparing Tables 5 and 6 it is clear that the observed cycle times are always longer than the calculated cycle times. The differences between the two are the lost times due to the excessive queuing times at the terminals because of the excessive number of the operating buses. In Section 3.7 it will be explained that the magnitude of the lost times has direct correlation with the ratio of the number of the operating to the number of the required buses.

3.4. Number of Passengers

The number of passengers per trip is calculated from summation of the number of passengers boarding through the bus doors along the route from one terminal to the other, averaged to the number of the observed trips. And then the total number of passengers per bus per day is calculated from the number of passengers per trip multiplied by the number of trips per bus per day, the result of which is shown in Table 7.

It seems Tanjung Karang-Korpri is the only route whose number of passengers per bus per day exceeds World Bank standard (440-525). As already explained in Section 3.1 DAMRI was successful in getting high number of passengers by holding the headway long enough (20 minutes), compared to the standard (1-12 minutes). Rajabasa-Metro is an intercity buses, so the total number of passengers per bus per day could not be directly compared to the standard.

Table 7: Number of Passengers

Route	pax/trip	trip/bus/day	pax/bus/day
Tanjung Karang-Korpri	55	11.63	640
Rajabasa-Panjang	61	5.58	340
Rajabasa-Metro	36	4.00	144
Rajabasa-Metro (AC)	20	6.07	121

Source: Budianto (2004); Nurcholis (2004); Setiawan (2004); Widodo (2003)

3.5. Average Travel Distance per Passenger

The average travel distance per passenger is calculated from the total passenger-kilometre (pax-km) divided by the total number of passenger. The pax-km itself is a summation of the multiplication of the number of passengers onboard the buses by the length of the route sections, for the whole sections of the route and again for all observed trips. Result of the analysis in this regard is presented in Table 8.

Table 8: Average Travel Distance of Passengers

Route	km/pax
Tanjung Karang-Korpri	5.74
Rajabasa-Panjang	7.40
Rajabasa-Metro	26.60
Rajabasa-Metro (AC)	26-40

Source: Budianto (2004); Nurcholis (2004); Setiawan (2004); Widodo (2003)

The average travel distance per passenger is directly related to the route length. On the shortest route (Tanjung Karang-Korpri = 13.10 km), the average travel distance is shorter than on Rajabasa-Panjang (route length = 22.60 km) or Rajabasa-Metro (route length = 40 km). The AC buses on the route of Rajabasa-Metro employ 'seat only' and a flat fare system irrespective of the distance travelled. In this route the travel distance survey was conducted only on the Non-AC buses which resulted 22.60 km. The average travel distance on the AC buses is estimated to be longer than on the Non-AC buses.

3.6. Load Factor

Load factor is the ratio between the numbers of passenger to the seats available. From the passenger survey, the load factors on every section of the route and on every trip can be computed which are then averaged across the total number of the observed trips, the result of which is presented in Table 9.

Table 9: Number of Passengers and Load Factor

Number of passengers per trip	T Karang-Korpri	Rajabasa-Panjang	Rajabasa-Metro	Rajabasa-Metro (AC)
Minimum (pax)	0	0	3	7
Maximum (pax)	70	62	42	29
Average (pax)	18	21	25	22
Capacity (seats)	26	26	27	28
Load factor (%)	69.23	80.77	92.59	78.57

Source: Budianto (2004); Nurcholis (2004); Setiawan (2004); Widodo (2003)

Even though the average number of passengers never exceeds the seat capacity that the load factor stays below 100%, the maximum number of passengers on certain sections of the route and on certain time of the day reaches very high figure as seen on the route of Tanjung Karang-Korpri (70 pax, load factor 269%). This route is interesting to discuss since, even DAMRI applies a long headway (20 minutes) and is successful to record the highest load factor (read: overcrowded), the average load factor never exceeds 70%, indicating that the passenger demand is concentrated on certain sections of the route and on certain time of the day. On the other routes on the other hand, the average load factors already exceed 70% that it may be necessary to increase the service frequencies.

3.7. Number of Buses

The number of buses may be assessed in many ways: the required number; the available number and the number operating daily. The ratio between the number of operating buses to the available number (expressed in percent) is called 'availability' in the World Bank standard. The required number of buses can be calculated from the cycle time divided by the headway and a spare fleet of 10% is usually added. In this exercise the average cycle time and the minimum headway are used to get the optimum number of buses. Results of the analysis is shown in Table 10. Also shown in the same table are the available number and the number of operating buses in order that the 'availability' factor can be computed.

Table 10: Number of Buses by Route

Route	Number of buses (units)			Availability
	Optimum	Available	Operating	(%)
Tanjung Karang-Korpri	6	7	6	85.71
Rajabasa-Panjang	50	61	60	98.36
Rajabasa-Metro	42	12	12	100.00
Rajabasa-Metro (AC)	18	50	32	64.00

Source: Budianto (2004); Nurcholis (2004); Setiawan (2004); Widodo (2003)

Only the AC buses on the route of Rajabasa-Metro whose performance fall below the standard. This does not mean that most of the buses are not roadworthy, instead the operators own more buses than required. The additional buses can be operated immediately when the demand increases or they are used to serve chartered services.

On the route of Rajabasa-Metro (Non-AC) the required number is 42, while the available number and the operating number daily is 12 units. Again, this does not mean that the required number is not met, since on the Rajabasa-Metro corridor there are other buses totalling 47 units. These buses do not only serve Rajabasa-Metro vice-versa, but they continue the service to other cities. Based on the observation, the total number of the Non-AC bus trips in this corridor is 91 per day (maximum number within a week). The number of Non-AC buses which merely serve Rajabasa-Metro is 12 units each making an average of 4 trips per day (totally 48 trips per day), therefore the other 43 trips (out of 91 trips) should be made by the other buses. If each bus other than those belong to the Rajabasa-Metro group makes 1 trip per day in this corridor, the required number of trips is already met. And so it may be said that the number of operating buses on this route is sufficient.

In Section 3.3 it is said that buses lost time for queuing at the terminals because there are too many operating buses. At this section it will be explained that the magnitude of the lost time is directly related to the ratio between the number of operating buses to the required number. The higher the excess the longer the lost time is as shown in Table 11. In Bandar Lampung there is no serious traffic congestion that bus speed is still within normal expectation. Accordingly, normal length of cycle time could be expected as long as the required number of buses is properly met. What happens is the bus number is excessive which is directly related to the lost time due to queuing and subsequently the cycle time.

Table 11: Relationship between Lost Time to the Excess Number of Bus

Route	Cycle Time (minutes)		Lost Time	Ratio of (*)
	Observed	Calculated	(%)	Bus No.
Tanjung Karang-Korpri	98	82	16.33	1.00
Rajabasa-Panjang	175	135	22.86	1.20
Rajabasa-Metro	266	152	42.86	1.40
Rajabasa-Metro (AC)	202	115	43.07	1.78

(*) ratio between the operating to the required numbers

3.8. Revenue-Cost Analysis

In his research Nurcholis (2004) conducted a simple revenue-cost analysis on the Non-AC bus operation on the route of Rajabasa-Metro, which shows that the bus operation is profitable with an average income of Rp40,000.- and Rp20,000.- for the driver and the helper, respectively. This section shall discuss the influence of headway changes to the income of the bus crew.

Table 12 shows the comparison of the bus performance in the existing operating condition (cycle time 266 minutes) and the expected operating condition (cycle time 152 minutes, service frequency increased by 100% from 4 to 8 trips per bus per day), computed based on the revenue-cost analysis according to Nurcholis (2004) with an assumption of the elasticity of demand to change of frequency +0.30.

The table shows that driver income increases by 30% (from Rp40,000.- to Rp52,000.- per day) with a relatively longer working time (from 8.86 to 10.13 hours per day). Anyhow, they have to work much harder (frequency increases by 100% from 4 to 8 trips per day), which may not be interesting, therefore the expected operating condition does not materialize.

Table 12: Comparison of Bus Performance to Frequency Change

Bus Performance	Original Condition	Expected Condition
Cycle time (minutes)	266	152
Frequency (trips/bus/day)	4	8
Operating hours (hours/day)	8.86	10.13
Number of pax/bus/day	144	187
Bus revenue (Rp/day)	428,000	556,000
Bus operating costs (Rp/day)	348,000	452,000
Driver income (Rp/day)	40,000	52,000
Helper income (Rp/day)	20,000	26,000

4. CONCLUSION AND RECOMMENDATION

Based on the analysis and discussion presented in the previous sections, the following are some findings, conclusions and recommendations on performance of the buses operating in Bandar Lampung.

4.1. Conclusions

The average headway ranges 5-22 minutes, indicating no tendency that on the city bus routes the World Bank standard are met, or vice versa, since from 2 intercity and 2 intracity bus routes one of them each does not meet the standard. In the travel distance per bus per day, most of the routes fall below the standard (230-260 km) except the AC route of Rajabasa-Metro (243 km).

The observed cycle time is always longer than the calculated figure based on the normal travel and lay-over times, which causes lost operating time due to queuing at terminals. From the analysis it is evidenced that the excessive number of operating buses, well above the required number, is responsible for the lost time. The higher the ratio between the operating to the required number the more the lost time is. Higher service frequency is beneficial to the users, however this is not materialized since the increased income of the bus is not comparable to the additional effort they should make.

Tanjung Karang-Korpri is the only route which exceeds the standard on number of passengers carried per day which is, however, made by sacrificing user convenience by applying long headway (20 minutes) and the highest maximum load factor (269%), while the average load factor is the lowest (below 70%) because passenger demand is concentrated at certain sections and time of day.

4.2. Recommendations

The total number of operating buses already exceeds the required number that there should be no more addition. For user convenience, the service frequency can be increased without the need to add more bus, by reducing the lay-over time (which is excessive) to reduce headway.

There must be further research on the more accurate revenue-cost analysis for the bus operation either intercity or intracity in order to decide the optimum number of buses to avoid a condition of excessive number which causes low driver income or the opposite, too few number which makes operators enjoy too much profit.

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