

Analysis of Travel Time and Bus Utilization Of Corridor 1 Trans Jakarta to Realize the Smart Mobility Concept

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Abstract—The concept of Smart Mobility is very closely related to public transportation. Trans Jakarta's operational effectiveness is one of the important factors in realizing Smart Transportation in the province of DKI Jakarta. This research looks at the strategies and technologies that have been applied by the company, the travel time of buses which operate on Corridor 1, and the factors affecting trip duration. The analysis was conducted based on the data obtained, which comprised of both primary and secondary data. Primary data includes interviews and field observations, such as the number of stops, the duration of traffic lights, and areas that point to potential obstacles. Secondary data was obtained from the company, which includes the number of passengers, bus travel history, and bus specifications and capacity. By adapting to the research conducted by Benevolo, et al. [5] regarding Smart Mobility Taxonomy, Comi, et al. [1] regarding travel time variability, and Berhan, et al. [2] regarding the optimization of the number of buses operating using the Linear Programming method, this research obtained results in the form of benefits of the technology implemented, as well as providing a solution in the form of a bus schedule (time table) which will subsequently be used as a basis to determine the minimum number of buses operating in order to optimize bus utilization and daily operating costs.

Index Terms—smart mobility, Trans Jakarta, optimization model, bus utilization, travel time

I. INTRODUCTION

Jakarta as the capital and the most populous city in Indonesia is developing a Smart City concept to solve its existing problems. The Jakarta Smart City concept is based on six pillars, namely Smart Governance, Smart People, Smart Environment, Smart Living, Smart Economy, and Smart Mobility (<http://smartcity.jakarta.go.id>). The transportation sector is a complex and difficult issue to solve and is closely related to Smart Mobility.

Public transportation plays an important role in realizing the concept of Smart Mobility. This research focuses on Trans Jakarta, particularly Corridor 1 with the route of Blok M - Kota. This corridor was chosen because it is one of the corridors with a high level of activity and also passes through several business areas. With a route length of 14.1 km and 18 bus stops along its route, the expected travel time is approximately 30-45 minutes. The reality is that the travel

time may take up to 30-90 minutes, depending on the time of day. Additionally, there are also many buses that are half empty every hour. The company has also developed a strategy and technology to improve the operations of Trans Jakarta, but it has not been seen how far it is related to the Smart Mobility concept.

This study observed the strategies and technologies that have been applied by the company, the travel time of the buses that operate on Corridor 1, and what factors affect trip duration. By adapting to studies conducted by Benevolo, et al. (2016) on Smart Mobility Taxonomy, Comi, et al. regarding travel time variability [1], and Berhan, et al. regarding optimization of the number of buses operating using the Linear Programming method [2], this research obtained results in the form of the benefits of the implementation of technology and also provided a solution in the form of a bus schedule (time table) that can subsequently be used as a basis for determining the minimum number of buses operating in order to optimize bus utilization and daily operating costs.

The research began by identifying the problems and continued with the research objectives. Literature review was carried out to build the concept, as well as to look for theories and methods that are in accordance with the research. The next stage was collecting the research data, which consisted of primary and secondary data, and data processing to obtain taxonomies and create an optimization model. The last step was to perform analyses and formulate conclusions for the conducted research.

II. LITERATURE REVIEW

A. Jakarta Smart City and Smart Mobility

Smart City is a development vision of the city to integrate information and communication technology with internet technology to develop the urban area by utilizing all assets owned. To implement the concept of Smart City, it is not only technology that plays an important role; the roles of all government agencies and communities are equally important. Musa explains that to implement the Smart City concept, local governments need to create a roadmap to realize this

concept [3]. The Jakarta Smart City concept is based on six pillars: Smart Governance, Smart People, Smart Environment, Smart Living, Smart Economy, and Smart Mobility (<http://smartcity.jakarta.go.id/>). By carrying out accurate and effective solutions, all these issues are expected to act as valuable stepping stones in Jakarta's journey in becoming a Smart City.

Mobility is closely related to transportation. Based on research conducted by Bencardino and Greco, the purpose of Smart Mobility can be divided into several categories, such as reducing air and noise pollution, traffic density, and transportation mode transfer costs; as well as increasing security and safety, and speed of the moving mode of transportation [4]. Benevolo, et al. explained how much influence Smart Mobility has from its development as well as the role of technology in supporting Smart Mobility [5]. The classification of various Smart Mobility policies and activities is carried out using taxonomy by considering the parties concerned, the intensity of the technology used, and the objectives and benefits of Smart Mobility policies and activities.

B. Bus Rapid Transit

Transportation is the basis for economic development and community development, as well as the growth of industrialization. Public transportation is an option that should be considered in urban areas. A type of public transportation that can be found in almost every area is the bus. Teng and Lai in their research explained that there were major steps to improve bus reliability, such as regulating bus lanes and providing bus priority signals [6]. Public transportation modes that use this facility are commonly called Bus Rapid Transit (BRT).

The optimization process of a transportation network based on the BRT concept must not only consider the demands of city development, traffic, increased efficiency and the benefits of network traffic, but also the integration and coordination between public transport facilities and service systems [7].

C. Travel Time and Its Relation to Bus Operational Planning

Travel time is the main issue found in transportation planning and decision making. As part of the traffic information system, predictions and actual conditions for bus arrival plays an important role in reducing passenger waiting times, improving services, and increasing public interest in traveling by bus [8]. Mahzoumi, et al. conducted a study of factors that influence the variability of bus travel time by conducting a GPS-based data analysis [9].

Planning is an important factor in daily bus operations. Several countries have used time tables for each stop. Based on research conducted by Jeong and Rilett [10], Tetreault and El-Geneidy (2010), Shalaby, et al. [11], and Hickman and Sun [12], bus operations are influenced by several factors, i.e.:

- Passengers → Passenger up and down times
- Infrastructure → Number of stops, traffic lights and route length
- Bus operational area → Weather, traffic patterns, and traffic incidents

- Driver → Rest time
- Operational management → Travel schedule and operational time recording

Jeong and Rilett combined several models to predict travel time, including historical data-based models, regression models, time series models, and neural network models [10]. Chen, et al. conducted a study on arrival prediction based on the division of area [13]. They had analyzed bus travel time instability at different dates and time periods. Shih and Mahmassani, in their research conducted the selection of vehicle size and frequency determination on a route based on the existing bus network and a demand matrix of the place of origin-destination (OD) [14].

III. RESEARCH METHODOLOGY

A. Research Model

This research consists of two parts. In the first part, the author qualitatively analyzes the process and also the application of technology that has been implemented in the company. In the second part, statistical analysis is performed to see the average travel time in each period and also proceeds to the optimization model.

The research begins by identifying the problems and continuing with the research objectives. Literature review was carried out to build the concept, as well as look for theories and methods that are in accordance with the research. The next stage was collecting the research data, which consisted of primary and secondary data. Data processing was performed to obtain the Smart Mobility Taxonomy and also create an optimization model. The last step was to perform the analysis and formulate the conclusions of the research.

B. Data Collection

There were two sources of primary data. The first source were interviews with three section managers of PT. Trans Jakarta and four routine users of Corridor 1 Trans Jakarta. The second was direct observation on Corridor 1 to obtain several types of data, such as the number of stops, duration of traffic lights, and potential barrier areas. Direct observations were also conducted at the Trans Jakarta head office with the aim of understanding the operational conditions, especially how the company controls the operation of buses. Secondary data was obtained from several divisions in Trans Jakarta, i.e. the Service Development Division, Planning Division, and Control Division. The data consisted of the number of passengers starting their trip at a Trans Jakarta Corridor 1 bus stop in the period of March 2018, travel time on Corridor 1 for the period of March 2018, and also specifications and capacity of the buses.

C. Research Areas and Bus Routes

Corridor 1 has a high activity level and runs through several business areas, including Blok M, Sudirman, Thamrin, Gajah Mada and Kota. This corridor has a route length of 14.1 km and 20 bus stops along its route. However, with the construction of the MRT along this corridor, the bus stops in

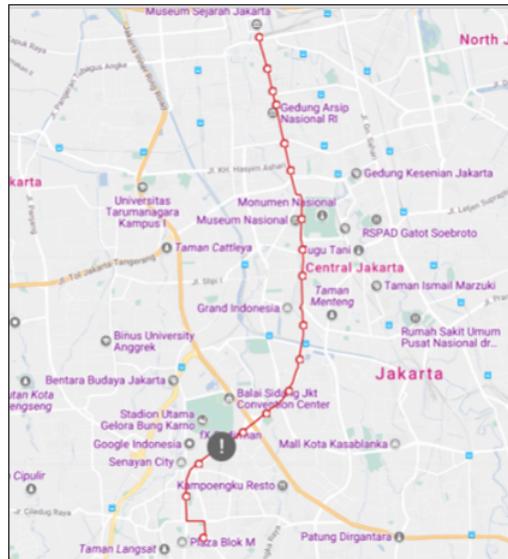


Fig. 1: Route of Trans Jakarta corridor 1 (source: TRAFI application).

this corridor were reduced to 18 stops. There are several areas where Trans Jakarta has special lanes and also areas where Trans Jakarta merges with other vehicles.

D. Optimization Model

The data obtained was processed using a combination of two optimization models, the Time Series method for travel time analysis and the Linear Programming method to determine the number of buses operating to run optimally. Comi, et al. in his research on the variability of bus travel time utilized the Time Series method to see the operational patterns of buses in Rome [1]. The calculation of travel time between terminals/bus stops was used so that the results of the research were more accurate. The formula for the travel time between terminals/bus stops (Terminal-to-Terminal bus travel time) of each fleet can be written as the following equation:

$$TV = RT + DW \quad (1)$$

Where: RT = Running Time, and DW = Dwelling Time

Data processing also utilized the Linear Programming method. In his research on the analysis of the bus control system, Berhan, et al. used the Linear Programming method to obtain the optimal number of buses to operate [2]. In this study there is a modification to calculate the optimum number of bus usage. The linear programming equation used is as follows:

$$\text{minimum} \sum_{i=1}^m \sum_{j=1}^n (X_{ij} + Y_{ij}) \quad (2)$$

$$aX_{ij} + bY_{ij} \geq D_{ij} \quad (3)$$

$$\sum_{i=1}^m \sum_{j=1}^n X_{ij} \leq c * \sum_{i=1}^m \sum_{j=1}^n T_{ij} \quad (4)$$

$$\sum_{i=1}^m \sum_{j=1}^n Y_{ij} \leq d * \sum_{i=1}^m \sum_{j=1}^n T_{ij} \quad (5)$$

$$\sum_{i=1}^m \sum_{j=1}^n (X_{ij} + Y_{ij}) \geq \sum_{j=1}^n W_j \quad (6)$$

$$\sum_{i=1}^m P_i = 1 \quad (7)$$

$$X_{ij}, Y_{ij} \geq 0 \quad (8)$$

Where: a and b = Total capacity of Bus Type-I and Bus Type-II, c and d = Fleet size of Bus Type-I and Bus Type-II, X_{ij} and Y_{ij} = Number of Trips made by Bus Type-I and Bus Type-II, i = Number of Route, j = Number of Shift, D_{ij} = Passenger demand of route i at shift j , P_i = Passenger proportion for route I , W_j = Minimum number of trips required at a given shift j , T_{ij} = Trip factor, maximum trips a bus can make on route i at a given shift j .

Equation 2 is the objective function that minimizes the total number of trips required per route per shift. Equation 3 ensures the total trips made by the two type of buses must satisfy or exceed the demand of route i during shift j . Equations 4 and 5 also ensure the total numbers of trips to be made is less than or equal to the total available trips made by bus type-I and bus type-II respectively. Equation 6 entails the number of trips made by either type of buses be at least equal to the minimum number of trips required for a given route i during that shift j . Equation 7 ensures the sum of all the trip proportion must be in unity. Equation 8 indicates the non-negativity restriction.

Several parameters need to be clearly defined for this model. The minimum number of trips needed in a period of j must meet the standard waiting time. The value of W_j can be calculated using the following equation:

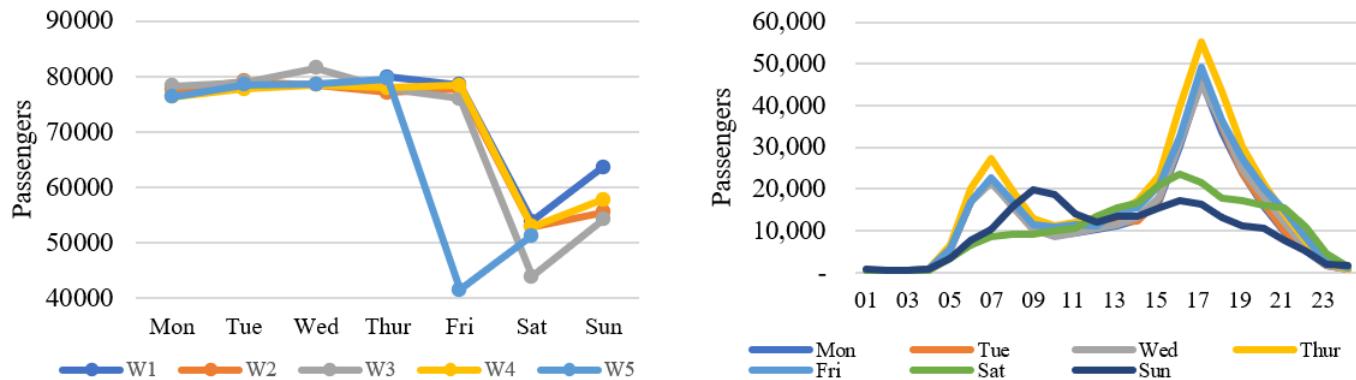


Fig. 2: Total passengers of corridor 1 in March 2018 (left-based on week | right-based on hour).

TABLE I: Demand proportion and duration of each shift (workdays)

Shift	Time Interval	Duration (hours)	Demand Proportion
Morning Peak	05:00–10:00	5	22,19%
First Off-Peak	10:00–15:00	5	17,01%
Evening Peak	15:00–21:00	6	54,15%
Second Off-Peak	21:00–05:00	8	6,65%
Total		24	100%

$$W_j = \frac{\text{Total duration for shift } j \text{ minutes}}{\text{Waiting time}} \quad (9)$$

Another parameter that needs to be defined is the trip factor or T_{ij} . The value of this parameter can be calculated using the following equation:

$$T_{ij} = \frac{\text{Total duration for shift } j \text{ minutes}}{\text{Single trip travel time for route } i} \quad (10)$$

In addition, there is the parameter P_i . This parameter is used to allocate the number of passengers or customer requests on a route i in period j . The number of requests for each route is calculated based on the proportion of the total requests for all routes.

$$P_i = \frac{\text{Daily demand of route } i}{\text{Total daily demand of all route}} \quad (11)$$

IV. RESULTS

A. The Operation of Trans Jakarta and Its Relation to the Smart Mobility Concept

Trans Jakarta has operated 13 corridors since 2004 to May 2018. There are 12 bus operators comprising of both private and government companies that operate all units. The brands and types of buses used by each operator are distinct from each other and will affect the amount paid by Trans Jakarta to each operator. In terms of bus capacity, the differences in brands can affect the number of passengers transported. This is influenced by the strength of the chassis. In terms of fuel, the company has gas-fueled buses. The number of buses that use gas is 428 units or 21% of the total number. The use of gas is to create green and efficient public transportation.

The Bus Operational plan is arranged every day and consists of the number of buses operating, the operators that operate, and which buses operate that day. In the current condition, operational time is divided into four periods: the peak periods in the morning (05.00 - 09.00) and evening (16.00–20.00), and the off-peak periods of late evening until early morning (21.00–05.00) and afternoon (09.00–16.00). Based on data obtained from the company, the passenger total of Corridor 1 in March 2018 was 2,168,251 customers. The distribution of passengers can be viewed on Figure 2. It can be seen that the total passengers on weekdays is fairly even. Passengers decrease on Saturday and Sunday due to it being a holiday and people choosing to use private vehicles or having no activities in the area on those days.

On Figure 2 (right), it can also be seen that there are differences in the busy period between workdays, Saturday/holidays, and Sundays. Of these three parts, a redistribution was made based on the shifts to see the distribution of passengers every hour, which will be used to determine the number of buses operating to maximize bus utilization (Table I).

Trans Jakarta has made several developments such as the addition of fleet for all types and specifications of buses, as well as the development of technology and infrastructure to improve service to every user to realize one of their slogans, “Smart Mobility for Smart City”. The role of Trans Jakarta in supporting the Smart Mobility concept can be seen on Table II, which was adapted from the research of Benevolo, et al. [5]. From the table it was found that vehicles, infrastructure, and local government policies related to Trans Jakarta have the influence to realize the concept of Smart Mobility.

TABLE II: Smart mobility taxonomy

Components	Reduction of Pollution	Reduction of Congestion	Increased Safety	Reduction of Noise Pollution	Improving Transfer Speed	Reducing Transfer Costs
1. Public Mobility: vehicles and innovative transport solutions						
Vehicles Euro 5	*			*		
Use of Alternative Fuels (Gas)	*					*
Route integration	*	*	*	*		*
Integrated ticketing system					*	*
2. Infrastructure and policies to support mobility						
Message signs about mobility		*				*
Bus lane or bus only lane		*	*			
Tariff integration						*
Speed limit		*				

BLOK M - KOTA	TERMINAL-to-TERMINAL TRAVEL TIME											
	FIRST PEAK			FIRST OFF-PEAK			SECOND PEAK			SECOND OFF-PEAK		
	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
Blok M - Masjid Agung	0:24:25	0:01:25	0:05:37	0:30:11	0:01:55	0:08:07	0:21:25	0:01:25	0:07:35	0:15:30	0:01:05	0:03:32
Masjid Agung - Bund Senayan	0:20:30	0:01:13	0:05:45	0:21:40	0:00:35	0:05:27	0:07:10	0:01:05	0:03:55	0:12:05	0:00:50	0:02:36
Bund Senayan - Gelora Bung Kamo	0:06:25	0:01:13	0:02:25	0:06:45	0:01:30	0:02:26	0:11:45	0:01:30	0:03:17	0:08:30	0:01:00	0:01:56
:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:
Olimo - Glodok	0:03:40	0:00:50	0:01:31	0:29:15	0:00:55	0:02:20	0:03:05	0:01:05	0:01:33	0:07:05	0:01:00	0:01:33
Glodok - Kota	0:06:25	0:00:40	0:01:54	0:15:40	0:01:20	0:02:48	0:31:25	0:01:05	0:02:56	0:14:11	0:00:20	0:01:55
TOTAL	2:35:56	0:20:11	0:49:52	3:32:24	0:21:59	0:57:04	3:40:35	0:20:35	0:58:26	2:05:11	0:14:12	0:35:48

Fig. 3: Terminal-to-terminal bus travel time (workdays & Blok M–Kota).

KOTA - BLOK M	TERMINAL-to-TERMINAL TRAVEL TIME											
	FIRST PEAK			FIRST OFF-PEAK			SECOND PEAK			SECOND OFF-PEAK		
	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG
Kota - Glodok	0:11:40	0:00:40	0:02:35	0:04:30	0:00:35	0:02:16	0:23:05	0:00:40	0:03:23	0:12:55	0:00:30	0:01:58
Glodok - Olimo	0:03:25	0:00:40	0:01:25	0:03:02	0:00:47	0:01:55	0:03:45	0:00:40	0:01:34	0:06:07	0:01:00	0:01:30
Olimo - Mangga Besar	0:03:13	0:00:45	0:01:11	0:03:02	0:00:45	0:01:21	0:03:55	0:00:40	0:01:25	0:06:07	0:00:25	0:01:19
:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:
:	:	:	:	:	:	:	:	:	:	:	:	:
Bundaran Senayan - Masjid Agung	0:07:35	0:01:37	0:03:33	0:04:55	0:01:15	0:02:49	0:06:00	0:02:00	0:03:32	0:04:43	0:01:03	0:02:11
Masjid Agung - Blok M	0:11:10	0:00:55	0:04:28	0:15:40	0:00:45	0:05:05	0:14:40	0:00:55	0:06:03	0:09:41	0:00:40	0:03:17
TOTAL	2:09:18	0:19:54	0:49:19	1:42:22	0:23:31	0:49:44	2:31:20	0:19:02	0:54:20	1:41:22	0:15:10	0:33:51

Fig. 4: Terminal-to-terminal bus travel time (workdays & Kota–Blok M).

B. Optimization Model Results

1) *Time Series:* The travel time of the Trans Jakarta buses on Corridor 1 varies greatly for each period and route. The variation of travel time is due to several reasons, such as the Trans Jakarta bus line, the number of passengers, the time to stop at each stop, and the number of intersections passed. Using the Time Series method, we obtained results in the form of travel time between stops (Terminal-to-Terminal Bus Travel Time). These results can be used by companies later on to create timetables.

2) *Linier Programming:* By using the Linear Programming method, the optimal number of buses operating in each period (shift) was obtained by looking at the available number of buses, increasing bus utilization and decreasing operational costs, as well as keeping the level of service of the company

in mind. There are three types of buses operating, but in this model only two types are most often used for Corridor 1 operations, which are the articulated buses and standard buses.

The articulated bus is named as Bus Type-I and has a capacity of 109 passengers, whereas the standard bus is named Bus Type-II and has a capacity of 63 passengers. During March 2018, the maximum number of buses operating on Corridor 1 were 70 units of Type-I and 17 units of Type-II. In order to create comfort for passengers, the bus capacity used in this model is 90% of the maximum capacity.

There were also several assumptions used in this model. All passengers located at the Blok M–Tosari bus stop are heading to Kota. For passengers located at the Stasiun Kota–Sarinah bus stop, all of them are headed to Blok M. There are also additional restrictions on weekdays during the first

TABLE III: Input parameters for the linier programming model (workdays)

Route	Total Passengers (Demand)	Pi	Demand (D_{ij}) per Shift				Trip Factor (T_{ij}) per Shift			
			D1 W1 = 60	D2 W2 = 30	D3 W3 = 72	D4 W4 = 48	T1	T2	T3	T4
1 (Blok M-Kota)	45.661	58,40%	10.131	7.766	24.727	3.038	6,00	5,26	6,21	13,33
2 (Kota-Blok M)	32.521	41,60%	7.216	5.531	17.611	2.164	6,12	6,00	6,67	14,12
Total	78.182	100%	17.347	13.296	42.337	5.201				

TABLE IV: Number of trips per shift per route (workdays)

Route	First Peak		First Off-Peak		Second Peak		Second Off-Peak	
	Bus 1	Bus 2	Bus 1	Bus 2	Bus 1	Bus 2	Bus 1	Bus 2
Blok M-Kota	83,32	16,66	63,86	12,77	203,34	40,677	—	48,22
Kota-Blok M	59,34	11,87	45,48	9,10	144,82	28,96	—	34,34
Total	142,66	28,53	109,35	21,87	348,17	69,63	—	82,56
Total Trip	171,19		131,22		417,80		82,56	

TABLE V: Number of buses per shift per route (workdays)

Route	First Peak		First Off-Peak		Second Peak		Second Off-Peak	
	Bus 1	Bus 2	Bus 1	Bus 2	Bus 1	Bus 2	Bus 1	Bus 2
Blok M-Kota	13,89	2,78	12,13	2,43	32,76	6,55	—	3,62
Kota-Blok M	9,69	1,94	7,58	1,52	21,72	4,34	—	2,43
Total	23,58	4,72	19,71	3,94	54,48	10,90	—	6,05
Total Bus (Round Up)	24	5	20	4	55	11	0	7

peak period, first off-peak period, and second peak period. The number of trips made by Bus Type-II totaled a maximum of 20% of Bus Type-I. In addition, there were no trips made by the Type-I bus in the second off-peak period. This limit is applied so the bus can be effectively used to transport passengers. The minimum number of trips needed in a period of j must meet the standard waiting time. In this case, the standard waiting time was 5 minutes during the peak period and 10 minutes for the off-peak period. To complete the Linear Programming model, the initial data must be entered as input into the model. This data is obtained from the calculation of the above formula and secondary data.

Data was generated from the input data contained in Table 4 on the number of trips per route in each period as found on the following table.

From the number of trips, the number of buses can be generated from the following calculation:

$$\text{Number of Buses} = \frac{\text{Number of Trips}}{T_{ij}} \quad (12)$$

From the equation, the minimum number of buses that can serve passengers on Corridor 1 of Trans Jakarta can be viewed on the following table:

V. DISCUSSION

From the processing results of the Linear Programming models, it appears that there are differences in the number of standard buses used to serve the passengers in each period of the day and time. There were more articulated buses used in the three initial periods compared to the standard buses because the prior have a much larger capacity, as well as

considering the operational costs of the buses. In the last period, the standard bus is used due to the lower number of passengers. Therefore to maximize bus utilization, the standard type of bus is chosen to serve passengers in that period. A time table was also generated from the two optimization models as a reference for the bus operational schedule. The example of the time table is as shown on Table V.

From the data processing results of the optimization model, it was found that companies also benefit in terms of fuel operating costs. All articulated buses operating on Trans Jakarta corridors are gas-fueled; whereas standard buses are all diesel-fueled. The savings in fuel consumption by Trans Jakarta can be viewed on Tables VI and VII.

Data processing showed that with the optimization model, fuel cost efficiency on the working days is Rp 14.111.668/day. By optimizing the total number of buses operating, the company can create efficiency in other areas, such as employee operational costs, drivers, and vehicle maintenance costs.

VI. CONCLUSION AND RECOMMENDATIONS

A. Conclusion

This study has formulated several conclusions from the data collection process through direct observation and interviews with several sources, to data processing. The routine operational plans show that the company strives to provide optimal services for all customers. This can be better implemented when historical data is also used, and is not just based on intuition. This method can also be done on a weekly or monthly basis, not daily as the current condition. Regarding Trans Jakarta's operations, the company has implemented a fairly good strategy. The deposition of units is one of the

TABLE VI: Example of Trans Jakarta corridor 1 time table (left-schedule with deposition — right-without deposition)

Bus Code: BM 1			Bus Code: BM 2		
Location	Shift 1	Shift 2	Location	Shift 1	Shift 2
Blok M	5:00	15:00	Blok M	5:03	13:37
Kota (arrive)	5:50	15:58	Kota (arrive)	5:53	14:35
Kota	5:55	16:03	Kota	5:58	14:50
Blok M (arrive)	6:45	16:57	Blok M (arrive)	6:48	15:38
Blok M	6:55	17:05	Blok M	6:58	15:45
Kota (arrive)	7:45	18:03	Kota (arrive)	7:48	16:43
Kota	7:50	18:08	Kota	7:53	16:48
Blok M (arrive)	8:40	19:03	Blok M (arrive)	8:43	17:31
Blok M	8:50	19:13	Blok M	8:53	17:36
Kota (arrive)	9:40	20:11	Kota (arrive)	9:43	18:34
Kota	9:45	20:16	Kota	9:48	18:39
Blok M (arrive)	10:35	21:11	Blok M (arrive)	10:38	19:34
Blok M	SPLIT	POOL	Blok M	11:02	19:44
Kota (arrive)			Kota (arrive)	11:59	20:42
Kota			Kota	12:09	21:00
Blok M (arrive)			Blok M (arrive)	12:57	21:35
					POOL

TABLE VII: Details of Trans Jakarta bus fuel consumption

Type	Route Length	Fuel/Litre	Fuel/Trip	Price/Litre	Fuel Cost/Trip
Gas	14,1 km	2,5 km	5,64 litres	Rp 3.100	Rp 17.484
Diesel	14,1 km	4 km	3,525 litres	Rp 5.150	Rp 18.154

TABLE VIII: Fuel efficiency (workdays)

TOTAL BUS OF CORRIDOR 1								
Detail	First Peak		First Off-Peak		Second Peak		Second Off-Peak	
	Bus 1	Bus 2	Bus 1	Bus 2	Bus 1	Bus 2	Bus 1	Bus 2
Optimization Results	24	5	20	4	55	11	0	7
Actual	75	9	62	9	75	9	0	6

TRIP FACTOR				
Detail	First Peak		First Off-Peak	
	T 1	T 2	T 3	T 4
Optimization Results	6	6	7	14
Actual	6	8	6	12

EFFICIENCY OF FUEL COST/DAY (Rp)									
Detail	First Peak		First Off-Peak		Second Peak		Second Off-Peak		
	Bus 1	Bus 2	Bus 1	Bus 2	Bus 1	Bus 2	Bus 1	Bus 2	
Optimization Results	2.517.696	544.613	2.098.080	435.690	6.731.340	1.397.839	—	1.779.068	15.504.325
Actual	7.867.800	980.303	9.004.260	1.307.070	8.169.188	980.303	—	1.307.070	29.615.993
TOTAL EFFICIENCY								(14.111.668)	

excellent strategies used to maximize existing bus utilization and reduce operating costs. For the operational conditions of Corridor 1, the mixed lane that merges with other vehicles greatly impacts the travel time of the Trans Jakarta buses, both for the overall travel time and between bus stops. Other factors that greatly affect travel time include traffic density that often occurs along Corridor 1, the number of red light intersections, and the even-odd policy implemented along Sudirman–Thamrin Road.

The terminal-to-terminal travel time data can also be used by companies in the future to create time tables for each bus. In addition, research data on the minimum number of buses required can also be used as a reference by the company to determine the number of buses operating. By optimizing the number of buses operating, the company can perform operational cost efficiency in other aspects, such as fuel, employees, and vehicle maintenance.

B. Managerial Implications

Trans Jakarta's operational conditions are fairly good, but many developments and improvements can still be done. From data processing results, the terminal-to-terminal travel time between stops can be used as a reference by companies to compile bus schedules (time tables). Results of data processing concerning the minimum number of buses show differences in the number of buses that operate every day. The difference in the number of buses can optimize ongoing Trans Jakarta operations and provide savings for the company.

With the current development of other public transportation modes such as the Mass Rapid Transit (MRT) and Light Rail Transit (LRT), Trans Jakarta must be able to develop strategies to synergize Trans Jakarta's operations with these two modes of transportation. By synergizing Trans Jakarta's operations with the MRT and LRT, as well as increasing the number of non-BRT routes, Trans Jakarta will continue to be considered as a choice method of public transportation for the people.

C. Recommendations

After conducting research on the operational analysis and scheduling system of the Trans Jakarta Corridor 1, the suggestions that can be given are as follows:

- Preparation of operational plans on a weekly/monthly basis and based on data analysis
- Allocation of buses that have a fixed route
- The process of downloading and trimming data periodically
- Implementation of the Trans Jakarta special lane
- Active scheduled maintenance of Trans Jakarta buses and its supporting facilities
- Application of technology that connects between the systems of each bus with traffic lights

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