Traffic queue proposal solution on T-junction by utilizing arena simulation software (case study of Dinoyo T-Junction Malang City)

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Abstract. Dinoyo T-junction is one of the intersections with the densest traffic in the city of Malang. This is because T-junction is connecting several major campuses in the Malang city and it is one of the main traffic lanes in town. This study conducted a simulation study of traffic queue on T-junction utilizing Arena simulation software, by giving some proposals solution through simple experiments. Research outcome show that a reduction of red lights duration by 15 seconds in traffic queue simulation for each segment on Dinoyo T-junction be able to gives a significant queue reduction result.

1 Introduction

In the city of Malang there are many intersections that traffic conditions are quite solid. Data on the number of motor vehicles in the city of Malang from the Central Bureau of Statistics [1] amounted to 90,058 units of four-wheeled vehicles and 456,693 units of two-wheeled vehicles, while there has been no significant increase in road capacity in the past 3 years in the Malang city. Traffic congestion cause the community cannot to reach the destination location with a predetermined time. Not only that, it can happen that the delivery of goods is too late when shipped to other company or even an ambulance that brings emergency patients to the hospital.

As happened at the Dinoyo T-junction, its frequent occur dense congestion. At Dinoyo T-junction there are three paths namely Gajayana Street is the path from the direction of Islamic University of Malang, the path of M.T Haryono is the path from Kota Batu Wisata and to Universitas Brawijaya and vice versa. As reported by online media [2], the Dinoyo line connection becomes one of the intersections of 7 (seven) points of traffic jam in Malang. Based on those report traffic queues often occur at 06.00 am until 07.00 pm and at 14.00 pm until 16.00 pm. At the hour above is the time when people go to work at 06.00 am until 07.00 am and on the day of work from home or noon at 14.00 pm until 16.00 pm.

To investigate the problem, this research used a simulation method, and employ the Arena simulator software v.14.05. With the simulation method, it can facilitate the research, and it will be able to save time, cost and energy significantly in making problem solving recommendation of T-junction path.

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2 Literature Review

Previous research that underlies this research includes as follows, first; [3] has conducted a study of which intersections have a high wait time and solve the problem using simulation methods. Software used by researchers to simulate it is Extend^{TM}. Secondly; research is by [4], their study calculate the signal time on each beacon to optimize the deviation. They are using Manual road capacity Indonesia [5] and to manage data using Vissim simulator software.

3 Research Methodology

In conducting this study, research methods are used as a way to obtain data or information to discuss a problem faced. This research done with several stages to overcoming related problems. The following stages are among others; the first stage is a field study. It is a preliminary stage undertaken to understand the topic or problem at the Dinoyo T-junction. Field studies are also accompanied by literature studies conducted by searching or collecting information on literature books, previous research reports, and other written sources of resources. The second stage is the identification stage of the problem, the researchers identify the problem contained in the object of research (T-junction Dinoyo).

The third stage of data collection methods that already done as follows; observation method and documentation method. The fourth stage is traffic simulation model is built on Arena simulation software, through 2 stages, verification stage and validation stage. This verification stage is intended for the adjustment model to be run in accordance with its function and in accordance with the existing state of the research object [6] while validation is used to compare the initial simulation data with the original field research data [7] using T-test Statistic method. The fifth stage is the development of traffic simulation scenario, at this stage is done by simple experiment. Figure 1 is a simple experiment to be performed on the simulation model that is by changing the duration of the traffic light and observing the outcome of the parameter changes made.

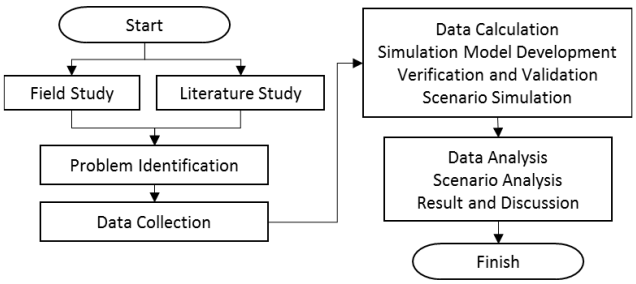


Fig. 1. Research flow diagram.

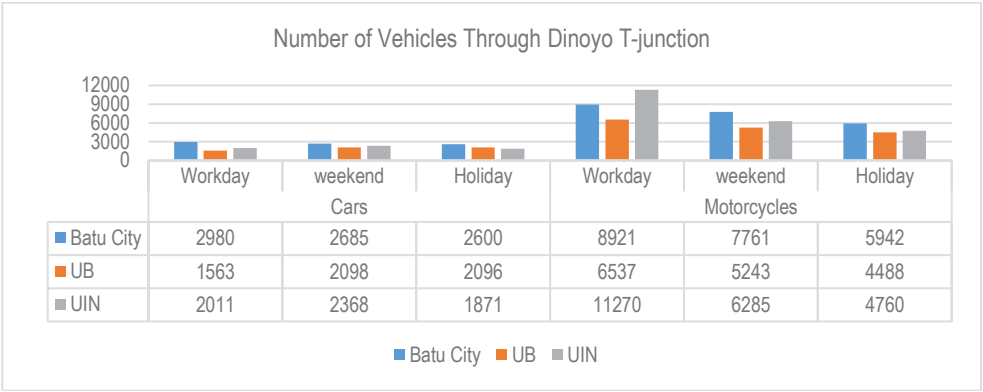
4 Data Collection & Model Development

4.1. Data Collection

Using the collected data, it is finally known which paths have traffic density. The following is the density data based on location path (vehicle path) and time based on the vehicle coming to Dinoyo T-junction. Here is Dinoyo T-junction road scheme which adopted from google map when data collection is still in progress. From the direction of Batu city, there

are two paths, which is a straight line to UB and turn right into UIN. And from UB there are two paths that turn left into UIN and straight path to Batu City. While from UIN there are also two lines, turn right into UB and left turn to Batu City (Figure 2)

Fig. 2. The image with the yellow line is the T-Junction Dinoyo.
A: Jalan Gajayana line of the State Islamic University of Malang (UIN)
B: Jalan M.T Haryono line from Universitas Brawijaya (UB) line
C: Jalan M.T Haryono line from Batu line



	Cars			Motorcycles		
	Workday	weekend	Holiday	Workday	weekend	Holiday
Batu City	2980	2685	2600	8921	7761	5942
UB	1563	2098	2096	6537	5243	4488
UIN	2011	2368	1871	11270	6285	4760

Fig. 3. Number of vehicles through Dinoyo T-junction.

The result data from the observation of the number of vehicles passing through the Dinoyo T-junction as a whole can be seen in the following table, where it shows the proportion of the number of vehicles passing from each lane. From Figure 3, the data is sorted according to the time of collection, the type of vehicle and the location of the research during the observation it will appear that the traffic density characteristics of the three paths. Of figure 3, it appears that motor dominates on a working day while cars data general tends to be evenly distributed. For vehicle data (number of cars) in Batu city line seem have high traffic compared to other days. while cars data in UIN line is relatively lower than other line data.

4.1.1 Distribution Fitting

The fit test distribution is used to find the statistical distribution of the original data [8] in order to be used in the simulation model. To find the original data distribution pattern using the input analyser tool, which is one of the application tools provided by the simulation software arena, which aims to find the appropriate distribution to be used in the simulation model (Figure 4).

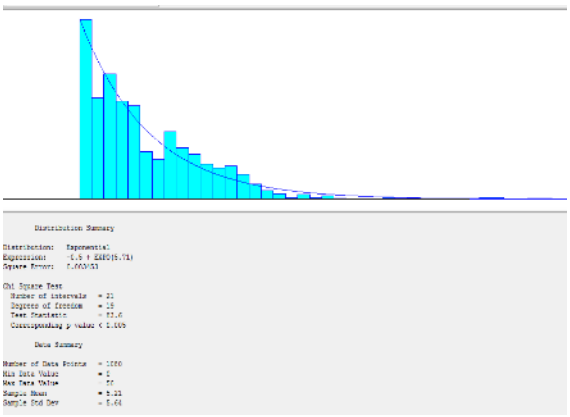


Fig. 4. Result from input analyser arena simulation software.

4.2 Traffic Simulation Model Development

Traffic simulation modelling is done by employing Arena Simulation Software, as shown in the Figure 5, is part of one of the road segment models from Dinoyo T-junction. Where each section of the road has the same elemental structure in the model.

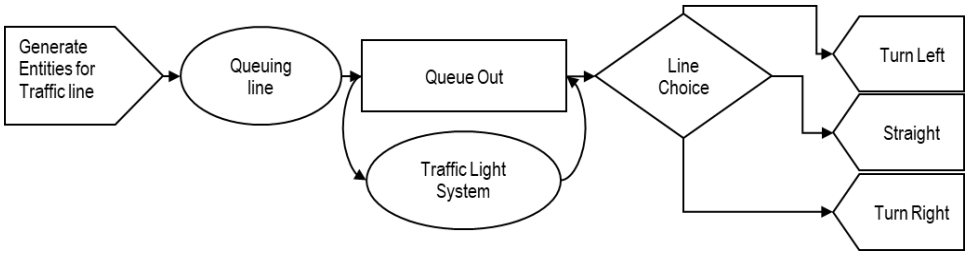


Fig. 5. Part of activity cycle diagram for Dinoyo T-junction models in Arena simulation software.

Traffic model simulation made through the verification stage, which aims to examine all model elements to fit the actual state of the research site. At this stage there will be a model approaching the real state, so this model will be a reference to be used in accordance with the problems that occur in the field. As shown in the Figure 6, is an animated Dinoyo T-junction simulation model used in the model verification phase.

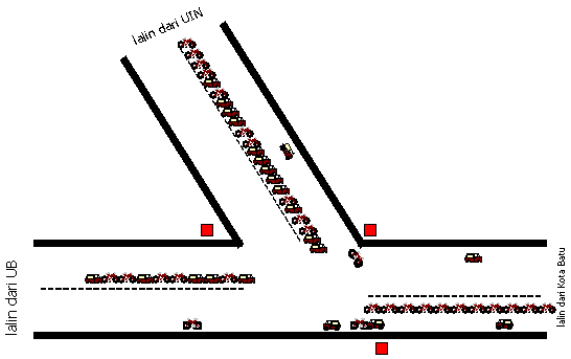


Fig. 6. Animation of Dinoyo T-junction traffic simulation model.

While for the validation phase of traffic simulation model using T-test statistical method. T- test aims to compare the original data of observation result and data from running simulation model of traffic [8]. Hypothesis used H_0 (data have similarity of original data) and H_1 (data has no resemblance to original data). The terms used in the T test are when T Count <T table then H_0 is accepted. Validation is done by using MS Excel analysis tool pack to simplify the data validation. This applies to all path data, in the same way from table 1, where all data has been tested and the results are all valid.

Table 1. Example of T-test for Validation phase of one of part Dinoyo T-junction.

Mean	10.14127	11.39997
Variance	129.0676	304.1958
Observations	2159	14516
Hypothesized Mean Difference	10.14	
df	3866	
t Stat	**-40.1161**	
P(T<=t) one-tail	8.1E-295	
t Critical one-tail	**1.645248**	
P(T<=t) two-tail	1.6E-294	
t Critical two-tail	1.960578	

5 Result and Discussion

From the experiments that have been done found the average data and the number of vehicle arrivals. From the data is done comparison with initial data of simulation which become reference of repair of traffic light duration in order to be able to parse the existing queue. It can be seen that reducing the duration of the red time makes the number of vehicles queuing up at traffic lights decreased considerably compared to the green light overruns that caused the number of vehicles queuing up at traffic lights. Also obtained from the experimental results, reduction of red light duration 15 seconds able to decreasing the queues smaller significantly compared to other experiments and simulation initial data. Here is the comparison of experiments that have been done (Figure 7).

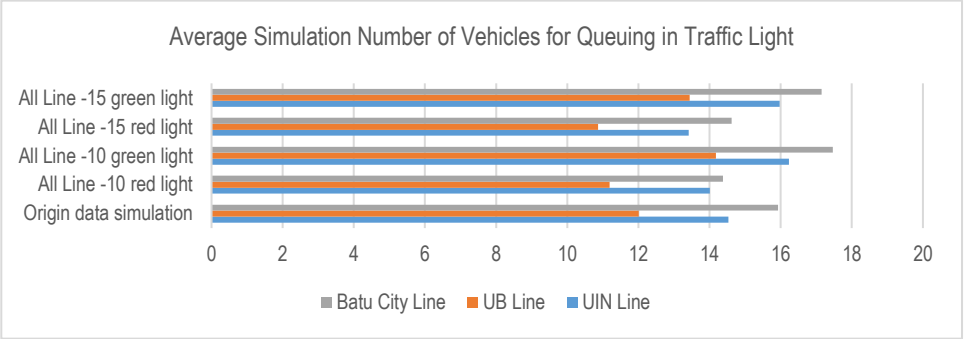


Fig. 7. Each result of scenario simulation (reducing green-light and red-light duration)

6 Conclusion

The experimental outcome by the red-light duration of 10 seconds and 15 seconds were analysed using the average data of the vehicle and the number of vehicles entering the traffic light system compared to the initial simulation data. Experiments with scenarios by reducing the duration of red lights in 15 seconds able to reduce the queue levels in the traffic light system significantly compared to other simulation scenario results.

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