Traffic Simulation Study for Alleviating Traffic Congestion Problem in Jakarta Intra Urban Toll Road

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Abstract: Increasing economics activities and vehicle growth has lead to traffic congestion at Jakarta Intra Urban Tol Road (JIUTR). Many ways can be done to alleviate that problems, such as traffic engineering and traffic management. However, the final result by applying scenario traffic model simulation (such as adopting contra flow, 3 in 1 etc) or network simulation by combining the policy to add the number of lanes and traffic management shows that the road capacity still not adequate to overcome the condition in long terms periode and should be added other effort such as improving the public transport system etc.

Keywords: Jakarta Intra Urban Toll Road, Network Analysis, Traffic Model Simulation

1. INTRODUCTION

The economic growth of a city may be reflected from the economic activities of the city itself and its surrounding areas. The activities must be supported with good transportation infrastructures that provide positive implication in increasing the growth and development of the city. However, there are also negative implications such as traffic congestion and accidents due to increasing number of vehicles. The traffic congestion problems will cause high vehicle operating cost, time losses, increasing number of accidents, and also air and noise pollutions.

Jakarta Intra Urban Toll Roads (JIUTR) as major roads in Jakarta experience severe traffic congestion problems due to insufficient capacity, thus increasing travel time and decreasing average speed of vehicles. This study aims to simulatesome traffic management schemes and propose the best scheme to reduce the congestion problemon JIUTR.

The traffic management schemes considered in this study includes 3 in 1 scheme (a policy which requires that a vehicle entering the toll road with minimum occupancy of three person), contraflow scheme (a policy which allows vehicle from a more congested direction utilize part of lanes dedicated to vehicle from the other direction), dynamic tariff scheme (the toll tariff is increased during peak hours only), tariff rationalization scheme (toll tariff is increased for all period), one direction flow scheme, lane/structure addition scheme, and ramp metering scheme.

2. PREVIOUS STUDIES

Various studies have been conducted related to some traffic management schemes proposed in this study. Lembaga Teknologi FT UI (2010) studied the impact of applying dynamic tariff at some intra urban and rural toll roads around Jakarta area.A stated preference survey was conducted to find the willingness to pay of the toll road users.The toll road users were offered a reduced tariff beyond morning peak period (05.00 – 10.00 AM), and the number of users that were willing to shift their travel time was determined. The result shows that majority (50%) of respondents do not want to shift their travel time regardless the reduced tariff whereas only 27% of respondents agreed to shift their travel time beyond the morning peak hour if the tariff was reduced by 10%.

Karsaman et al (2011) studied the influence of toll tariff variation in reducing the traffic demand in JIUTR and JORR (Jakarta Outer Ring Road). In the study, the toll tariff is increased by 10%, 25%, 50%, and 100% of the original tariff during peak hours.The effect of the reduced demand caused by the increasing toll tariff during peak hours to the daily revenue of the toll road operators was also studied to obtain the most optimum amount of increase that would not affect the revenue of the toll road operator. The result shows that the most optimum increase in tariff is 10% in which the number of demand in JIUTR and JORR will reduce to 8% and 15%, respectively, but such increase would not affect the overall revenue of the toll road operators. The study also shows that the increase in toll tariff during peak hours will not significantly influence the level of service of the toll roads.

Suprayitno (2013) evaluated the traffic performances of Cawang-Tomang-Cengkareng segment in JIUTR due to contraflow policy at Cawang – Semanggi (STA 0+700 – STA 8+100). The traffic performances when the contraflow is applied (at 6.00 – 9.30 AM) were measured and compared to those when there are no contraflow. The result shows that the overall traffic performances (in the form of flow to capacity ratio, average speed, and travel time) when the contraflow is applied are better compared to the traffic performances during the period when contraflow is not applied. However, there are some safety issues contributed by the application of contraflow.

3. METHODOLOGY AND DATA COLLECTION

Figure 1 presents the methodology used to conduct this study. The study begins with reviewing related literatures and legislations, followed by data collection process. The data needed in this study consists of road network geometric data, traffic data (origin-destination, traffic volume), and user characteristics and perception data. The road network geometric data was collected from related institution meanwhile the origin-destination data was collected from previous study. The traffic volume data were collected on field by conducting traffic counting survey. The toll road user characteristics and perception data were collected by conducting toll road user interview.

The next step is to develop models for existing condition and for simulated conditions by using SATURN (Simulation and Assignment of Traffic to Urban Road Network) software. The results of the models were then used to analyze the traffic performance of the JIUTR for existing condition and for any of the traffic management schemes developed in this study. Further, this study recommended the best traffic management scheme that can be applied to improve the traffic performance of the JIUTR.

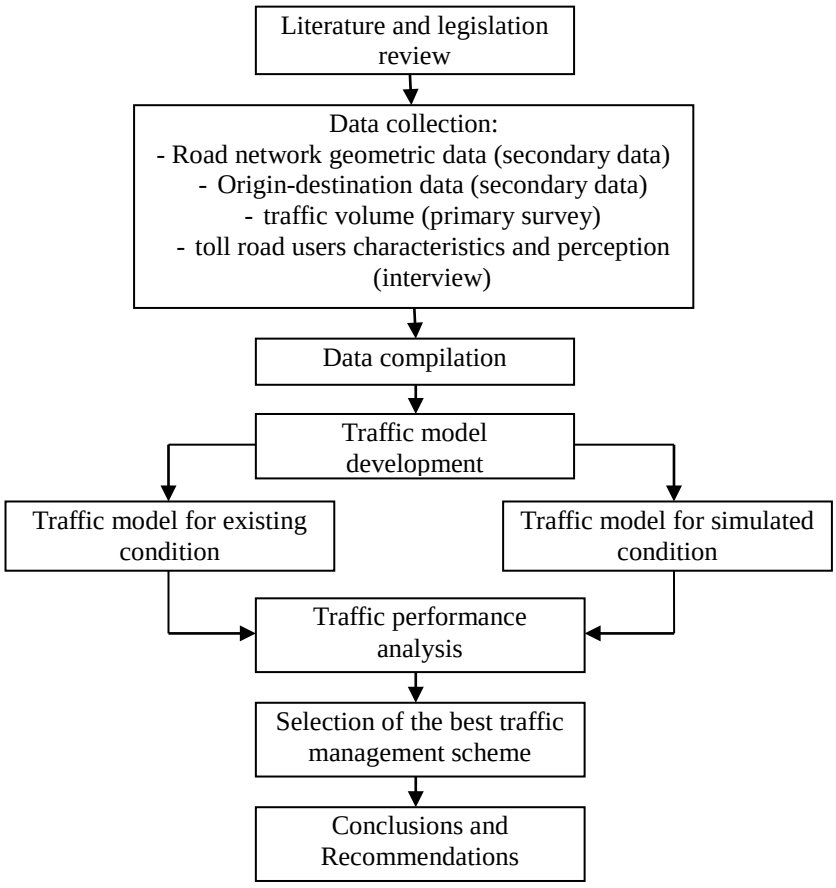


Figure 1.Methodology

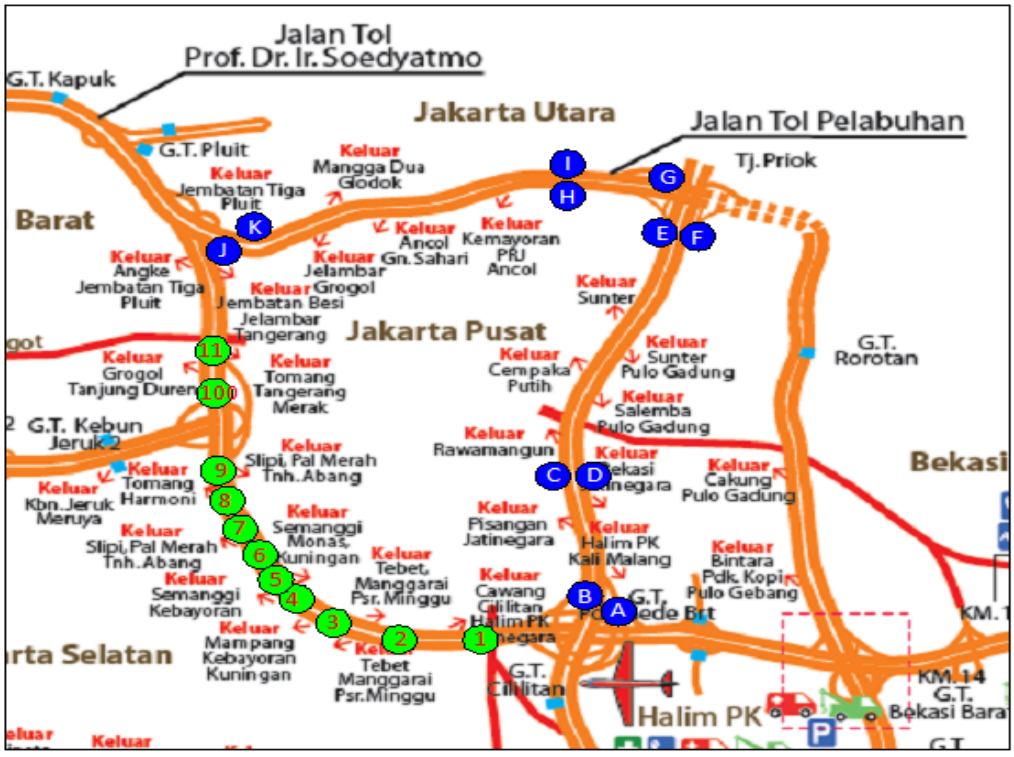


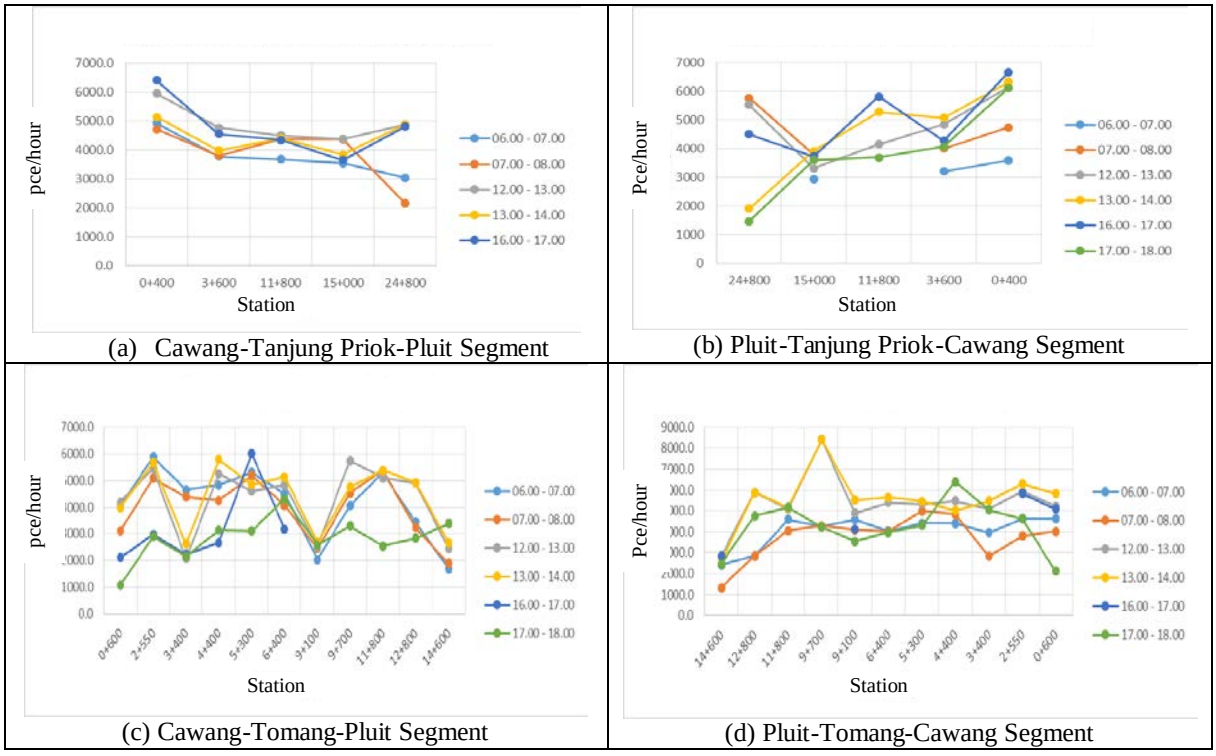
Figure 2.Traffic Counting Survey Locations

The traffic counting survey was conducted on 22 points of observation (as seen in Figure 2, points A to K and points 1 to 11) by using video camera. At each point of observation, the counting was conducted for two hours in morning (06.00-08.00), noon (12.00-14.00), and evening (16.00-18.00) peak hours.

The objective of the toll road user interview is to obtain information regarding the characteristics of the toll road users and regarding their willingness to keep using the JIUTR given any proposed traffic management scheme is applied. There were 200 respondents interviewed, most of them (95%) are car owners who frequently use JIUTR. The interview was conducted on public places accessible by the JIUTR, such as restaurants and offices.

4. RESULTS OF DATA COLLECTION

The result of traffic counting survey is presented in Figure 3.There are four charts presented in the table, each for Cawang-TanjungPriok-Pluit segment (chart a), Pluit-TanjungPriok-Cawang segment (chart b), Cawang-Tomang-Pluit segment (chart c), and Pluit-Tomang-Cawang segment (chart d).



(a) Cawang-Tanjung Priok-Pluit Segment

(b) Pluit-Tanjung Priok-Cawang Segment

(c) Cawang-Tomang-Pluit Segment

(d) Pluit-Tomang-Cawang Segment

Figure 3. Hourly Traffic Volumes (in pcu/hour) at Selected JIUTR Locations

Figure 3 shows that the traffic volumes are greatly varied along all segments observed in this study. The Cawang-TanjungPriok segment (Figure 3(a): STA 0+400 – STA 11+800) has higher traffic volumes than the TanjungPriok Segment (Figure 3(a): STA 11+800 – STA 24+800). During the survey, vehicle speed in the Cawang-TanjungPriok segment is in the range of 30-50 km/hour while that for the TanjungPriok-Pluit segment is in the range of 50-60 km/hour. The highest volume observed during the survey for Cawang-TanjungPriok-Pluit segment occurs at Sta 0+400 during 06.00-07.00 AM, which is about 6500 pce/hour. Since the

Cawang-TanjungPriok-Pluit segment has only three lanes with lane width of 3.25m and narrow shoulders, the capacity of this segment is below 6000 pce/hour. Therefore, for the next hour (07.00-08.00 AM), the volume at this segment drops significantly to about 4800 pce/hour as density increases. The Pluit-TanjungPriok-Cawang segment is the opposite direction of the Cawang-TanjungPriok-Pluit segment. The location which has the highest volume observed during the survey also occurs at Sta 0+400 during 04.00-05.00 PM.

The traffic volume at Cawang-Tomang-Pluit segment shows several locations that experience peaks during different time of day. During morning peak hour (06.00-07.00 AM), the highest volume occurs at STA 2+550 while for afternoon peak hour (01.00-02.00 PM) the highest volume occurs at STA 3+400. During the evening (04.00-05.00 PM), the highest volume occurs at STA 5+300. For all the three peak periods, the highest volume is about 6000 pce/hour. Just as the other segment observed in this study, the Cawang-Tomang-Pluit segment has also three lanes; therefore the capacity of the segment is below 6000 pce/hour. Therefore, the traffic density along this segment is very high, especially up to STA 5+300.

The result of toll road user interview shows that as many as 89% of respondents will keep using the JIUTR if the operator applies contraflow along the JIUTR during morning and evening peak hours.In this contraflow scenario, vehicles from the peak direction are allowed to use one lane (median lane) of the opposite direction. It also shows that when the toll road operator applies policy that a vehicle will only be allowed to enter the toll road if it carries minimum three person inside it during peak hours (3 in 1 scheme), there are 69% respondents that will divert to non-toll roads or shift their time of travel outside the peak hours.

If the toll tariff is increased by 10% then 90% of respondent said that they will surely keep using the JIUTR, but when the toll tariff is increased by 50% then the number of respondent that will surely keep using the JIUTR decrease to 60%. If the toll tariff is increased by 100%, then only 50% of respondentswill surely keep using the JIUTR. However, when the toll tariff during some non-peak hours is reduced by 25%, there will be 40% respondents that will shift their time of travel. When it is reduced by 50%, there will be 50% of respondents that will shift their time of travel. However when the tariff is reduced by 100%, there are only 5% increase in the number of respondents that will shift their time of travel compared to the 50% reduced tariff.

5. EXISTING CONDITION ANALYSIS

The desire lines in the study area based on the origin-destination matric that has been developed are shown in Figures 4 and 5. Figure 4 presents the desire lines at Semanggi-Sudirman area and Bintaro-Tangerang area, while Figure 5 presents the desire lines at Bogor-Cibubur area and Bekasi-Cikampek-Karawang area.

Beside the desire lines, the amount of trip from one zone to another zone can be shown by the amount of trip generation and trip attraction from each of the zones. Figure 6 presents the magnitude of trip generation and trip attraction in the study area during peak hour for existing condition, which is year 2014.

Outputs of running the developed model for existing condition are in the form of demand flow (pcu/hour) and Volume to Capacity Ratio (VCR) at the modelled toll road.The results are basic references in analyzing the proposed schemes. The results of modelling in the form of demand flow (pcu/hour), VCR, and speed are presented in Table 1 and Table 2 for Cawang-Tomang-Pluit (CTC) toll road segment and Cawang-TanjungPriok-Pluit (CMNP) segment, respectively.

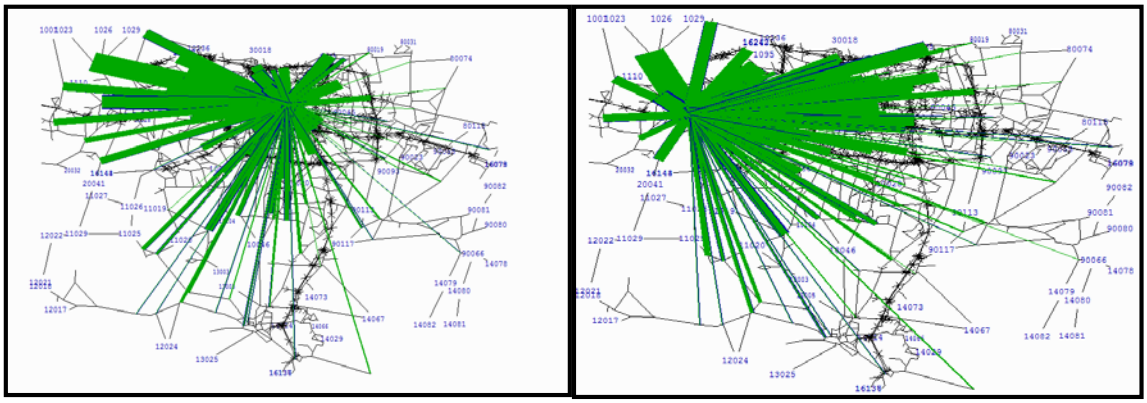


Figure 4. Desire Linesat Semanggi-SudirmanArea (left) and Bintaro-TangerangArea (right)

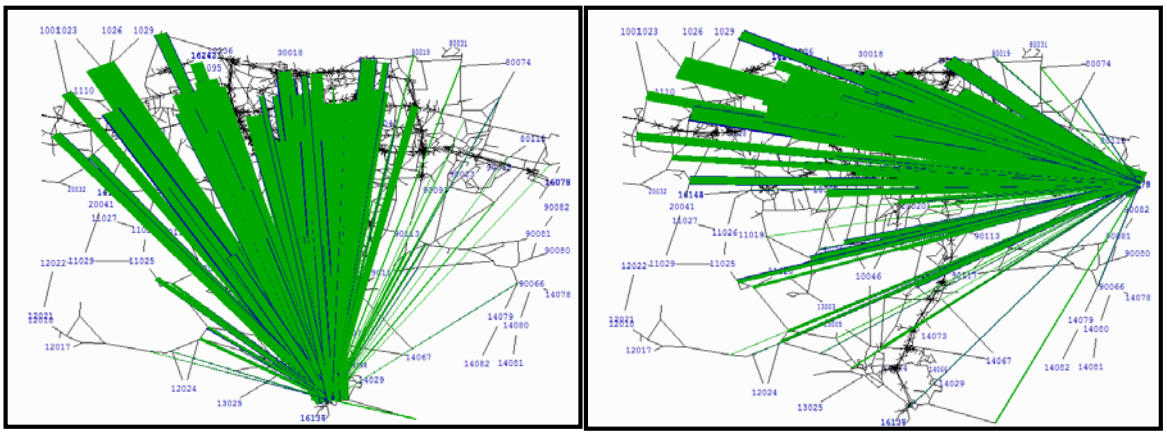
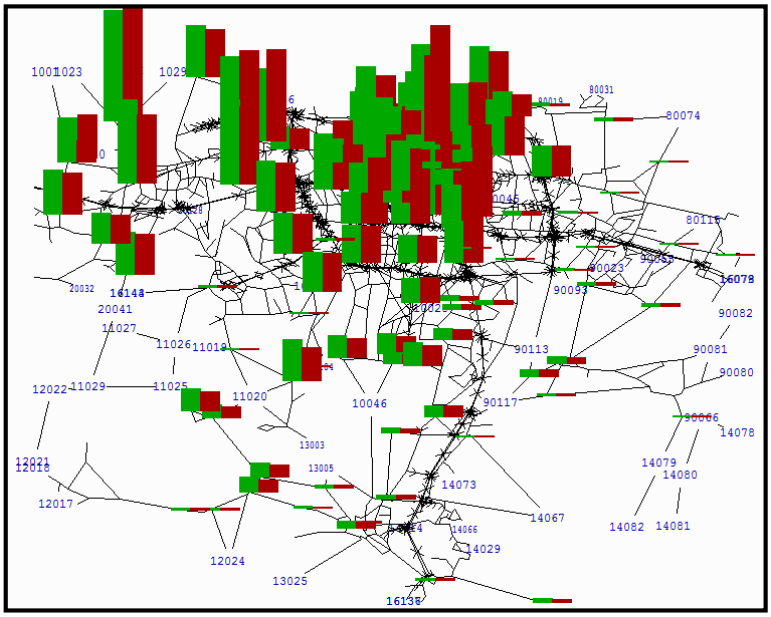


Figure 5. Desire Lines at Bogor-Cibubur Area (left) and Bekasi- Karawang Area (right)



Green color box: traffic generation; red color box: traffic attraction

Figure 6. Traffic Generation and Attraction During Peak Hour at Existing Condition (2014)

Table 1. Modelling Results on JIUTR Cawang-Tomang-Pluit(CTC) Segment

Observation Point	Direction	STA	VCR	Speed (km/hour)
Cawang-Pluit Direction				
A	After Cawang Interchange	0+600	0,93	36
B	Before Off-ramp toTebet	2+550	1,13	5
C	AfterTebet Off-ramp	3+400	0,94	35
D	AfterTebet On-ramp	4+400	1,01	23
E	AfterMampang Off-ramp	5+300	1,31	3
F	AfterKuningan 1 On-ramp	6+400	1,12	5
G	AfterSenayan On-ramp	9+100	1,12	3
H	AfterSlipi Off-ramp	9+700	1,04	19
I	Before Tomang Off-ramp	11+800	1,19	3
J	Before Tomang Interchange	12+800	1,03	17
K	After Tomang Interchange	14+600	0,83	37
Pluit-Cawang Direction				
A	After Cawang Interchange	0+600	0,91	42
B	Before Off-ramp toTebet	2+550	1,02	19
C	AfterTebet Off-ramp	3+400	0,56	55
D	AfterTebet On-ramp	4+400	1,06	8
E	AfterMampang Off-ramp	5+300	1,03	22
F	AfterKuningan 1 On-ramp	6+400	1,01	21
G	AfterSenayan On-ramp	9+100	0,95	41
H	AfterSlipi Off-ramp	9+700	1,03	2
I	Before Tomang Off-ramp	11+800	0,8	46
J	Before Tomang Interchange	12+800	0,57	55
K	After Tomang Interchange	14+600	1,07	8

Table 1 describes the results of modelling at the Cawang-Tomang-Pluit (CTC) segment of JIUTR. For Cawang-Pluit direction, the highest VCR occurs at the segment before the off-ramp to Tomang at Sta 5+300, with the VCR value 1.31 and speed only 3 km/hour. Meanwhile, the lowest VCR occurs at segment after Slipi off-ramp at Sta 14+600, with VCR value 0.83 and speed 37 km/hour. In the direction of Pluit-Cawang, the highest VCR occurs at segment after Tomang Interchange in Sta 14+600, with VCR value 1.07 and speed 8 km/hour. The lowest VCR occurs at segment before Tomang Interchange in Sta 12+800, with VCR value 0.57 and speed 55 km/hour.

Table 2 describes the modelling result for Cawang-TanjungPriok-Pluit (CMNP) segment of JIUTR. In the direction of Cawang-Pluit, the highest VCR occurs at TanjungPriok – Ancol segment, traffic movement from south to north at Sta 15+000, with VCR value of 1.38 and speed 4 km/hour. Meanwhile, the lowest VCR occurs at segment off-ramp to TanjungPriok, movement from south to north at Sta 11+800, with VCR value of 0.16 and speed 76 km/hour. In the direction of Pluit-Cawang, the highest VCR occurs at segment Ancol-TanjungPriok, traffic movement from north to south at Sta 15+000, with VCR value 1.07 and speed 19 km/hour. The lowest VCR occurs at TanjungPriok Interchange – on-ramp from TanjungPriok at Sta 11+800 with VCR value 0.14 and speed 68 km/hour.

Table 2. Modelling Results for JIUTR Cawang-TanjungPriok-Pluit (CMNP) Segment

Observation Point	Direction	STA	VCR	Speed (km/hour)
Pluit-Cawang Direction				
K	Pluit Interchange, from Airport toJembatanTiga	24+800	0.73	42
I	Ancol - TanjungPriok segment, from north to south at CMNP segment	15+000	1.07	19
F	TanjungPriok Interchange, fromAncolto CMNP segment	11+800	0.64	46
	TanjungPriok Interchange, fromTanjungPriokto CMNP segment	11+800	0.14	68
D	Jatinegara Flyover, from north to south at CMNP segment	3+600	0.81	38
A	Cawang Interchange, from CMNP segment to Jagorawi	0+400	0.61	53
	Cawang Interchange, from CMNP segment to Cikampekand CTC segment	0+400	0.66	52
Cawang-Pluit Direction				
B	Cawang Interchange, fromJagorawito CMNP segment	0+400	0.79	
	Cawang Interchange, fromCikampekand CTC segment to CMNP segment	0+400	0.33	71
C	Jatinegara Flyover, from south to north at CMNP segment	3+600	0.96	31
E	Off-ramp to TanjungPriok, from north to south at CMNP segment	11+800	0.16	76
G	On-ramptoAncol, from south to north at CMNP segment	12+000	0.73	58
H	TanjungPriok–Ancol segment, from south to north at CMNP segment	15+000	1.38	4
J	Pluit Interchange, fromJembatanTigato Grogol	24+800	0.34	70
	Pluit Interchange, fromJembatanTigatoAirport	24+800	0.53	56

Figure 7 describes the segments of JIUTR at the existing condition which has VCR value greater than one (the red colored segments). It can be seen that majority of the JIUTR segments have VCR value greater than one, which means that the segments have already experienced severe traffic congestion problem.

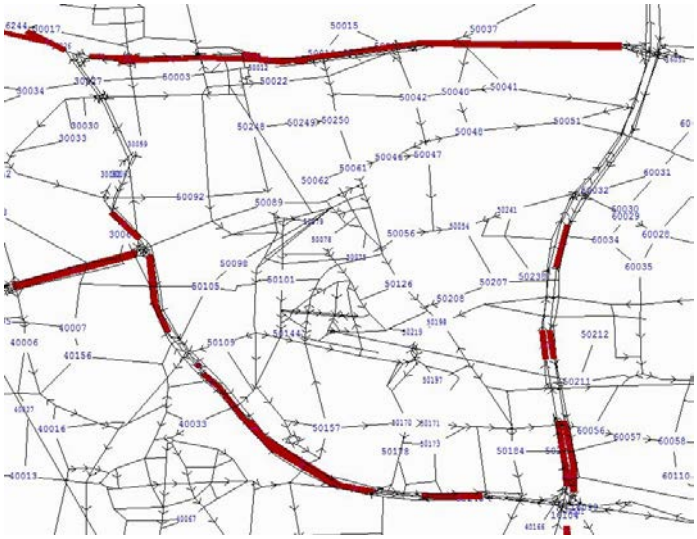


Figure 7. Segments with Its Volume that Exceed Its Capacity (VCR > 1)

6. ANALYSIS OF SCHEMES

6.1 Three-in-One Scheme

The result of modelling by running the three-in-one (3 in 1) scheme is presented in Table 3.

Table 3. Modelling Result of Running 3 in 1 Scheme

No	Segment	Parameter	
		Average VCR	Average Speed (Km/Jam)
1	Toll CTC Cawang-Pluit	0.98	22
2	Toll CTC Pluit-Cawang	0.85	39
3	Toll CMNP Cawang-Pluit	0.92	24
4	Toll CMNP Pluit-Cawang	0.82	41
Average		0.89	31,5

The result shows that there is decreasing number of traffic into the toll road. However, the 3 in 1 regulation makes the traffic on non-toll roadparallel to the toll roadbecomesabout 20% higher,and the VCR on non-toll road is also higher and their speed is slower than before.In addition, the regulation of 3 in 1 at JIUT is rather difficult to be implemented due to so many entry ramp from others toll roads such as Jagorawi, BandaraSoekarnoHatta (Sedyatmo), JORR 1 (Outer Ring Road) and Cikampek.

6.2 Contraflow Scheme

The capacity of segment where the contraflow is applied (i.e. Cawang-Semanggi segment) is higher than usual as there is one lane addition (from three lanes to four lanes) for the contraflow vehicles. When contraflow is applied, the segment capacity has increased from 6900 pce/h up to 9200 pce/h. With this increase in capacity, VCR becomes lower and speed become highers. However, this changeis not very significant due to equilibrium condition

with higher traffic demand into toll road.

On the other hand, the capacity of Semanggi-Cawangsegment is decreasing from 3 lanes to 2 lanes (or from 6900 pce/h to 4600 pce/h). Therefore its VCR is higher and its speed issignificantly slower than before and makes the traffic more congested.

Overall, the condition of contraflow schemeis not too different with existing condition, therefore this scheme was abandoned. This is also reflected in the field where this policy was stopped after 29 months of implementation.

6.3 Dynamic Tariff Scheme

The result of modelling by running the dynamic tariff scheme is presented in Table 4.

Table 4. ModellingResult of Running Dynamic Tariff Scheme

No	Tariff Scenario	Parameter	
		Average VCR	Average Speed (km/h)
1	Increased by 10%	0.94	24.3
2	Increased by 25%	0.94	24.3
3	Increased by 50%	0.93	24.7

The effect of this policy was promising, due to different toll tariff, the traffic flow on peak hour decreases. However, the increment of dynamic tariff should be suited with existing condition and could not be implemented without strong regulation as legal basis. Therefore, the implementation of this policy needs to be more elaborated.

6.4 Tariff Rationalisation Scheme

The result of modelling by running the dynamic tariff scheme is presented in Table 5.

Table 5. Modelling Result of Running Tariff RasionalisationScheme

No	Tariff Scenario	Parameter	
		Average VCR	Average Speed (km/h)
1	Increased by 100%	0.92	25.7
2	Increased by 200%	0.91	27.2

The effect of this policy was promising; due to very high toll tariff, the traffic flow decreases. However, this policy should be accepted by public and could not be implemented without strong regulation as legal basis. Therefore, the implementation of this policy needs to be more elaborated.

6.5 One Way Flow Scheme

6.5.1 One Way Flow Scheme fromCTC to CMNP Segment

The application of One Way Flow from CTC to CMNP segment is carried out without changing entry and exit ramps on both directions. This schemeis expected to alleviate the traffic congestion that occurs on entry rampsfrom Cikampek andJagorawi toll roads. The result of modelling by running the one way flow scheme from CTC to CMNP segment is presented in Table 6.

Table 6. Modelling Result of Running One Way Flow Scheme from CTC to CMNP Segment

No	Segment	Parameter	
		Average VCR	Average Speed (Km/H)
1	CTC Cawang - Pluit	0.92	28
2	CMNP Pluit - Cawang	1.02	17

When implemented, this scheme needs to involve many stakeholders for good traffic management. At segment CTC on morning peak hour, the VCR will decrease and at arterial road Pluit-Cawang direction the VCR will increase due to traffic flow on JIUT that was diverted only toCawang-Pluit direction. On the other hand, on afternoon peak hour at CMNP segment, the VCR will decrease and at arterial road on Cawang-Pluit direction will increase due to diversion of traffic flow of JIUT only toPluit-Cawang direction.

6.5.2 One Way Flow Schemefrom CMNP to CTC Segment

The results of modelling by running the one way flow scheme fromCMNP to CTC segment shows that the demand fromSemanggitoTomang areas quite high. This could be seen from the decrease in VCR; however it is not too significant. On the contrary, at the arterial road on opposite side the VCR will increase because there is excessive demand due to the non-existence of alternative roads which could be passed by. The implementation of this schemeis very difficult due to unsuitable ramp position for one way flow opposite to CTC-CMNP direction, especially on elevated segment of CMNP (WiyotoWiyono), which is above the arterial road.

Table 7. Modelling Result of Running One Way Flow Scheme from CMNP to CTC Segment

No	Segment	Parameter	
		Average VCR	Average Speed (km/h)
1	CTC Pluit – Cawang	1,01	24
2	CMNP Cawang - Pluit	0,98	26

6.6 Provision of Additional Toll Structure/Lanes Scheme

This scheme could be adopted by widening and adding new lane or by built new level of structureon top of the existing toll road. The additional structure could be one lane or two lanes for every direction, in 5 and 10 years period, started from 2015 as the base year.

6.6.1 Provision of Additional Toll Structure on Year 2020

The additional structure/lanes will be in the form of double deck system at CTC segment and road widening at CMNP segment. Thisscheme consists of the provision of additional structure/lanes for both CTC and CMNP segments, for CTC segment only, and for CMNP segment only. The results are presented in the following tables.

Table 8 presents traffic performance at JIUTR if no additional structure/lanes provided at year 2020.

Table 8. Traffic performance at JIUTR withoutproviding additional toll structure/laneon year 2020

Segment	Parameter		
	VCR	Speed	Flow
Cawang-Tomang	1.25	8.0	8641
Tomang-Pluit	0.80	30.5	5501
Pluit-Tj.Priok	1.40	4.3	9651
Tj.Priok-Cawang	0.94	21.0	6466
Overall	1.11	15.7	7684

Adding one lane will increase toll capacity to 9200 pce/h and adding two lanes will increase toll capacity to 11500 pce/h. The modelling results of this provision of additional structure/lane are presented in Table 9, as follow.

Table 9. Modelling results of providing additional toll structure/laneson year2020

Adding one lane									
Segment	2020 +1 lane			2020 +1 lane (CTC)			2020 +1 lane (CMNP)		
	VCR	Speed	Flow	VCR	Speed	Flow	VCR	Speed	Flow
Cawang-Tomang	1.15	12.5	10593	1.19	10.8	10952	1.23	9.7	8477
Tomang-Pluit	0.79	30.5	7318	0.87	28.1	8037	0.87	28.5	5997
Pluit-Tj.Priok	1.24	9.5	11414	1.34	7.4	9283	1.27	8.3	11696
Tj.Priok-Cawang	0.89	25.5	8245	0.95	23.6	6601	0.91	25.0	8337
SeluruhRuas	1.03	18.8	9519	1.10	16.8	8769	1.08	17.2	8743
Adding two lanes									
Segment	2020 +2 lanes			2020 +2 lanes (CTC)			2020 +2 lanes (CMNP)		
	VCR	Speed	Flowl	VCR	Speed	Flow	VCR	Speed	Flow
Cawang-Tomang	1.08	15.0	12409	1.14	12.5	13198	1.21	10.5	8316
Tomang-Pluit	0.87	28.8	9942	0.86	28.4	9963	0.86	28.7	5940
Pluit-Tj.Priok	1.15	12.7	13171	1.30	9.1	8984	1.17	13.5	13516
Tj.Priok-Cawang	0.87	28.7	10032	0.94	23.9	6519	0.88	26.3	10175
SeluruhRuas	0.99	20.9	11444	1.07	17.8	9682	1.04	19.0	9653

The provisional of additional structure/lanes shall be performed due to very high demand. However, in this scheme, the financial and construction/technical feasibility become big issues, therefore the application of this scheme should be decided carefully. Furthermore, the construction of additional lane one-by-one was very difficult and might not bepractical, thus all the two lanes should be constructed all in the same time.

6.6.2 Provision of Additional Toll Structure on Year 2025

This schemeis carried out as the scheme for year 2020, but has difference in the number of demand. The results of doing nothing condition on year 2025 and doing something (or adding one or two lanes) are shown in **Table 10** and **Table 11**.

Table 10. Traffic performance at JIUTR without providing additional lanes on year 2025

Segment	Parameter		
	VCR	Speed	Flow
Cawang-Tomang	1.51	2.5	10393
Tomang-Pluit	0.98	24.7	6737
Pluit-Tj.Priok	1.76	1.5	12162
Tj.Priok-Cawang	1.07	17.9	7360
Overall	1.34	10.6	9255

Table 11. Modelling results of providing additional toll structure/lanes on year2025

Adding 1 lane									
Segment	2025 +1 lane			2025 +1 lane (CTC)			2025 +1 lane (CMNP)		
	VCR	Speed	Flow	VCR	Speed	Flow	VCR	Speed	Flow
Cawang-Tomang	1.38	3.7	12648	1.41	3.2	13007	1.48	2.8	10202
Tomang-Pluit	0.94	25.0	8640	1.03	23.5	9501	1.05	21.5	7226
Pluit-Tj.Priok	1.54	2.1	14125	1.69	1.6	11652	1.58	2.1	14518
Tj.Priok-Cawang	0.99	21.4	9191	1.08	17.7	7452	1.03	20.4	9458
Overall	1.22	12.2	11258	1.31	10.6	10425	1.29	11.1	10443
Adding 2 lanes									
Segment	2025 +2 lanes			2025 +2 lanes (CTC)			2025 +2 lanes (CMNP)		
	VCR	Speed	Flow	VCR	Speed	Flow	VCR	Speed	Flow
Cawang-Tomang	1.27	5.8	14638	1.36	3.7	15613	1.45	3.0	10025
Tomang-Pluit	1.01	20.1	11563	1.03	22.8	11793	1.04	21.1	7170
Pluit-Tj.Priok	1.39	3.1	16031	1.64	1.7	11302	1.44	4.5	16537
Tj.Priok-Cawang	0.96	23.4	11002	1.08	17.3	7478	0.99	22.4	11467
Overall	1.16	13.0	13325	1.28	10.6	11532	1.24	12.3	11445

6.7 Ramp Metering Scheme

Modelling was carried out by looking at the modelling result at existing condition (2014). The modelling result tells which segments experience high VCR, and for these segments, the entry ramps are closed so that their VCRs decrease below the preset limit (0.85). Based on these existing conditions, the lists of ramps that are closed are:

1. At CTC (Cawang – Pluit): Ramp Cawang (STA 2+200), RampSenayan (STA 9+000) and Ramp Tomang ITC (STA 12+000).
2. At CTC (Pluit – Cawang): Ramp Grogol (STA 13+500), Ramp Pejompongan (STA 9+700) and Ramp Kuningan (STA 4+800).
3. At CMNP (Cawang – Pluit) : Ramp Kebon Nanas, Ramp Rawamangun and Ramp Ancol Barat.
4. At CMNP (Pluit – Cawang): Ramp Ancol Barat, Ramp Sunter and Ramp Jatinegara.

Table 12 presents the modelling result of running the ramp metering scheme. The result shows that the VCR and average speed of vehicles are not highly affected by thisscheme. Although this scheme may suppress the demand, but traffic flows on the arterial roads parallel

to the road are increasing. In addition, implementation of the ramp metering scheme is not easy (i.e. to close and to open ramps depend on existing traffic flow condition). Therefore, it needs very close coordination among the stakeholders involved.

Table 12. Modelling result of running ramp metering scheme

No	Segment	Parameter	
		Average VCR	Average Speed (km/h)
1	CTC Cawang - Pluit	0.96	23
2	CTC Pluit–Cawang	0.88	31
3	CMNP Cawang - Pluit	0.98	20
4	CMNP Pluit - Cawang	0.84	34
Average overall		0.94	26,1

6.8 Selection of The Better Scheme

Based on the modelling results of all the proposed schemes, the comparison of each parameter for each respected year is shown on Tables 13 to 15.

Table 13. Modelling results of all schemes on year 2015

No	Scheme	Parameter			
		Average VCR	Average Speed (km/h)	Flow (pce/h)	Capacity
1	Existing Condition	0.99	21.3		6900
2	3 in 1 Scheme	0.89	31.5		6900
3	Dynamic Tariff Scheme				
	Increased by 10%	0.94	24.3		6900
	Increased by 25%	0.94	24.3		6900
	Increased by 50%	0.93	24.7		6900
4	TariffRasionalisationScheme				
	Increased by 100%	0.92	25.7		6900
	Increased by 200%	0.91	27.8		6900
5	Contraflow Scheme	0.98	20.9		6900
6	One Way Flow Scheme				
	One Way Flow fromCTC to CMNP	0.97	22.3		6900
	One Way Flow from CMNP to CTC	0.98	21.8		6900
7	Additional Lane/Structure of Toll Road				
	Adding 1 Lane	-	-	-	-
	Adding 2 Lanes	-	-	-	-
	Adding 1 Lane on CTC	-	-	-	-
	Adding 1 Lane on CMNP	-	-	-	-
	Adding 2 Lanes on CTC	-	-	-	-
	Adding 2 Lanes onCMNP	-	-	-	-
8	Ramp Metering Scheme	0.94	26.1		

Table 14. Modelling results of all schemes on year 2020

No	Scheme	Parameter			
		Average VCR	**Average Speed (km/h)**	**Flow (pce/h)**	**Capacity**
1	Existing Condition	1.11	15.72	7659	6900
2	3 in 1 Scheme	1.07	21.42	7383	6900
3	Dynamic Tariff Scheme				
	Increased by 10%	1.11	15.97	7645	6900
	Increased by 25%	1.11	15.94	7612	6900
	Increased by 50%	1.10	16.25	7590	6900
4	Tariff Rasionalisation Scheme				
	Increased by 100%	1.11	15.97	7645	6900
	Increased by 200%	1.11	15.94	7612	6900
5	Contraflow Scheme	1.10	16.25	7590	6900
6	One Way Flow Scheme				
	One Way Flow from CTC to CMNP	1.16	15.18	8004	6900
	One Way Flow from CMNP to CTC	1.17	14.82	8073	6900
7	Additional Lane/Structure of Toll Road				
	Adding 1 Lane	1.03	18.77	9476	9200
	Adding 2 Lanes	1.00	20.94	11476	11500
	1 Lane on CTC	1.10	16.78	10120	9200
	1 Lane on CMNP	1.08	17.16	9936	9200
	2 Lanes on CTC	1.07	17.84	12305	11500
	2 Lanes on CMNP	1.04	19.01	11960	11500
8	Ramp Metering Scheme	0.94	26.1		
9	Combination of adding lanes and 3 in 1				
	Adding 1 lane and 3 in 1	0.93	24.7	8489	9200
	Adding 2 lanes and 3 in 1	0.90	30.87	10387	11500

Table 15. Modelling results of all schemes on year 2025

No	Scheme	Parameter			
		Average VCR	**Average Speed (km/h)**	**Flow (pce/h)**	**Capacity**
1	Existing Condition	1.34	10.62	9246	6900
2	3 in 1 Scheme	1.29	14.57	8901	6900
3	Dynamic Tariff Scheme				
	Increased by 10%	1.34	10.79	9237	6900
	Increased by 25%	1.34	10.77	9228	6900
	Increased by 50%	1.33	10.98	9189	6900
4	Tariff Rasionalisation Scheme				
	Increased by 100%	1.31	11.39	9039	6900
	Increased by 200%	1.28	11.90	8832	6900
5	Contraflow Scheme	1.42	9.65	9798	6900
6	One Way Flow Scheme				
	One Way Flow from	1.40	10.33	9660	6900

No	Scheme	Parameter			
		Average VCR	Average Speed (km/h)	Flow (pce/h)	Capacity
	CTC to CMNP				
	One Way Flow from CMNP to CTC	1.41	10.08	9729	6900
7	Additional Lane/Structure of Toll Road				
	Adding 1 Lane	1.22	12.24	11224	9200
	Adding 2 Lanes	1.16	12.96	13340	11500
	1 Lane on CTC	1.31	10.62	12052	9200
	1 Lane on CMNP	1.29	11.09	11868	9200
	2 Lanes on CTC	1.28	10.56	14720	11500
	2 Lanes on CMNP	1.24	12.26	14260	11500
8	Ramp Metering Scheme	1.36	12.07	9384	6900
9	Combination of adding lanes and 3 in 1				
	Adding 1 lane and 3 in 1	1.11	15.87	10224	9200
	Adding 2 lanes and 3 in 1	1.05	18.53	12069	11500

From the above table, it can be concluded that adding just one or two lanes at the segments of JIUTR will not decrease the VCRs to below 1.00; the performance of JIUTR still needs to be improved by combining the structure/lane addition with other scheme/s. Modelling result shows that, the scheme of adding structure/lanes must be must be accompanied or combined by other policy, as well as implementing other scheme, such as dynamic tariff,three in one rule, etc.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusion

The modelling result of every scheme proposed in this study shows that provision of additional structure/lane on the JIUTR cannot increase the performance of JIUTR during the study period (2014-2025). The better scheme to increase the performance of JIUTR is to combine the provision of additional structure/lanes on year 2020 or earlier with other schemes such as implementing dynamic tariff, three in one policy, etc.

However, the combination of these schemes itself seems not to be very effective in increasing the performance of the JIUTR up to acceptable condition (VCR lower than 0.85). Therefore, the implementation of this scheme/s shall also be accompanied by improving public transport services, developing more roads, and implementing road pricing on some major arterial roads.

7.2 Recommendation

The proposed schemes shall be coordinated with related toll road operators and other stakeholderswhen implemented. The follow-up of this study includes the revision of related laws and regulations,conducting feasibility study, updating bussines plan, etc. These action shall also be communicated and consulted with public to have their support.

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REFERENCES

Jihanny, J. (2013) Pemodelan pemilihan jalan tol akibat pengaruh variasi tarif. Master Thesis, Master Program in Civil Engineering, Institut Teknologi Bandung.

Karsaman, R. H., Frazila R.B., Jihanny, J., and Darmawan, A. (2011) Study on Toll Tariff Variation on Traffic Flow and Level of Service. Jurnal Teknik Sipil, 20(1), pp 55-65.

Suprayitno, H. (2013) Evaluasi kinerja pelayanan jalan pada pelaksanaan contra flow, Master Thesis, Master Program in Highway Engineering and Development, Institut Teknologi Bandung.