Determination of balance ratio load factor and calculation of waiting time for urban transportation in Depok

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ISSN : 1978-774X

DETERMINATION OF BALANCE RATIO LOAD FACTOR AND CALCULATION OF WAITING TIME FOR URBAN TRANSPORTATION IN DEPOK

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ABSTRACT

Urban transportation as part of public transport has an important role in supporting the mobility of the population of Depok. Besides that, urban transportation has fleet number more than other types. The population is increasing each year cause increased mobility of the population so that the existence of public transportation can help fluency. The object of this study is only one route, that route is Terminal Depok-Depok II Middle East. Secondary data collection routes include the route and the number of fleet. While the need for primary data obtained from survey interviews public transportation drivers to get the vehicle operational data and dynamic surveys to get the number of passengers. Static survey on the road is to get the value of headway. D02 urban transportation routes based on passenger waiting time indicator of the standard 5 -10 minutes have a less good performance with a value of 1.015 minutes. Based on the results of dynamic systems simulation built a rational number of urban transportation in the city of Depok to D02 Route 100 units thus providing a load factor value of 9.61%. This condition can increase revenue driver.

***Keywords**: transportation, urban transportation, dynamic system, load factor, fleet, waiting time*

1. INTRODUCTION

City has are major role as a growth centre. City is the location of the most efficient and effective for the productive activities in relation with the availability of facilities and infrastructure, availability of labour, availability of funds as a fleet and so on. In ten years the city of Depok had rapid growth, both the trade sector, industry, education, tourism, hospitality, and residential. Depok is the gateway of West Java Province which borders the capital city of Jakarta. Because many people are judge that Depok promising a good life expectancy.

Increasing population along with the increasing number of facilities to be provided by the government to support the needs of its population. Public transport as one means of transport are has a significant role in determining the effectiveness and efficiency of transportation systems in the city. So that also played a role in determining the level of community life.

The increasing demand for urban transportation services as a result of the high mobility of the population has not felt able to offer seamless and satisfactory service. So that will performed determining the balance value of the load factor between the number of urban transportation and the number of passengers and calculations of passenger waiting time urban transportation.

Therefore, urban transportation system of transportation that there now needs to be reorganized into an integrated transport system, thus mobility of passengers to and from the destination is well organized, smoothly and satisfactory.

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2. THEORETICAL BACKGROUND

2.1. Previous Research

Previous research which can be used as a source of literature performed by Fadlillah et al. (2008) with the title of Model Development Evaluation of Transportation

System in Jakarta City with Dynamic System Simulation.

The research was performed in Jakarta, especially North Jakarta. Discussion of the study was to determine the balance ratio of load factor and developing urban transportation scheduling scenarios.

Results were obtained by a rational number of the urban transportation is 30 fleet and the balance ratio of load factor is 30%.

2.2. Transportation

Transport is defined as the transfer of goods or humans from place of origin to destination (Nasution, 1996).

From the definition, it can be concluded that transportation activities will occur if certain conditions are met there is loads that is transported, provided a sufficient equipment transport and road facilities and bridges have to be passed.

2.3. Performance Analysis of Transportation

1. Waiting Time

The waiting time is the time it takes passengers to get a urban transportation wants. Passenger waiting time related to headway. Assuming a constant headway, the arrival of passengers and vehicles having a lot of uneven places, times the average passenger waiting obtained by the equation (Nasution, 1996) :

$$w = \frac{h}{2} \quad (1)$$

where:
w = the average waiting time (minute)
h = headway (minute)

2. Load Factor

Load factor is the ratio of the amount contained in the transport of passengers with a seating capacity available. Standard parameters of the load factorbased on PP 41/1993 is0.7 (Nasution, 1996). The formula to calculate the load factor is:

$$Load\ factor = \left(\frac{number\ of\ passenger}{capacity}\right) x\ 100\% \quad (2)$$

2.4. System Approach

System is the overall interaction among the elements of an object within a particular environment that works to achieve goals (Muhammadi, 2001).

The overall question is more than just the sum or composition (aggregate), which lies in the strength (power) generated by the whole is far greater than the sum or arrangement.

2.5. Dynamic System

Dynamic Systems is an approach to understanding the behaviour of complex systems from time to time. Is related with internal feedback and time delays that affect the overall behaviour of the system. What makes the dynamic system is different from other approaches for studying complex systems is the use of feedback loops and stocks and flows.

2.6. Dynamic System Simulation

Simulation is an imitation of a dynamic system by using computer models used to evaluate and improve performance of system.

Simulation is defined as a completion or stage by stage calculation of the mathematical equations that describe the state of the system to know the changes that occur in the system so that the known behaviour (Forrester, 1961).

2.7. Validation of Dynamic System Models

To determine is model valid to create a simulation of alternative policy or non policy and forecasting, it is necessary to do a validation model, with a view to considers the extent to which the model can represent the actual condition.

In this research, statistical criteria for validation of the value used was U-Theil's Inequality Coefficient (U).

$$U = \frac{\sqrt{\frac{1}{n}\sum_{t=1}^{n}(Y_t^s - Y_t^a)^2}}{\sqrt{\frac{1}{n}\sum_{t=1}^{n}(Y_t^s)^2} + \sqrt{\frac{1}{n}\sum_{t=1}^{n}(Y_t^a)^2}} \quad (3)$$

Where:
Y_t^s = the basis of the simulation results of observation variables
Y_t^a = the actual value of the variable observation
N = number of observations

U statistic value is useful to determine the ability of the model for simulation analysis. U-Theil's coefficient value (N) ranged between 1 and 0. If U=0 then the model prediction is perfect, if U=1 then the naive model prediction.

3. RESEARCH METHOD

Conceptual framework begins with the determination of the location that will be the research centre. This study begins by reviewing previous research ever conducted about solving problems in transportation.

Determination of the amount of route is the first survey activities conducted in this research. This information can be collected in Depok City Department of Transportation. Amount of route data collected is limited only to fleets that operate public transportation serving the community in Depok.

After an unknown number of route, it will be the prioritization of route using Simple Random Sampling method. Based on the route selected, then the observation will be conducted to determine the number of passengers and freight headway in the city. Observations will be performed directly on weekdays.

Determination of the balance of ratio of the load factor between the number of fleet and passengers carried after the data on the route, the number of fleet and number of passengers using the simulation of dynamic systems.

Simulations will be performed by using software Power Simulation. Validity of the simulation will be performed by using a statistical U-Theil's approach then performed the calculation of the waiting time of passengers to wait for current conditions urban transportation.

4. RESULT AND DISCUSSION

From the survey data was then analysed to determine the balance of value the ratio of load factor urban transportation and the number of passengers and calculate the waiting time of passengers to wait for urban transportation D02 in Depok.

4.1. Determine The Balance Ratio between The Number of Fleet and Passengers

To determine the balance between the number of fleet and passengers will be modelling and assumed the Dynamic System Simulation. To be able to model an urban transportation system problems first created a causal diagram or a Causal Loop Diagram (CLD).

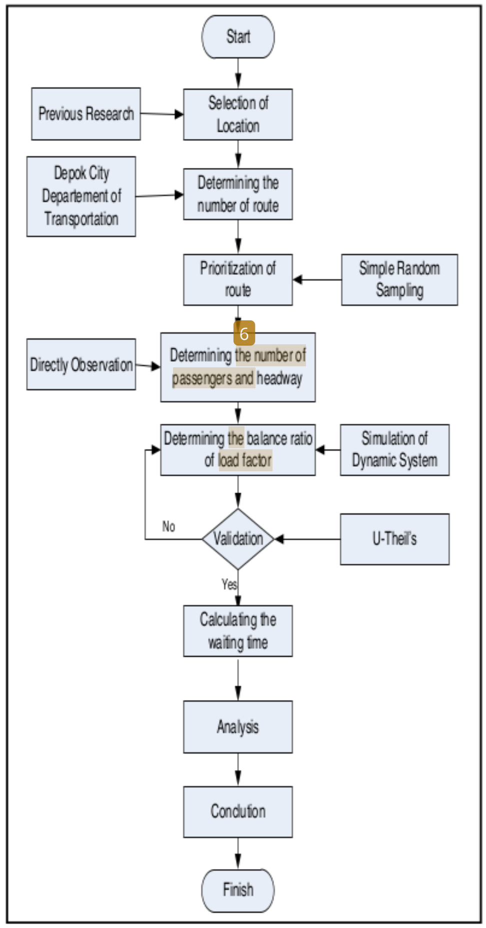

Figure 1.Flow Chart of Research Methodology

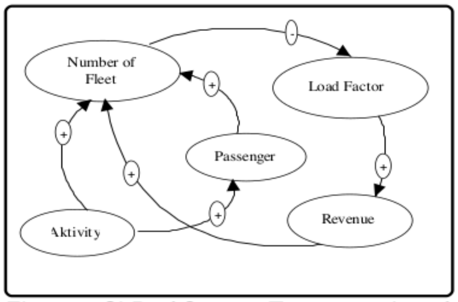

Figure 2.CLD of System Transportation of D02 Fleet Number of Fleet

CLD can be categorized as a type of closed loop. It means that all variable systems that are in the integration of the various activity occurring in the scope of the route D02 very affect the number of passengers.

Activity occurring here is a school activity, employment, trade (including the market) and others.

4.2. Simulation Model Balance of Total Fleet and Passenger with Dynamic System Simulation

The calculation of the balance ratio between the number of fleet and number of passengers using the system dynamic simulation is divided into two shifts, the early shift and the day shift.

Early shift is the time to operate the fleet of D02 in the round at 5 am until 13 pm. While the day shift is the time to operate the fleet of D02 at 13pm to 20pm.

Based on interviews with public transportation drivers, on average in a single day occurred eleven times a round, 6 rounds for the early shift and 5 rounds for the day shift. Average travel time for one round of the origin and destination is for 1 hour 30 minutes.

SFD model in Figure 3. represents the second round of morning. Total number of passengers the 2nd round of morning is obtained by adding constant number of passenger origin and destination of the second round of morning.

The total number of passenger origin and destination set as constants for passengers who ride on the assumed fixed by observation of passengers up and down during the workday.

Each round of origin and destination are calculated load factor to determine the ratio between the number of passengers and fleet capacity D02 as many as 14 people. Then the load factor of origin and destination rounds averaged to determine the value of load factor for the second round.

The calculation of performed load factor separately for the early shift and afternoon shift, that is the ratio between the total passengers morning or afternoon with the conversion of fleets to the number of passengers that can be transported by the fleet. The ratio obtained from an average ratio of early and afternoon.

Revenue driver is net income drivers who brought home every day. Net Revenue is obtained by reducing the gross revenue with other costs that is rental fee, fuel costs, and unexpected cost of (police and illegal retribution).

Determination of the amount of revenue driver that is affected by the ratio need to know variable number of drivers. Variable number of drivers are added by inserting a constant number of fleets.

Based on the simulation results as presented in the SFD Load Factor in Figure 3. between the number of fleet, ratios, revenue drivers and U-Theil's value calculation described in Table 1. known that less number of available fleet, the higher the ratio of load factor, and the higher revenue driver.

Conversely, more the number of available fleet, the lower the ratio of load factor, and the smaller the revenue driver. The smaller the value U-Theil's shows that the simulation results better than the actual condition.

Table 1.Simulation Result

Number of Fleet	Ratio *Load Factor*	U-Theil's Value	Revenue Driver (Rp)
569	0.0169	0.9529	354.900
100	0.0961	0.7586	3.508.920
50	0.1921	0.5693	7.335.450
30	0.3202	0.3723	12.437.483
20	0.4804	0.1860	18.815.025
15	0.6405	0.0444	25.192.567

ISSN : 1978-774X

To determine the optimality of the number of fleets, the value of the ratio and amount

of income drivers, and which can describe the meeting point between these values visible on the graph in Figure 4.

From Figure 4 can viewed that the value of the ratio of the optimal load factor was at a point with a value ratio of 0.0961 with a fleet of 100 fleet andand revenue drivers per day is Rp 3,508,920,-

This proves that the current condition is irrational, because the amount of the existing fleet of 569 vehicles and result in load factor value ratio 0.0169. Here we can see that the value of the vehicle load factor is currently very low.

4.3. Calculating the Waiting Time

Headway is the time interval between two vehicles of similar one route sequence. Waiting time is half of headway. As a parameter to assess the characteristics of public transportation systems use a standard used by the World Bank related to passenger waiting time by an average of 5-10 minutes and the average headway between public transportation is 0-20 minutes (Nasution, 1996). Analytical results based on data obtained as in Table 2. Point of Balance

Table 2. Headway Calculation Results and Waiting Time Urban Transportation D02

No.	Description	Value
1	Headway (minute)	2.030
2	Waiting Time (minute)	1.015

Obtained the passenger waiting time for 1.015 minutes. This indicates that performance of D02 fleet is poorly although advantageous for passengers not too long to wait to get urban transportation.

But this result not a good for driver because the passenger is gained to be reduced. Can be estimated that the average headway and passenger waiting time during peak hours (where the demand for public transport to achieve the highest number in one day) is smaller than its average value.This is related to the tendency of drivers to speed up service during peak hours with the intention to do more trip thus gaining greater profit.

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

1. Based on a model that has been built then the balance ratio of the optimal load factor that is 9.61% by the number of urban transportation D02 is 100 fleets, and revenue driver is Rp 3,508,920, -.
2. Based on indicators of passenger waiting time the standard is 5-10 minutes, urban transportation D02 have a poorly performance with a value of 1.015 minutes.

5.2. Recommendation

1. Reduction of the number of fleets to increase the value of load factor which affects the revenue driver.
2. Provision of facilities bus stops in every public transport stops, especially on a busy road.
3. There needs to be re-regulating the number of fleet-related control of route license and the feasibility of operating vehicles.
4. Future research can be performed to determine the headway and the optimal waiting time.

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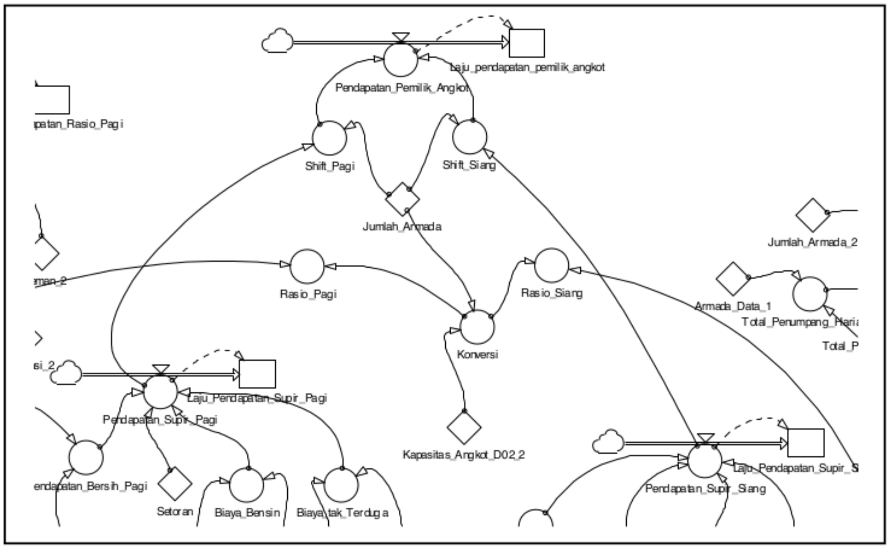

Figure 3.Stock Flow Diagram Load Factor

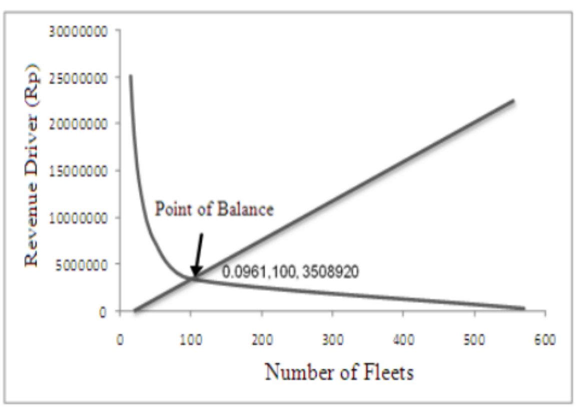

Figure 4.Graph of Relationship between Number of Fleets and Revenue Driver

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