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How Many Cost Losses Caused By Traffic Jam In Term Of Fuel Consumption and Value of Time On Main Road in Bandar Lampung

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Abstract— Bandar Lampung, capital city of Lampung such as gate of Sumatera with 902,885 population in 2012, having 120,554 passenger cars. Like other major cities in Indonesia, especially during peak hour, congestion is commonly visible in several main roads. Traffic jams of course will lead to a considerable loss in terms of the value of time, fuel consumption, air pollution, noise and some other qualitative aspects. This research tries to calculate how the losses incurred as a result of congestion in terms of fuel consumption and time value. A survey carried out for six days in the peak time morning, noon and afternoon to calculate the traffic volume, speed, travel time and delay in one main road of this city along . Fuel consumption for each vehicle type is obtained from interviews and secondary data from vehicle dealers. The type of vehicles that are reviewed are some brands of private cars with 2 types of diesel and gasoline also public transport, without reviewing a motorcycle. After we obtain travel time per each liter fuel consumption and delay, we reach fuel consumption in traffic jam. From the analysis results showed that the loss is due to congestion based on fuel consumption is around Rp. 4.751.432.140,- per year. While the value of time obtained by the method of income approach and stated preference generate each value Rp. 16.903 per hour and Rp. 18.437 per hour. Financial losses from value of time is calculate by multiply time of traffic jam, traffic volume and value of time. Using Income Approach, the loss is due to congestion based on time value is around Rp. 3.607.076.443,- per year. The total cost of the losses due to congestion in terms of fuel consumption as well as value of time is Rp. 8.358.508.583 per year. It takes only a few sample in main road which is less than 5 km only. We can imagine the loss due to all of city area with many road segments that was crowded. This financial value is also only results from congestion due to fuel consumption and value of time, not counting from air pollution, noise and other aspects resulting from the raise of traffic volume. If engineering improvement such as traffic management not done to reduce private vehicles growth, the quality of urban communities's life will be declining and environmental damage getting worse for future generations.

Keywords— fuel consumption; time value; traffic jam; financial losses; stated preference

I. INTRODUCTION

Bandar Lampung is the capital of Lampung Province with an area of 197.22 km ² which is divided into 20 districts and 126 sub district with a population of 902.885 inhabitants (based on BPS 2012), this population will increase each year. The needs of life that increase, will affect the increasing travel demand due to the increased activity of the movement of people and goods in Bandar Lampung.

Teuku Umar and Zaenal Abidin Pagar Alam Road is the road that is frequently crossed by the people of the city of Bandar Lampung as the trip generation. This leads to the need for transportation services that causes congestion in this area. Congestion on the roads is worst if there is no improvement on the existing transportation system and will also be very harmful for the users.

The purpose of this study is to calculate the value of travel time in Bandar Lampung and analyze financial losses caused by congestion due to increased travel time and fuel consumption. The amount of loss due to congestion only in terms of the value of travel time and fuel consumption. Roads to be reviewed are the two main roads along the ± 3.7 km. Analysis of the value of travel time using the Income Approach method. Financial loss due to congestion is more focused on fuel consumption according to the type of vehicles that includes the specified time freezes and travel time per 1 liter of gasoline. The type of vehicle being simulated in this study is the private cars with premium fuel and diesel fuel and public transport such as "mikrolet" and Bus Rapid Transit (BRT).

II. THEORETICAL BASIS

A. Delay and Queue Time

Delay is the additional travel time due to vehicles driving at high speed inhibited by an oncoming vehicle at low speed. The formulation of delay time (R) is as follows:

$$R=L/X - L/Y \quad (1)$$

Where:

R = delay time of vehicle (hour)
X = low speed of vehicle (km/ hour)
Y = high speed of vehicle (km/ hour)
L = queue length (km)

Queuing time is the amount of time in which the high speed vehicle is at queuing behind a low speed vehicle during the trip. The formulation of queuing time (T) is as follows:

$$T = \frac{R}{\left(\frac{1}{X} - \frac{1}{Y}\right) X} \quad (2)$$

Where:

T = queue time of vehicle (hour)
R = delay time of vehicle (hour)
X = low speed of vehicle (km/ hour)
Y = high speed of vehicle (km/ hour)

B. Congestion Cost

The congestion cost is travel costs incurred due to traffic delays and additional traffic volume exceeds the capacity of the road service. The main components of trip cost is vehicle operating costs and travel time value. Vehicle operating costs are incurred in the operation of transport systems such as the cost of fuel, lubricant, tires, vehicle maintenance costs, and so forth. While the value of time is a specific time that is measured based on income level.

One of the methods used in calculating the value of travel time is Income Approach. This method is relatively simple, as it only considers two factors: Gross Regional Domestic Product (GRDP) of individuals and the amount of working time in a year that the individual time used to produce a product in the form of a person's income. The formulation of this method are as follows:

$$\text{Value of time} = \frac{\frac{GDRP}{Person}}{Amount\ of\ Working\ Time\ per\ person\ per\ year} \quad (3)$$

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III. DATA ANALYSIS

The primary survey are traffic volume, travel time, delay time and the vehicle speed.

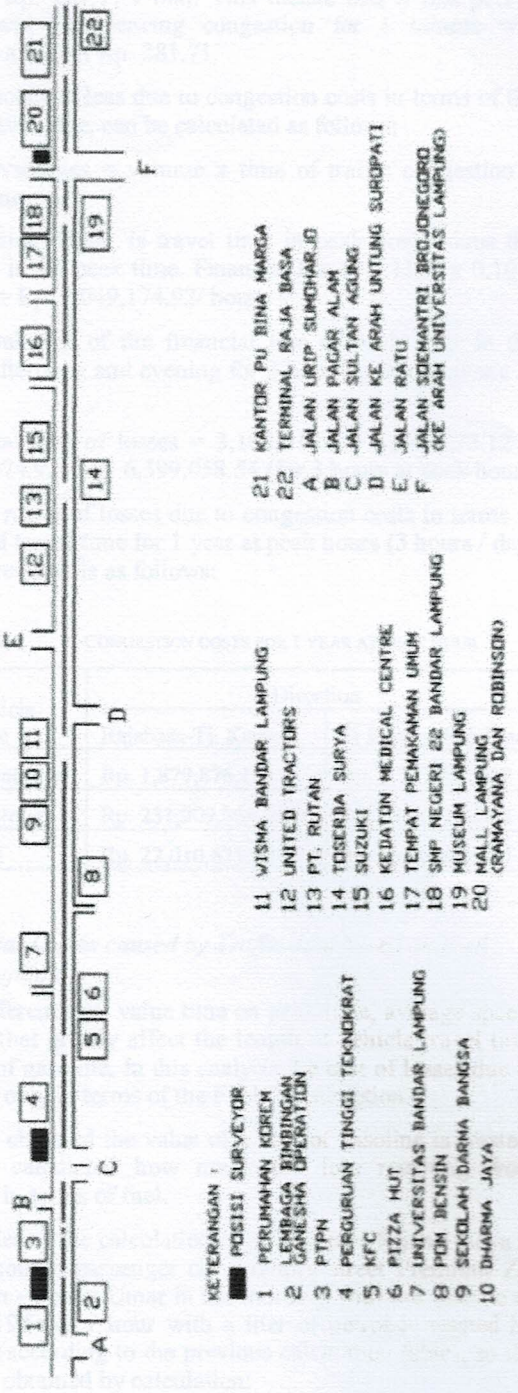

Fig. 1. Survey Location

survey conducted on Monday, Wednesday and Sunday at peak hours in the morning, afternoon and evening.

D. Traffic Volume

The following Figure 2 and Figure 3 is the charts of vehicles volume on weekdays which explains the high volume of private vehicles over public transport.

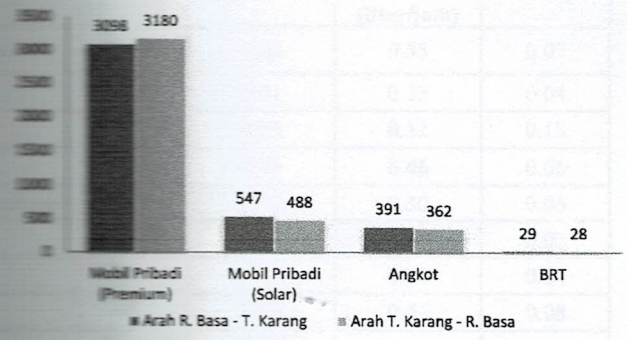

Fig.2. Traffic Volume on Working Day

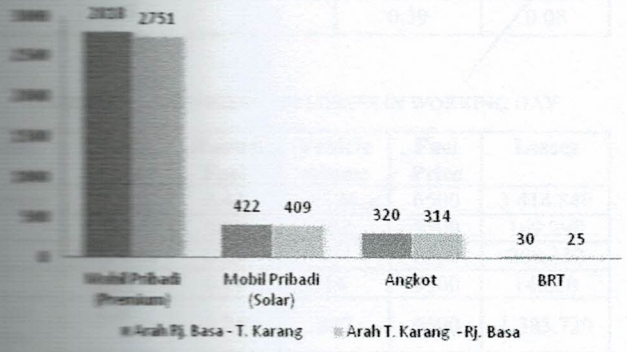

Fig.3. Traffic Volume on Holiday

E. Value of Travel Time

Data used is the number of working age population 16-64 years, to calculate the time value of the income approach method. By age group of workers, the population of Bandar Lampung amounted to 629,403 people. As for the GDP (Gross Domestic Income) Bandar Lampung is Rp. 25,552,453,000,000.00 (based on BPS 2012).

For work time in a year, assuming one person working for 8 hours a day with 25 working days in a month, then the amount of working time of the year are as follows:

Total working time a year = 8 x 25 x 12 = 2400 hour/person

So, the value of travel time

$$\frac{25,552,453,000,000.00}{\text{Person}}$$
$$2400$$

= Rp 10,648.89/hour

= Rp 281.71/minute

F. Financial Losses caused by Traffic Jam based on Value of Travel Time

In this analysis the cost of losses due to congestion only in terms of the value of travel time. Value of travel time is obtained based on the analysis of the Income Approach method is Rp. 281.71 / min. This means that if one person traveling and experiencing congestion for 1 minute will experience a loss of Rp. 281.71.

The amount of loss due to congestion costs in terms of the value of travel time, can be calculated as follows:

Cost disadvantages = volume x time of traffic congestion x value of time

Congestion Time is travel time in peak hour minus the travel time in off peak time. Financial losses = 1199 x 0.10 x 16,902.89 = Rp. 2,049,174.92/ hour

The total cost of the financial loss of peak hour in the morning, afternoon and evening for 3 hours on Monday are as follows:

The total cost of losses = 3,108,610.5 + 1,241,273.12 + 2,049,174.92= Rp. 6,399,058.54 (for 3 hours at peak hour)

So, the result of losses due to congestion costs in terms of the value of travel time for 1 year at peak hours (3 hours / day) for 2-way reviews is as follows:

TABLE I. CONGESTION COSTS FOR 1 YEAR AT PEAK HOUR

No	Vehicle Type	Direction	
		Rajabasa-Tj. Karang	Tj Karang-Rajabasa
1.	Private Car	Rp. 1,879,876,153	Rp. 1,285,653,758
2	Mikrolet	Rp. 231,909,565.6	Rp. 176,017,605.9
3	BRT	Rp. 22,010,625.52	Rp. 11,608,735.84

G. Financial Losses caused by Traffic Jam based on Fuel Consumption

The difference of value time on peak time, average speed, of vehicle that greatly affect the length of vehicle travel time per 1 liter of gasoline. In this analysis the cost of losses due to congestion only in terms of the Fuel Consumption

Having obtained the value of a liter of gasoline is wasted, it can be calculated how much the loss resulting from congestion in terms of fuel.

Examples of the calculation of private cars Kijang Inova is fueled gassoline. passenger car crossing street Premium ZA Pagar Alam - Teuku Umar in the morning with the volume of vehicles 1194 veh / hour with a liter of petrol is wasted by 0.44 liters (according to the previous calculation table), so the loss values obtained by calculation:

= Liters of gasoline is wasted x fuel prices

= 0,44 / liter x Rp. 6,500, - / liter x 1194 veh / h

= Rp 3.414.840, - / veh (morning peak hour)

TABLE II. WASTED FUEL

Time	Vehicle Type	Congestion (hour)	Travel Time per 1 liter gassoline (liter/jam)	Gassoline that wasted (liter)
Morning	Private	0.02	0.35	0.07
	Private	0.01	0.28	0.04
	Mikrolet	0.06	0.32	0.18
	BRT	0.03	0.46	0.06
Afternoon	Private	0.02	0.30	0.06
	Private	0.01	0.38	0.02
	Mikrolet	0.07	0.30	0.24
	BRT	0.04	0.46	0.08
Evening	Private	0.03	0.55	0.05
	Private	0.04	0.41	0.11
	Mikrolet	0.06	0.43	0.14
	BRT	0.03	0.39	0.08

TABLE III. CONGESTION LOSSES IN WORKING DAY

Time	Vehicle Type	Wasted Fuel	Vehicle volume	Fuel Price	Losses
Morning	Car	0.44	1194	6500	3.414.840
	Car	0.19	162	5500	169.290
	Mikrolet	0.23	134	6500	200.330
	BRT	0.19	14	5500	14.630
After noon	Car	0.24	887	6500	1.383.720
	Car	0.18	190	5500	188.100
	Mikrolet	0.14	140	6500	127.400
	BRT	0.14	8	5500	6160
Evening	Car	0.42	1017	6500	2.776.410
	Car	0.35	195	5500	375.375
	Mikrolet	0.35	117	6500	266.175
	BRT	0.22	7	5500	8.470

From the table above shows the value of the largest loss generated at peak hours in morning and afternoon peak hours, as well as the highest value of the loss generated by private car premium fuel at peak hours morning and afternoon of Rp. 2,449,262,920, - and Rp. 2,776,410, -

TABLE IV. FINANCIAL LOSSES CAUSED BY CONGESTION FOR 1 YEAR

Vehicle Type	Financial Losses for a week (Rp)	Financial Losses for a year	Fuel
Passenger Car	47.101.210	2.449.262.920	Premium
Passenger Car	4.590.960	238.729.920	Solar
Mikrolet	3.862.040	200.826.080	Premium
BRT	192.040	9.986.080	Solar

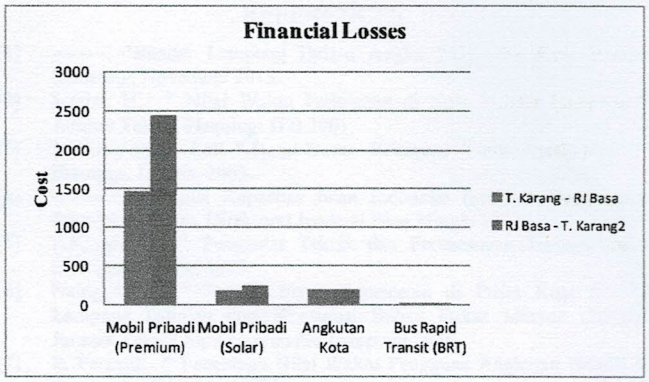

Fig. 4. Financial Losses

Seen biggest bottlenecks resulting from the direction of Rajabasa - Tj. Karang for both private vehicles and public transport. This is due to the higher volume of vehicles in the direction of Tj. Karang - Raja Basa in the opposite direction than the direction of Tj. Karang - Raja Basa and vehicle travel time is longer at direction of Rajabasa - Tj. Karang as side barriers and traffic light that is much more in that direction. As for the reverse direction, the largest congestion value seen from private vehicles, especially premium fuel which looks more dominating than other types of vehicles.

IV. CONCLUSSION AND RECOMMENDATION

A. Conclussion

1. Finansial Losses caused by congestion base on value of travel time using Income Approach for Rajabasa – Tanjung Karang per year in peak time is Rp. 1,879,876,153 for private, Rp. 231,909,565.6 for mikrolet, and Rp. 22,010,625.52 for BRT. As for the direction of Tanjung Karang – Rajabasa is Rp. 1.285.653.758 for private car, Rp. 176.017.605,9 for mikrolet dan Rp.11.608.735,84 for BRT.
2. from the direction of the vehicle the biggest losses occurred in the direction of Rajabasa – Tanjung Karang visible from losses on the private car premium fuel produced by Rp.2.449.262.920, - than in the reverse direction with the same vehicle is Rp. 1473281160, -. This is due to the high volume of vehicles, especially private cars premium fuel and vehicle travel time is longer in the direction of Rajabasa – Tanjung Karang dikarena side barriers and traffic light that is much more in that direction.

B. Recommendation

The amount of congestion loss in terms of the travel time value for 1 year at a busy hour, is very large and will increase from year to year. Expected action, resetting traffic management, and policy - the policy of the government to tackle congestion not only prevention for a while but if it can for long periods of time and it also requires support from the entire community as well.

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