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By Joni Arliansyah

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Needs analysis of the bridge infrastructures crossing over the Musi River of Palembang

Joni Arliansyah[a,*], Adi Taruna[a], Rhaptyalyani[a], Astri Yuli Kurnia[a]

[a]*Department Of Civil Engineering, University of Sriwijaya Inderalaya Sumatera Selatan 30662 Indonesia*

Abstract

Palembang is the capital city of South Sumatra Province with a population of about 1.8 million people and its territory is divided into two parts by the Musi River. Currently these two parts have only been connected by a bridge, the Ampera Bridge, whose traffic is concentrated on the major roads connected by the Ampera Bridge. Congestion occurs almost evenly in all parts of Palembang particularly at peak hour. Palembang is one of the major cities in Indonesia which have congestion problems.
A construction plan of additional bridges has been planned in the past ten years. However, its implementation is delayed mainly due to land acquisition. In the general spatial plan of Palembang in 2012, it was stated that until the year 2037 there would have been constructed six bridges, yet the implementation would be delayed due to social issues and land acquisition. This study analysed the traffic conditions of Palembang with or without the construction of a bridge for the medium-term plan that is up to the year 2027, planning to construct four additional bridges.Traffic on the road network of Palembang was modelled using a four-step transport model developed by JICA STRADA program (System for Traffic Demand Analysis) where the ratio of traffic volume of the survey results with modelling results for 2014 produced a coefficient of determination (R^2) of 0.839.The results indicate that the constructions of Musi III Bridge in 2022 and Musi VII Bridge in 2027 for the medium term are very needed to deploy traffic movement and significantly reduce the congestion in Palembang. If the constructions of both bridges are delayed, Palembang will suffer from the severe congestion in both 2022 and 2027.

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Keywords:transport model; congestion; bridge.

* Corresponding author. Tel.: +062 813 6755 3790; fax: +062 711 362 388.
E-mail address:joniarliansyah@yahoo.com

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1. Introduction

Palembang metropolitan city with the population of about 1.8 million people keeps running into a rapid increase in trade and economy leading to the increasing movement of people and goods. In addition, Palembang has an international sporting area, Jakabaring, which is one of the most complete sports facilities in Indonesia. Many sporting activities of national and international levels in Palembang such as the National Sports Week, Asean Games, and AFC - Asian Cup. To avoid the transport problems in Palembang, the increasing movement of the existing motor vehicles must be balanced with the provision of transport facilities and infrastructures.

The activity center of Palembang is divided by Musi River into Hilir and Hulu areas which are currently connected only by the Ampera Bridge. This results in traffic collection through the Ampera Bridge and the city main streets, especially during rush hours. Congestion occurs almost throughout the day and it is equitable throughout the city.

In the spatial plan of Palembang there has been a plan of road network development in which, besides the development of the city's ring road, there are six bridges to be constructed in Palembang. However, due to social issues and land acquisition there has not been any additional bridge to be constructed so far. In this study, demand analysis of the bridge construction in Palembang is carried out by taking into account the service level of bridges and road network in Palembang with or without the planned bridges. The traffic on the road network of Palembang is modeled using a four-step transport model and developed using JICA STRADA (System for Traffic Demand Analysis)

In this study the simulation and analysis of the conditions of the road network service in Palembang is conducted for the medium term plan until 2027, in which the planned 4 bridges will have been constructed.

2. Literature Study

The development of Palembang transportation modeling applies the System for Traffic Demand Analysis (STRADA) from JICA [1]. The modeling steps for the existing condition include the making of road network, OD matrix, mode choice and traffic assignment. For the modeling of network traffic loading in the future a four-step transport model are used consisting of trip generation and attraction prediction, trip distribution (gravity models), mode choice (Disagregate Model), and Trip Assignment. In general, the steps of modeling with JICA Strada are shown in Fig. 1 .

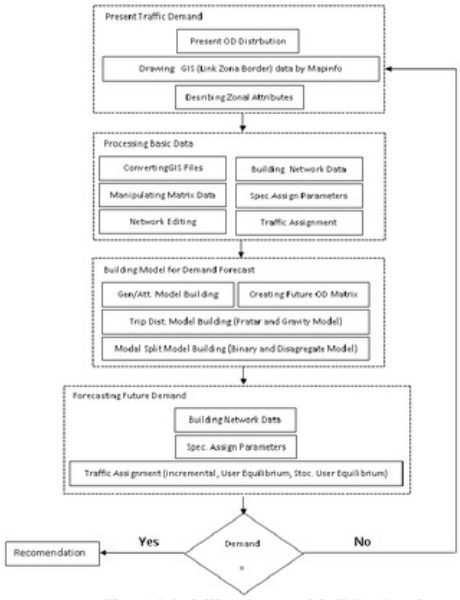


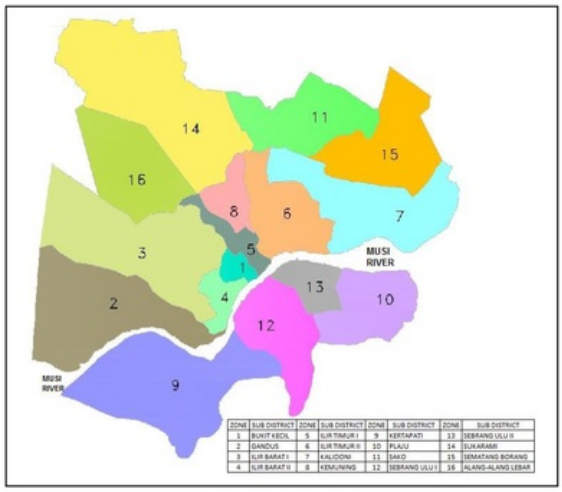
Fig. 1. Modelling Steps with JICA Strada

There have been many successful studies widely reported using JICA Strada in calculating the volume of traffic on the road network [2, 3, 4, 5, 6].

3. Methodology

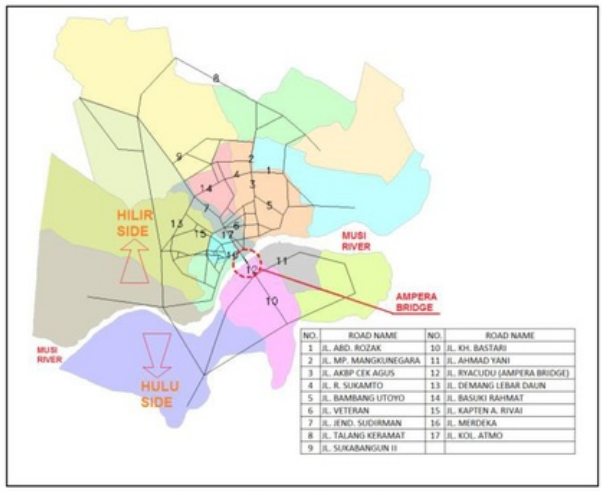
The steps conducted in this study are described as follows:

- OD Matrix of Palembang in 2009 [7, 8] was used as the basis for predicting both OD matrix of 2014 and other OD matrices in accordance with the needs analysis. Zones and road network in the study area are shown in Figures 2 and 3. Fig. 3 shows that Palembang is divided by Musi River into two parts where the city center is only connected by the Ampera Bridge.



ZONE	SUB DISTRICT	ZONE	SUB DISTRICT	ZONE	SUB DISTRICT	ZONE	SUB DISTRICT
1	BUKIT KECIL	5	ILIR TIMUR I	9	KERTAPATI	13	SEBRANG ULU II
2	GANDUS	6	ILIR TIMUR II	10	PLAJU	14	SUKARAMI
3	ILIR BARAT I	7	KALIDONI	11	SAKO	15	SEMATANG BORANG
4	ILIR BARAT II	8	KEMUNING	12	SEBRANG ULU I	16	ALANG-ALANG LEBAR

Fig. 2. Zoning Map



NO.	ROAD NAME	NO.	ROAD NAME
1	JL. ABD. ROZAK	10	JL. KH. BASTARI
2	JL. MP. MANGKUNEGARA	11	JL. AHMAD YANI
3	JL. AKBP CEK AGUS	12	JL. RYACUDU (AMPERA BRIDGE)
4	JL. R. SUKAMTO	13	JL. DEMANG LEBAR DAUN
5	JL. BAMBANG UTOYO	14	JL. BASUKI RAHMAT
6	JL. VETERAN	15	JL. KAPTEN A. RIVAI
7	JL. JEND. SUDIRMAN	16	JL. MERDEKA
8	JL. TALANG KERAMAT	17	JL. KOL. ATMO
9	JL. SUKABANGUN II		

Fig. 3. Road Network Map of Palembang

- The model reliability test was conducted by comparing the existing volume traffic of 2014 with the modeling result.
- After conducting the model reliability test, the simulation and analysis of traffic condition of roads and bridges in Palembang were undertaken with or without the constructions of the bridges as planned in Palembang Spatial Plan [9] shown in Table 1. In this study, the analysis refers to the medium-term plans of 2022 and 2027.

Table 1. Scenario of Network Development of Palembang

No	Scenario	Operational Year *)
1	Plan of Construction of Musi IV Bridge	2017
2	Plan of Construction of Musi VI Bridge	2019
3	Plan of Construction of Musi III Bridge	2022
4	Plan of Construction of Musi VII Bridge	2027
5	Plan of Construction of Musi V Bridge, Musi VIII Bridge and Palembang City Ring Road	2037

*) The Operational Year is estimated according to the result of interview with the concerned institution.

4. Analysis and Discussion

4.1. Model Reliability Test

The model reliability test was conducted to find out the extent to which the created urban transport models can represent the existing traffic conditions. It is carried out by comparing the volume of the existing traffic and modeling results of 2014 and the data of 17 main roads in Palembang to test the reliability of the model. The test result shows that R^2 values of 0.839 (Fig. 4). It indicates that the Palembang developed transport models can well represent the loading conditions of traffic on the road network in Palembang.

4.2. Conditions of Palembang Traffic in 2014

The results of traffic survey in Palembang in 2014 is shown Table 2. It can be seen that the roads in Palembang are currently not fully smooth in which the performance of some streets seems to have reached their capacity. The problems of the capacity of the existing road network are as follows:

- The existing bridge in the downtown, which is Ampera Bridge, has the busiest traffic volume with V/C of 1.28. It is due to the fact that there is no other alternative bridge in the city linking the Hilir and Hulu areas. It indicates that the construction of a bridge other than Ampera Bridge should urgently be implemented.
- There are six roads in Palembang suffering from congestion during rush hours. In the existing condition the congestion has disrupted the activities of the people of Palembang.

4.3. Simulation of the Service Level of Road Network in Palembang.

This study simulated the traffic conditions of Palembang for the medium terms, 2022 and 2027, where up to 2022 it is planned to have constructed three new bridges and in 2027 there will have been four new bridges constructed. Fig. 5 shows the stages of bridge construction in Palembang until 2027. The simulation was carried out to find out the traffic conditions of bridges and road network with or without the construction of the planned bridges.

Table 2. Traffic Conditions of Palembang in 2014

No	Road Segment	Capacity	Volume of Peak Hours (pcu/hour)	
			Survey Result	V/C
1	Jl. Abdul Rozak	3635	1632	0.449
2	Jl. M.P Mangkunegara	2581	1159	0.449
3	Jl. AKBP. Cek Agus	2581	1731	0.671
4	Jl. R. Sukamto	3635	2324	0.639
5	Jl. Bambang Utoyo	2890	568	0.197
6	Jl. Veteran	4449	2001	0.45
7	Jl. Jend. Sudirman	5132	4440	0.865
8	Jl. Talang Keramat	2668	724	0.271
9	Jl. Sukabangun II	2668	617	0.231
10	Jl. KH. Bastari	5742	4263	0.742
11	Jl. A. Yani	3300	2822	0.855
12	Jl. Ryacudu (Ampera Bridge)	5742	7333	1.277
13	Jl. Demang Lebar Daun	4372	3827	0.875
14	Jl. Basuki Rahmat	3164	3183	1.006
15	Jl. Kapt. Rivai	4372	3390	0.775
16	Jl. Merdeka	5638	3272	0.58
17	Jl. Kolonel Atmo	6709	3476	0.518

4.3.1. The Level of Bridge Service in Palembang in 2022

As shown in Figure 3, in 2022 it is planned that three bridges will have been constructed consecutively, that is Musi IV Bridge, Musi VI Bridge, and Musi III Bridge. The simulation was conducted to find out the level of bridge service existing in 2022 with the following conditions:

- Do nothing, where in 2022 there will be no addition of bridge construction.
- In 2022, there will have been only one bridge to be constructed, namely Musi IV Bridge.
- There will have been two additional bridge constructions in 2022, that is Musi IV Bridge and Musi VI Bridge.
- There will have been three bridges constructed in 2022 with an addition of Musi III Bridge.

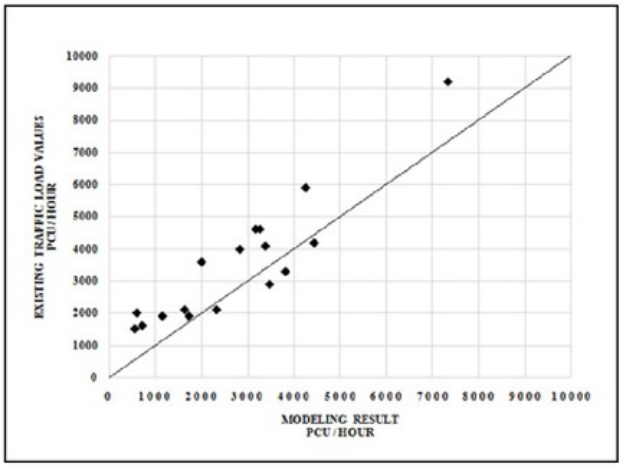


Fig. 4. Analysis of Correlation between the Existing Traffic Load Values and Modeling Result

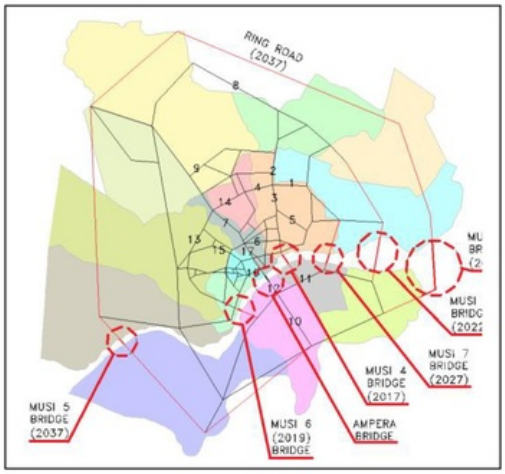


Fig. 5. Plan of Bridge Development in Palembang

The conditions of the level of bridge service in Palembang for the above four conditions is given in Table 3 as follows :

Table 3.Condition of the Level of Bridge Service in Palembang in 2022

No.	Bridge Name	Capacity	Condition in 2022							
			Existing (Ampera Bridge)		With 1 additional bridge (Musi IV)		With 2 additional bridges (Musi IV and Musi VI)		With 3 additional bridges (Musi IV, Musi VI and Musi III)	
			Volume (pcu/hour) (network 2014)	V/C	Volume (pcu/hour) (network 2017)	V/C	Volume (pcu/hour) (network 2019)	V/C	Volume (pcu/hour)	V/C
1	Ampera (existing)	5742	10800	1.88	6400	1.11	5900	1.03	5600	0.97
2	Musi II	5742	-	-	6900	1.20	5900	1.03	4800	0.83
3	Musi VI	5742	-	-	-	-	2800	0.49	2800	0.48
4	Musi III	5742	-	-	-	-	-	-	2500	0.43

The Table shows that the construction of the three new bridges up to 2022 is absolutely necessary to serve the demand of movement between the two parts of Palembang divided by the Musi River. If only one or two bridges are constructed, in 2022 the existing bridge is no longer able to bear the load of the existing traffic.

4.3.2. The Level of Bridge Service in Palembang in 2027

In 2027, it is planned to construct one additional bridge after the three additional bridges have been constructed in 2022. The simulation conditions of the traffic load on the bridges in Palembang in 2027 as follows:

- Do nothing, where in 2027 there will be no bridge construction.
- In 2027, there will be only one bridge to be constructed, namely Musi IV Bridge.
- There will have been two additional bridge constructions in 2027, that is Musi IV Bridge and Musi VI Bridge.
- There will have been three bridges constructed in 2027.
- There will have been four bridges constructed in 2027 with an addition of Musi VII Bridge

The condition of the level of bridge service in Palembang in 2027 for the above five conditions is given in Table 4 below:

Table 4. Condition of the Level of Bridge Service in Palembang in 2027

No.	Bridge Name	Capacity	Condition in 2027									
			Existing (Ampera Bridge)		With 1 additional bridge (Musi IV)		With 2 additional bridges (Musi IV and Musi VI)		With 3 additional bridges (Musi IV, Musi VI and Musi III)		With 4 additional bridges (Musi IV, Musi VI, Musi III and Musi VII)	
			Volume (pcu/hour) (network 2014)	V/C	Volume (pcu/hour) (network 2017)	V/C	Volume (pcu/hour) (network 2019)	V/C	Volume (pcu/hour) (network 2022)	V/C	Volume (pcu/hour)	V/C
1	Ampera (existing)	5742	11900	2.07	7100	1.24	6400	1.11	6200	1.08	5600	0.97
2	Musi II	5742	-	-	7400	1.29	6300	1.10	5100	0.89	4100	0.71
3	Musi VI	5742	-	-	-	-	3000	0.52	2900	0.51	3100	0.53
4	Musi III	5742	-	-	-	-	-	-	2900	0.51	1400	0.24
5	Musi VII	5742	-	-	-	-	-	-	-	-	3900	0.67

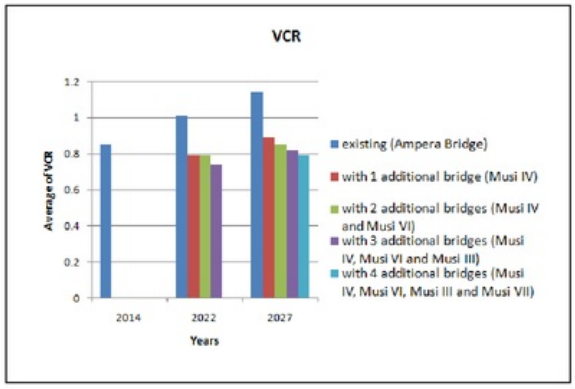


Fig.6. Average Degree of Saturation

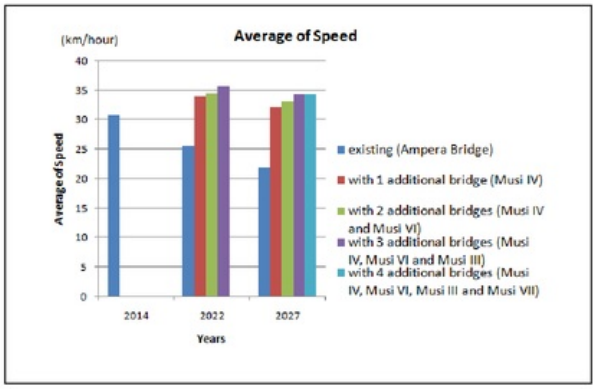


Fig.7. Average of Speed

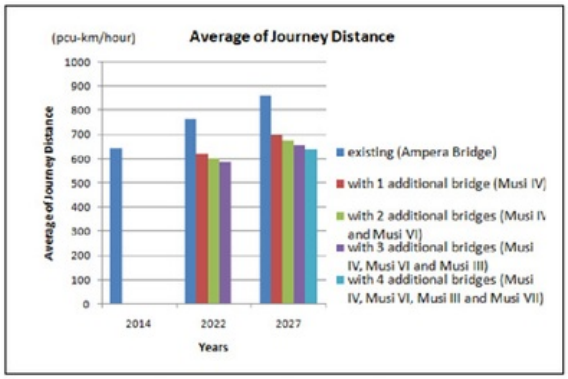


Fig.8. Average of Journey Distance

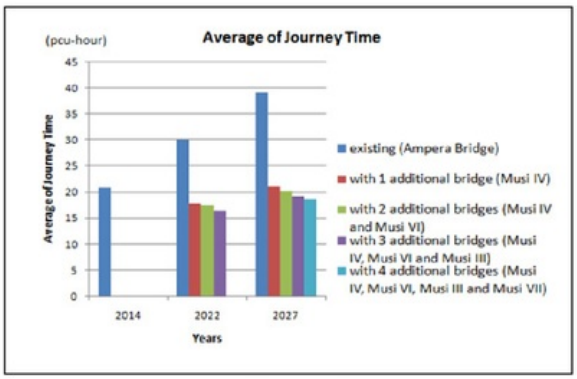


Fig.9. Average of Journey Time

4.4. Comparison of Conditions of Road Network Service Level in Palembang

The conditions of the road network service in Palembang in 2022 and 2027 consist of the average of the value of degree of saturation (VCR), average speed, average of journey distance, and average journey time shown in Figures 6 to 9.

Figures 6 to 9 show that the additional construction of the three bridges in 2022 and the additional four bridges in 2027 are indispensable in order to significantly disentangle and reduce traffic congestion on the road network in Palembang. Severe congestion will occur if the plan of additional construction of bridges fails to be implemented.

5. Conclusion

1. The developed Palembang transportation model can well represent the traffic conditions. It can be seen from the coefficient of determination (R^2) between the traffic volume of modeling results and the traffic volume of survey results .
2. The existing condition (2014) shows that the existing Ampera Bridge is not able to serve the movement of traffic between Hilir and Hulu areas of Palembang and the congestion occurs in the main streets of the city .
3. In the medium term plan, the constructions of the three additional bridges in 2022 and four bridges in 2027 constitute the solution to distribute the traffic and significantly reduce the congestion in Palembang. If the construction of both bridges is delayed, Palembang will suffer from severe congestion either in 2022 or in 2027.

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