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The solution of traffic congestion during flyover construction at Antapani intersection in Bandung

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Abstract. The Construction of Antapani Flyover has caused traffic congestion. This paper is to find the solution of congestions to achieve the queuing standard allowed referring to PKJI 2014. The method of research uses deductive and inductive which are analysed using the risk analysis of traffic disruptions. The scope of analysis is focused on the two critical construction works, namely abutment and bridge wall works. The traffic congestion analysis considers the narrowing road due to construction disruption. The traffic congestion analysis was carried out by comparing the congestion of the existing construction with the construction method proposed. The three proposed alternative solutions are by the increasing road capacity, scheduling construction methods, and a combining solution those two alternatives. The results show that the best alternative solution to reduce traffic congestion during construction is a combined solution between the increasing road capacity and scheduling construction methods. The result of alternative solution shows the decrease of queue on Terusan Jakarta road reaching up to 90% from the existing condition. The conclusion describes that the narrowing road of work zones of construction has a huge influence on traffic congestion. By this result is suggested to consider the magnitude of disturbance as well as the solution of the traffic congestion that may occurred.

1. Introduction

Flyover construction built as alternative to solve traffic problem, there is traffic congestion at intersection [1]. However, the implementation of Antapani Flyover construction has caused traffic congestion more than existing condition at Terusan Jakarta road. The traffic congestion occurs because of the decreasing effective road width at Terusan Jakarta road and Jakarta road due to the disruption of construction area. Whereas, the bottle neck occurs at that area because of the decreasing effective road width. Therefore, the traffic congestion analysis needs to propose alternative solution that can reduce traffic congestion on Terusan Jakarta road during construction. The three proposed method is the increasing road capacity, scheduling construction method, and a combining solution those two alternative. Those three proposed alternative could be the best alternative to reduce the bottle neck at that area.

This paper is focused on two critical construction works, namely abutment and bridge wall works. The existing condition at Terusan Jakarta road has 2 lanes with 2 lines on each lane. The narrowing road due to construction activities has caused Terusan Jakarta road condition became 2 lanes with 1 line on each lane. The narrowing road while constructing abutment on Terusan Jakarta road is 53% of road width and 47% of road width on Jakarta road [2]. In addition, the high volume of vehicles from Terusan Jakarta road is also one of the factors causing traffic congestion increased. By this reasons, the traffic

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congestion analysis is carried out by considering the existing condition as well as any alternative solutions proposed, that refer to PKJI 2014. The PKJI 2014 is determine the equation to planning and evaluating the performance of intersection traffic [3].

2. Methodology research

The methodology of this research is using deductive-inductive method. The deductive method of this research is the analysis that refer to PKJI 2014, and the inductive method is uses approaching model in the case of drainage construction on Pasteur road. The steps of this research are divided into five steps, namely initial survey at Pasteur road to produce a model approach of construction implementation, data collection and processing of traffic existing chatacteristics, risk identification, semi quantitative risk analysis, and risk response planning.

3. Literature review

This resarch refers to the PKJI 2014 in calculating queue length. This guideline is an update of MKJI 1997, with the same value but different in units [4]. In addition, this research uses risk analysis to identify, analyze, and respond to risks, so can maximize the probability and consequences of positive events, and minimize the probability and consequences of negative events on purpose [5].

The alternative solution used by previous researchers to reducing traffic congestion are construction of flyover that can reduce the queue length reaching up to 61% and widening road can reduce the queue length reaching up to 21.5% [6]. In addition, the solution design is to reduce traffic congestion by considering the spatial planning and traffic management. The result shows that reducing conflict at the intersection is the best strategy because the degree of saturation is reduced to 54% and the queue length is reduced reaching up to 97% [7].

4. Results and discussion

The analysis of this research is the analysis of construction method existing and alternative solution proposed. The analysis of existing construction method is to find the existing queue length during the construction period and the traffic characteristics during the construction. Then the analysis of alternative solution proposed to reduce traffic congestion occured at Antapani intersection, especially Terusan Jakarta approach.

4.1. Traffic existing characteristic

The Traffic Characteristic of Antapani intersection considered is it's characteristic during the construction, such as the frequency of vehicles, approach width, degree of saturation, and queuing length. The Traffic data is collected during weekend and weekday, at 06.00-08.00, 11.00-13.00, 16.00-18.00, and 23.00-01.00. The frequency of vehicles data is collected on post construction, because at that time the Antapani Flyover construction has been completed, assuming the data is a similar with the data during the construction. Whereas the road width data during the construction was obtained by measuring the width of road on post construction condition and adjusted to the preconstruction conditions, the reduced by the width of construction area obtained from PUPR data. The degree of saturation and queue length resulted from the PKJI 2014 equation.

4.2. The characteristic of model approach

The model approach of narrowing road from 50% to 30% at drainage construction on Pasteur road resulted a decrease of queue length reaching up to 90%. However, these results are obtained by different frequency of vehicles. In the case of the frequency of vehicles is considered in the same frequency, the result shows the decrease of queue length reaching up to 50%. That model approach shown at figure 1.

4.3. Risk identification
Risk identification is carried out to determine source of risk and variable risk of traffic congestion. The source of traffic congestions risk consist of the narrowing road and type of construction works, with the risk variables shown in influence diagram at figure 2.

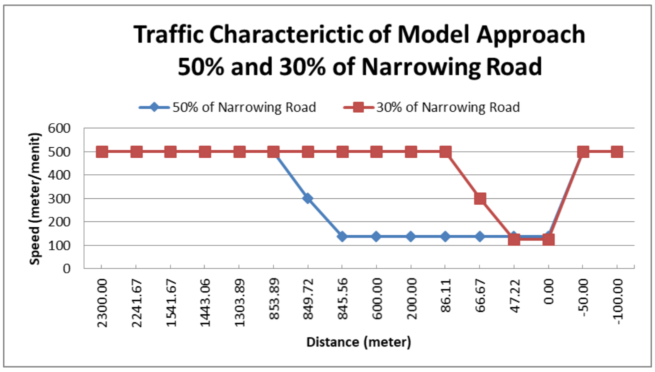

Figure 1. Model approach of drainage construction at pasteur road.

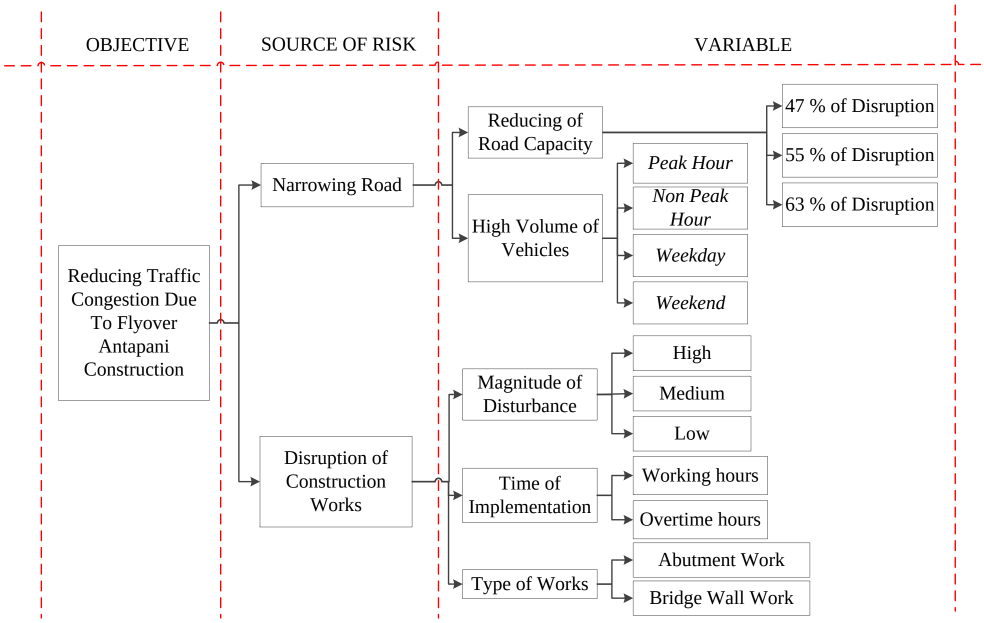

Figure 2. Influence diagram.

Figure 2 shows the sources of risk that need to consider to reduce traffic congestion during the Antapani Flyover construction. The source of risk has variables that may affect traffic congestion occurred. The variables described in the influence diagram are related to each other, for example abutment work gives a disruption of 47% and 53% of the road width. The traffic congestion that occurs will be different at every time, whether it is peak hour, non-peak hour, weekend, or weekday. By this reason, it is need to consider the impact of these risk variables.

4.4. Semi quantitatif risk analysis
Semi quantitative risk analysis is to analyze the probability of risk and impact to the objective defined using traffic congestion parameter, namely the queue length. The queue length determined by PKJI equation to obtain the highest congestion risk of existing condition in the Antapani intersection, especially at Terusan Jakarta approach. The highest risk could determined by using the PI Diagram

(Probability Impact Diagram). The PI Diagram is carried out to determine the highest risk variables. Therefore, the highest risk variables may be avoided to reduce traffic congestion. This analysis, uses time function for probability and construction method for the impact. Time function variable is distributed into three time dimensions, such as peak hour, average time, and night time (non-peak hour). Whereas, construction method variable is distributed into three type of disruption, such as 47%, 55%, and 63% of disruption. The disruption is the narrowing road that occurs in every construction works.

The abutment work was carried out by two methods, namely Method 1 and Method 2, causing a narrowing road by 47% and 55% of road width, consecutively. The implementation time of abutment works at peak hour, average time, and night time (non-peak hour). The traffic congestion occured is categorized as high risk at maximum condition. Whereas, bridge wall work was carried out by two methods, namely Method 2 and Method 3, causing a narrowing road by 55% and 63%of road width, consecutively. The implementation time of this work is similar with abument work. The traffic congestion occured is categorized as very high risk at maximum condition. The risk assessment using PI Diagrams on abutment and bridge wall works is shown in figure 3.

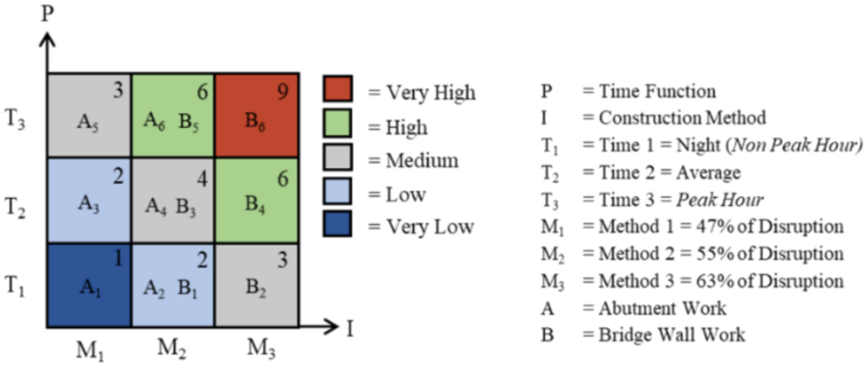

Figure 3. PI diagram of abutment and bridge wall works.

Based on Figure 3, the PI Diagram showed the high risk and the very high risk category to be avoided during Antapani Flyover construction. The construction work with high risk category must be avoided consisting of the construction work at average time with 63% of disruption, and the construction work at peak hour with 55% of disruption. In addition, the construction work with very high risk category must be avoided consisting of the construction work at peak hour with 63% of disruption. Based on that condition, risk mitigation needs to avoided the high risk and the very high risk category to reduce traffic congestion at Antapani intersection.

4.5. Risk response planning

Risk response planning is applied at this research in the form of risk mitigation, with the objective to reduce traffic congestion during the construction of Flyover Antapani. The risk mitigation is to avoide the high risk and the very high risk category on construction works. The three proposed alternative solutions as risk mitigation are the increasing road capacity, the scheduling construction methods, and a combining solution those two alternatives.

4.6. Analysis of the existing and alternative solution

The existing condition of Antapani intersection, especially at Terusan Jakarta approach resulted the maximum degree of saturation of 5.07 and the maximum queue length of 7,636.34 meters on abutment work. Whereas, bridge wall work resulted the maximum degree of saturation of 6.10 and the maximum queue length of 17,127.34 meters. The results of queue length on Terusan Jakarta road during Antapani Flyover construction shown in figure 4.

The Solution I-The Increasing Road Capacity. Based on the model approach, the best solution to reduce traffic congestion is by decreasing of narrowing road to 30%, shown in figure 5. Abutment works resulted the maximum queue length of 1,186.21 meters. This result reduces the traffic congestion reaching up to 84% compared to existing condition. Whereas, bridge wall works resulted the maximum queue length of 1,615.24 meters. This result reduces the traffic congestion reaching up to 91% compared to existing condition. The result of queue lengths on Terusan Jakarta road with alternative solution I shown in figure 6.

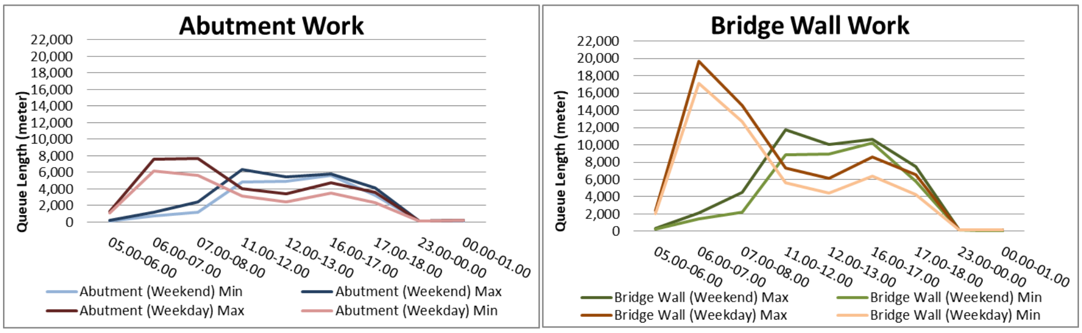

Figure 4. The Queue length existing on Terusan Jakarta road during abutment and bridge wall works.

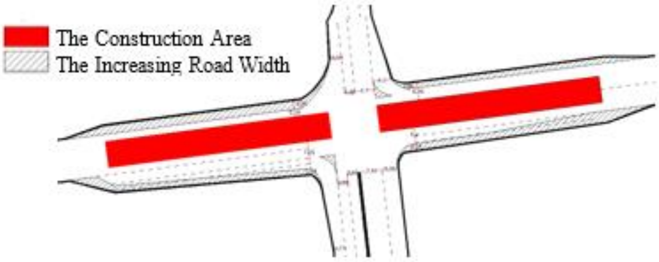

Figure 5. The increasing road capacity at Antapani intersection.

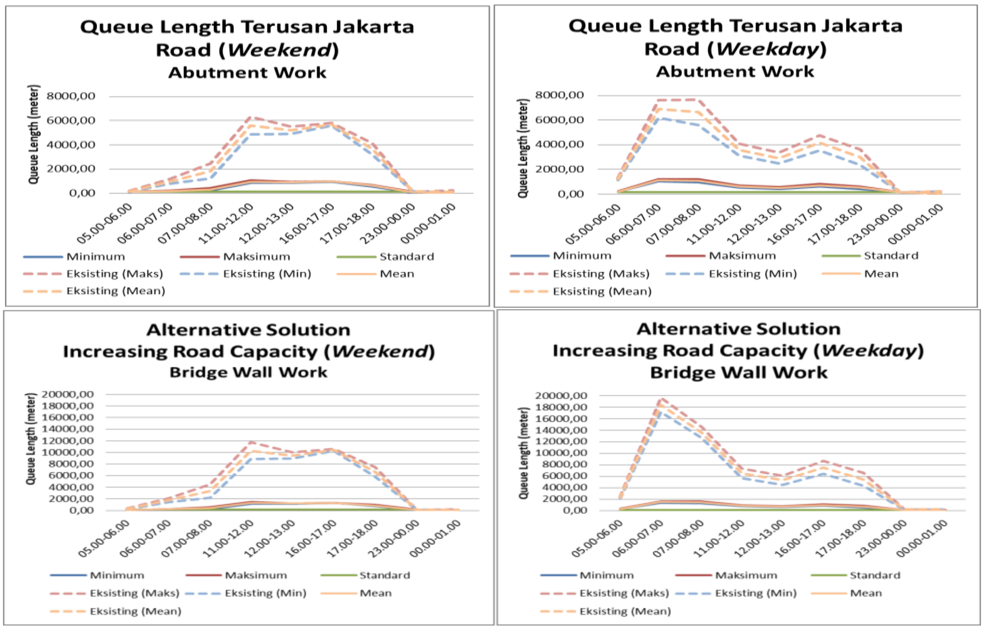

Figure 6. The queue length on Terusan Jakarta road during abutment and bridge wall works with the alternative solution increasing road capacity to 30% of disruption.

4.6.1. The solution II-the scheduling construction method. In this solution, the construction work is scheduled at non peak hours. The abutment work doesn't provide a different queue length compared to the existing condition. Whereas, bridge wall works resulted the maximum queue length of 7,636.34 meters. This result reduces the traffic congestion reaching up to 55% compared to existing condition. The results of queue length on Terusan Jakarta road with alternative solution II shown in figure 7.

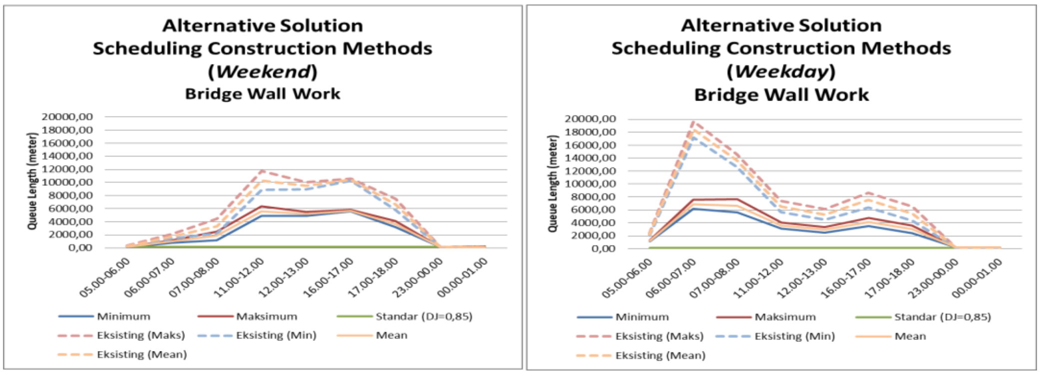

Figure 7. The queue length on Terusan Jakarta road during abutment and bridge wall works with the alternative solution scheduling construction method.

4.6.2. The solution III-the combining solution. Abutment works resulted the queue length the same with solution I. Whereas, bridge wall works resulted the maximum queue length of 1,186.21 meters. This result reduces the traffic congestion reaching up to 93% compared to existing condition. The results of queue length on Terusan Jakarta road with alternative solution III shown in figure 8.

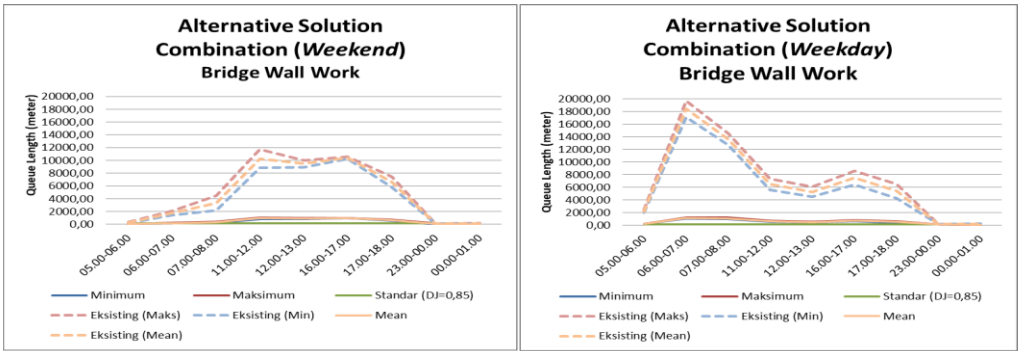

Figure 8. The queue length on Terusan Jakarta road during abutment and bridge wall works with the combine alternative solution.

4.7. *Recapitulation*

The recapitulation of maximum traffic congestion decrease from existing condition to alternative solution on Terusan Jakarta road shown in table 1.

Table 1. Recapitulation of maximum traffic congestion decrease from existing condition to alternative solution on Terusan Jakarta road.

No.	Works	Reducing Traffic Congestion from Eksisting Condition					
		Increasing Road Capacity Solution (%)		Scheduling Construction Method Solution (%)		Combined Solution (%)	
		Weekend	Weekday	Weekend	Weekday	Weekend	Weekday
1	Abutment	83	84	0	0	83	84
2	Bridge Wall	87	91	46	55	91	93

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Based on the table 1, the biggest reduction of traffic congestion when compared to the existing queue condition at Terusan Jakarta road, the solution is by combining solution between the increasing road capacity and the scheduling construction methods. The result of alternative solution shows the decrease of queue reaching up to 93% from the existing condition.

5. Conclusion
The conclusion describes that the narrowing road of work zones of construction has a huge influence on traffic congestions. By this result is suggested to consider the magnitude of disturbance as well as the solution of the traffic congestion that may occurred. The method to reduce traffic congestion is by the increasing road capacity and the managing construction schedule methods.

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