Traffic engineering simulation of campus area transportation using MATLAB SimEvents

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Abstract. Traffic Congestion occurs because of the high number of transportation equipment that is not proportional to the limited capacity of the highway. This condition often occurs in densely populated areas with high levels of community mobilization. This situation generally occurs in the campus environment. The smooth traffic system in the campus environment is one of the parameters of the orderly traffic community, besides the feasibility of facilities and the capacity of the highway around the campus. Traffic jams around the campus generally occur because of various campus activities including crossing the road, parking vehicles, and others. This congestion is also influenced by activities outside the campus such as the entry and exit of vehicles to an agency, the number of public vehicles that pass, and others. In this paper a number of alternative solutions are proposed for solving congestion problems through a traffic engineering simulation and run using the SimEvents MATLAB application. It is hoped that this method can be obtained and evaluated analytically regarding the accuracy, effectiveness and efficiency of the traffic engineering. The traffic engineering simulation was built based on queuing model.

1. Introduction

Congestion has always been one of the main problems in the city of Bandung, Indonesia. Based on the results of a recent Asian Development Bank (ADB) survey, which stated that Bandung is the most congested city in Indonesia [1]. In response to this condition, the city government of Bandung has prepared a number of additional flyover developments to solve congestion problems. However, the impact of this elevated road construction also caused extraordinary traffic, including traffic jams on the Jakarta and Gatot Subroto road [2].

The cause of congestion in the city of Bandung is not only limited road infrastructure. Therefore, if infrastructure construction is continuously carried out, including elevated roads, congestion will always occur. The point is that the main cause of congestion needs to be eliminated, so that the most appropriate solution can be formulated to solve the problem of the congestion [2].

One of the traffic jam locations is around the campus, where almost all roads around the campus in the city of Bandung are always full of vehicles. One of the traffic locations around the campus which is prone to congestion is Tamansari street with locations around the Bandung Islamic University (UNISBA) campus and Pasundan University (UNPAS), also in locations around the Bandung Institute of Technology (ITB) campus. This location is always jammed, especially at peak hours, namely noon during lunch hours (11.00-14.00) and afternoons when campus disbursements (15.00-18.00). Monitored from 2013 to 2019, the general cause of congestion is due to the large number of parking spaces on the
left and right sides of the road, the relatively wide road width, lots of vehicles in and out of campus, and public transportation that often stops around the location to raise and lower passengers [3].

Traffic congestion in the campus environment is part of a big agenda on solving traffic congestion problems in the city of Bandung. In this article we conduct a study of the causes of traffic congestion around campus. Through an understanding of what exactly causes traffic congestion in the campus environment, it is hoped that the best solution can be found to solve congestion problems.

2. Method
The method used in this research is descriptive analytic which describes concerning the traffic situation at Tamansari road, Bandung City. The traffic situation which then will be analyzed through observation and simulation. Through this activities, it is expected to get a clearance of what is actually happening on the traffic that causing congestion.

The research procedure consists of three phases: starting with the preparation, modelling and data analysis, and the last one is the implementation. In preparation phase, we collect traffic information. The observed traffic is at Tamansari Road as depicted in Figure 1. We make a constraint that the analysed traffic is the area near campus of UNISBA and UNPAS. The length of the observed and analysed road is 500 m, average width 5 m, 2 line directions, and maximum 1 lane vehicles for each line/direction.

![Figure 1. The road of Tamansari Bandung near UNISBA and UNPAS.](image)

We performed observations regarding traffic conditions at the Tamansari road and data were collected. Observations were made directly on the objects of Tamansari road in August to October 2019, specifically from 11.00 to 13:00 in the afternoon. The results of observations, besides of too many vehicles and very narrow road, several factors causing the congestions are as follow:

2.1. Vehicle in and out
A number of vehicles entering and leaving the campus and office/work at the location of Tamansari road caused traffic congestion. Figure 2 shows the process of vehicles’ entering and leaving a vehicle that is obstructing the flow of the vehicle. This process occurs in random time, but judging by its frequency, in and out of the vehicle is quite a cause of traffic jams.
2.2. **People crossing the road**
UNISBA has around 13,000 students in total [4] and UNPAS has around 4,000 [5] students for Tamansari Campus. So there are 17,000 students who take activities around Tamansari road in one week. There are so many students crossing the Tamansari road in every minutes. There is no crossing tunnel or bridge, so this situation also has been participating in blocking the flow of vehicles and causing congestion.

2.3. **Side road parking**
Vehicles park in the side of Tamansari road making the narrow road becomes worst. This condition resist the traffic flow and sometimes vehicles have to stop to give a chance for the opposite vehicles to move.

2.4. **People walking on the side road**
Some people walk on the side road because the sidewalk is not existed or taking over by the roadside seller. the vehicle lowers the speed of the vehicle and even stops to give opportunity to pedestrians. This situation caused the traffic congestion.

2.5. **Bad driver**
There are some drivers who stop at Tamansari road carelessly to raise and lower passengers. They are mostly the public transportation or online transportation. They sometimes don’t care they caused traffic jam.

Based on the cause of congestion, we observe and analyze in depth regarding to the factors. Observation data and analysis results are then implemented into the queuing model, and simulated using the MATLAB SimEvents application [6–9].

3. **Result and discussion**

3.1. **Arrival and obstacles**
Based on observations on Jalan Tamansari, the average arrival of vehicles is 28 vehicles per minute. This amount is included in two-wheeled vehicles that are converted into 6-wheeled two-wheeled vehicles as 4-wheeled vehicles. This is done to simplify the analysis and simulation of traffic.

Subsequently an analysis of the obstacles that occurred on the Tamansari road was quantified. The results of the analysis of obstacles caused by several factors causing congestion, are shown in table 1.
Table 1. Data of vehicle’s obstacles*.

| Obstacles             | Obstacle’s Average Time (in sec) |
|-----------------------|----------------------------------|
| In-Out Traffic        | 0.5                              |
| Crossing at UNISBA    | 1.2                              |
| Crossing at UNPAS     | 0.6                              |
| Side Road Parking     | 0.2                              |
| Pedestrian            | 0.2                              |
| Bad Driver            | 0.2                              |

*The obstacles data presented based on observation at Tamansari Road on August to October 2019

3.2. Queueing model
Data from observations and analysis are then implemented into the queueing model. In this study, it is assumed that the traffic conditions at Tamansari road follow the M/M/n model where vehicle arrivals follow the Poisson process with an average interarrival time and obstacles exponentially distributed [10–14]. The number of vehicle queues is assumed to be unlimited, and the queue is stable for an unlimited period of time.

3.3. Simulation
Based on the M/M/n queuing model, the simulation is then performed with reference to the data from the traffic observations with the simulation design shown in figure 3. The simulation is performed using the SimEvents application which is run on MATLAB software version 2014b.

Figure 3. The model of queueing system for Tamansari road.

Furthermore, the data in tables 1 is entered into the system and the simulation runs with a simulation time of 120 minutes.

3.4. Simulation result
The results of the simulation are the waiting time in the queue and the travel time, shown in figures 3 and 4, respectively. The basic reference for travel time delay at Tamansari road with normal traffic conditions (with a little queue) is 3 minutes.
Figure 4. Delay trip time of vehicles at Tamansari road.

As shown in figure 4, the number of vehicle queues is quite long. This is caused by the high level of obstacles so that the flow of vehicles is obstructed. These obstacles have an impact on increasing travel time as shown in figure 5.

Figure 5. Travel time at Tamansari road in congested traffic 11.00-13.00.

Figure 5 shows the travel time or the delay trip time at Tamansari road where it takes an average trip time of 10 minutes or more. When compared with normal travel times, congestion at Tamansari road has increased by more than 3 times. This happens because of the factors causing congestion mainly due to the high activities of students in crossing the road and the entry and exit of vehicles from offices and campuses to the Tamansari road.

One effort to reduce congestion is to implement strict regulations from the government and the campus authorities in regulating the entry and exit of vehicles during rush hour. In addition, building a bridge or underground tunnel for crossing road, will decrease the congestions. Through tight settings it is expected that traffic congestion can be reduced so that the travel time is not too far from the normal travel time.

4. Conclusion

This article has discussed the factors that cause congestion at the traffic near campus, specifically for traffic at Tamansari road, which near with campuses of UNISBA and UNPAS, located in Bandung city, Indonesia. Based on observations and analysis of traffic data, a queuing model has been built and simulated using the MATLAB SimEvents Application. Based on the analysis and simulation, the main cause of congestion is the crossing activities and the entry and exit of vehicles from campuses and offices.
to the road which causes travel time to increase from an average of 3 minutes in normal conditions to 10 minutes or more in the congested traffic conditions.

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