Model Microsimulation Roundabout Utilities in Makassar

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Abstract. The vehicle growth is one of the problems affecting traffic congestion. The circulation of entry vehicles and circulating vehicles in confluence made the conflict point. Avoidance the conflict is the need to increase road performance. The roundabout of the road is one of the utilities to increase the performances of traffic and reduce congestion. The prevention step is to maximize the utilities to control and manage the traffic. The roundabout dispersed and controlled the traffic flow. According to Makassar roundabout observation, the queuing and delay of vehicles recently occurs. This study aims to an analysis of the roundabout using the microsimulation Vissim program. The model uses the geometric condition of the road and volume of the vehicle that produce the models based on real condition and validation. This model performed the visual condition and calculated the capacity and shows the emission of the operational vehicle, and the general performances are summarized for operation performances at roundabout confluence sections. The result indicated that the roundabout is still useful to reduce the potential of queuing and delay the time of vehicles, and it needs supervision periodically for preventing the traffic from the potential congestion, especially in developing countries. The research result is useful as a reference for improving the capacity of roundabouts.

1. Introduction

Transportation is the movement of people or goods from one place to another by using a vehicle driven by man or machine. Along with population growth, the travel movement is also increasing. Vehicle growth is not matched by adequate infrastructure would be problematic, particularly for transportation. The congestion problem often occurs in individual road sections at peak hours (rush hour), for it is one of the ways to overcome transport problems is to maximize the functions of facilities and transport infrastructure.

Makassar City is one of the metropolitan cities in eastern Indonesia. Data motor vehicles in 2016, as many as 1,425,151 units increased from 2014, the number of vehicles ranging from 1,252,755 units. The growth rate of vehicles in 2015 for two wheels in Makassar is 6.29%, 10.20% of passenger cars, buses, and trucks 0.74% 7.55%. The long road of Makassar in 2016 was 2977.50 km with 66.80% good condition, the condition being 13.46%, 14.87% lightly damaged condition and severely damaged 4.87% (the city of Makassar in Figures, 2017), The growth of motor vehicles in the city of Makassar reach 7% per year, while the growth of road <1% per year [1].

Congestion often occurs on roads and intersections, especially at peak hours. Traffic congestion often occurs at the intersection of demand impact of traffic density are long queues and delays by vehicle [2]. This condition requires treatment that traffic congestion is not continuous. The handling facility at the
intersection can be a roundabout and traffic lights [3]. The research explains that the handling of the plot intersection, there are two types of treatment with the handling of traffic lights and no traffic lights [4].

There are several roundabouts in the city of Makassar, among others, the roundabout Tugu Mandiri, Mandai Simpang Lima roundabout and the roundabout Samata Gowa. This roundabout performance will be analyzed Vissim software using model-based microsimulation. This model shows the visual conditions such as field conditions. In this study, an analysis of the problems with using simulation software in order to produce a valid analysis and in accordance with conditions on the ground.

2. Literature Review

2.1. Characteristics of Macro & Micro Traffic

Parameters needed to define macro traffic directly related to the traffic system are [5]:
- Volume
- Speed
- Density

Traffic microscopic approach examines some of the critical parameters which influence the response to the vehicle itself in traffic on the highway while the parameters - parameters include [6]:
- Spacing and headway
- Lane Occupancy
- Clearance and Gap

2.2. Intersection and Roundabout

According to the Ministry of Transportation Directorate, the junction is a node on the network where the streets meet and intersect the vehicle trajectory. Intersection created to reduce potential conflicts between vehicles (including pedestrians) while providing maximum comfort and ease of movement of the vehicle [7]. The traffic circle (roundabout) can be regarded as a particular case of the canalization of the islands in the middle can act as a divider, and a steering controller for the traffic system rotates in one direction [8].

![Figure 1. Examples junctions’ piece and roundabout](image)

2.3. Traffic Management

Purpose of implementation of traffic management are [9]:
1) Getting the level of efficiency of traffic movement overall with the level of accessibility (comfort size) high by balancing demand with the movement of existing support facilities.
2) Increasing the level of safety of the user that can be accepted by all parties and improve the level of safety as possible.

According to the Regulation of the Minister of Transportation, one of the traffic planning is the determination of the level of service desired [10]. As for the level of service at the intersection of priority, "stop" can be seen in the Table 1 as follows:
Table 1. Income multiplier of transportation sector

| Level of Services | The average delay is stopped (seconds per vehicle) |
|-------------------|--------------------------------------------------|
| A                 | < 5                                              |
| B                 | 5-10                                             |
| C                 | 11-20                                            |
| D                 | 21-30                                            |
| E                 | 31-45                                            |
| F                 | > 45                                             |

2.4. Microsimulation Model

The concept of a simulation model is very often used in traffic in transportation planning an activity exceptionally dynamic and very spacious. Basically, the simulation models are grouped in three dimensions [11]:

a) Deterministic Simulation Model with Stochastic Simulation Model
b) Continuous Simulation Model with Discrete Simulation Model
c) Static Simulation Model with Dynamic Simulation Model

Micro-simulation model of a concept or system of analysis which is widely used today because with this concept helps users define and evaluate the best parameters to be used in the context of specific issues-based computerization [12].

Car Following Model is a model that is used to control the behavior of the driver, or the driver of the other riders who were on the same track of this model was developed.

![Image of Car Following Model](image)

Figure 2. Illustration of car following model

2.5. Applications PTV VISSIM

PTV Vissim software is used for simulation of microscopic traffic flow leading developed by PTV Planing Transport [13]. VisSim tool traffic micro-simulation used for planning and traffic modeling for urban areas in the countryside want any good for any analysis of the flow of vehicles or pedestrians flows and have the ability to simulate various types of traffic modes simultaneously [14]. Vissim can be used for several cases, among others:

- Building roads and intersections
- Planning and development
- Mass transport planning

3. Research Methodology

The method used in this research is to conduct a series of surveys of traffic especially, the survey vehicle volume and speed.

3.1. Place of Research

Location of the research carried out on three roundabouts in Makassar namely, Tugu Mandiri, Mandai and roundabout in Samata.
3.2. Research Framework Flow
Before doing research, then made steps groove implementation of research activities to be run in a systematic and targeted achievement of the objectives of the study. The first step that needs to be done is a preliminary study that consists of background, problem formulation, and purpose of the study, then examined in the literature review and a variety of basic theory. The flow can be seen in Figure 3.

![Figure 3. Research framework flow](image)

3.3. Procedure Research (Survey)
The survey was conducted based on the needs of the data as input to the application. The survey is divided into three categories:
1) Survey traffic count is traffic volume by recording the number of vehicles on the roundabout.
2) Speed survey conducted using a speed gun test by directing a tool to the type of vehicle to be measured speed.
3) Survey geometric conditions are conducted by recording the geometric road conditions such as lane width, lane, shoulder, etc.

The third survey was conducted on peak hour traffic volume in the morning and afternoon on weekdays and holidays. Other data supporting the research is secondary data such as the number of vehicles the city of Makassar, the population, and more.

4. Result and Discussion
4.1. Volume of Traffic Roundabout Intersections Tugu Mandiri
The volume of traffic flow on each - each closers intersection shows the flow of vehicles that will cross the intersection. Here’s the trend of vehicle volume of closer crossroads of observation area (Ujung Pandang-Nusantara-Sulawesi-Bundaran-Balai Kota- Slamet Riyadi).

![Figure 4. The trend of vehicle volume closers roundabout intersections](image)
4.2. Profile Speed Vehicle Traffic Flow at Intersection

The results of the survey of vehicle speeds in Simpang roundabout Tugu Mandiri as shown visually in figure 5, figure 6, and figure 7 below.

![Figure 5. Vehicle speed of Light Vehicle (LV)](image1)

![Figure 6. Vehicle speed of Heavy Vehicle (HV)](image2)

![Figure 7. Vehicle speed of MOTORCYCLE](image3)

The above figures show that the frequency of the phenomenon of the vehicle speed at the intersection tends distributed normally, the graph shows that the frequency of the velocity distribution by type of vehicle is almost identical except for the type of trucks and buses that have relatively little frequency.

4.3. Calibration Model Micro - Simulation

Based on the parameters that exist in VISSIM been several parameters by different traffic conditions than do the calibration of the volume of vehicles in the period of peak hour (peak hour) that the peak hours in the morning, afternoon, and evening. The value of the calibration and calibration test results are accepted using GEH test. Then, the model is used to make the simulation of the roundabout, especially in Tugu Mandiri intersection. The visualizations are shown in the following figure 8.

![Figure 8. The 3D visualization roundabout of Tugu Mandiri intersection](image4)
4.4. Validation Results Model Micro - Simulation

The analysis used is the chi-square test. Where would seem the probability value of the chi-square test. The validation results also show that the model is accepted.

4.5. Analysis of Micro - Simulation Traffic Existing

Analysis of microsimulation by the results of the value - the value of the parameters used to analyze the performance of the traffic junction roundabout Tugu Mandiri, long queues, and delays of vehicles for this research.

The traffic performance based on simulation results is shown in figure 9 and figure 10. The figure shows that the phenomenon of queuing and delays vehicles in each leg intersection is quite different, especially the long queues. For the long queues occurs at Jalan Ujung Pandang, which is longer than another side with the highest value at 38.12 m, this has occurred at 12:00 to 13:00. Otherwise, the traffic in Jalan Nusantara with value is around 8.89 m, which is closers to Road Bonerate and occurs at 15:08 am. As for the delay of vehicles show the opposite phenomenon was a delay at the intersection of Jalan Ujung Pandang foot taller by about 6-15 seconds compared closers Jalan Slamet Riyadi west just 5-9 seconds.

4.6. Improving Simulation Performance (Alternative of U-Turn on Jl. Riburane)

The alternative movement of a traffic intersection is made by the addition of U-Turn at the base of Riburane road, so vehicles initially have to pass through the roundabout into a U-turn ot the U-Turn. The comparative visualization results after optimization models with field conditions at each closer are shown in figure 11 and figure 12 below.
Figures 11 and 12 show that the optimum form of an adverse performance by adding a U-Turn at the base of the road Riburane. The results of the long queues and the maximum delay occur on Jalan Ujung Pandang 21.68 m; 8:56 second, Jalan Nusantara as much as 18.02 m; 7.76 seconds, Jalan Sulawesi, 34.46; 11.63 seconds, Jalan Bonerate 28.66 m; 17.60 seconds, Jalan Jampea 14.63 m; 24.66 seconds, Jalan Slamet Riyadi 28.66 m; Jalan Riburane 8.89 seconds and 18.68 m; 5:28 seconds. They were giving the U-Turn in the Road Riburane a positive impact on Jalan Ujung Pandang, namely a reduction in long queues at 31.41%, 12.15%, and Jalan Jalan Nusantara Riburane 53.57%. On the other hand, the lead of increasing of long queues occurs at Jalan Sulawesi of 13.65%, Jalan Bonerate 13:38%, 18.72% and Jampea Jalan Slamet Riyadi of 0.05%. After optimization was obtained, then it was improving the performance of road networks. Figure 14 shows the visualization of simulations results.

5. Conclusions
After the analysis and validation model, connecting the conclusions and linked directly as follows:

a. Model microsimulation of traffic conditions at the intersection of Jalan Nusantara - Jalan Ujung Pandang - Road Riburane using Vissim software through the calibration and validation of simulation models by using volume and long queues of vehicles in the field.

b. Traffic performance of existing conditions at the Roundabout Simpang Tugu Mandiri obtained value of the queue length, and the maximum delay occurs are Jalan Ujung Pandang 38.12 m at 14:32 seconds; Jalan Nusantara 8.99 m and 8:38 seconds; Sulawesi street 31.67 m and 8.06 seconds; Jalan Bonerate 15.53 m and 18:46 seconds; Jalan Jampea 16.50m and 10:13 seconds; Jalan Slamet Riyadi 28.78 m and 9:04 seconds; Riburane street 34.63 m and 5:30 seconds.

c. Giving U-Turn in the Road Riburane leave a positive impact on Jalan Ujung Pandang, namely a reduction in long queues at 31.41%, 12.15% and Jalan Jalan Nusantara Riburane 53.57%, but lead to increased long queues at Jalan Sulawesi amounted to 13.65%, Roads 13:38 Bonerate%, 18.72% and Jampea Jalan Slamet Riyadi of 0.05%. Overall the positive impact is resulting from the provision of U-Turn at broad Leh Riburane road. So in the case of a roundabout intersection Tugu Mandiri, to produce optimum performance, sufficient intersections are wearing alternative addition of U-Turn in the Road Riburane for generating traffic performance is better than the other phases of the movement.

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