

Modeling Bandung Traffic Jam Using Simulation Of Urban Mobility

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Abstract

The population density in Bandung City is rapidly increasing. It is also followed by the increasing number of vehicles. Today, people are able to get new vehicles much easier than ever before. The public services such as trains, buses, and "angkots" (public transportation) are still uncomfortable to most people for many reasons. On the other side, the streets in Bandung City cannot withstand the increasing density of the vehicles. The purpose of making this simulation by means of this research is to make a measurement tool that can be used to determine the solution to the traffic congestion issue in Bandung City. Making the simulation is done by editing the file osm from www.openstreetmap.org, converting, and adjusting traffic lights and vehicles at random into the simulation. By entering the total car-type vehicles at random, the simulation illustrates a significantly high congestion.

Kata kunci: capacity, streets of Bandung City, vehicles

I. Introduction

Bandung population growth each year has a rate of 1:26%. There were 2,483,977 people living in the city of Bandung. However, this growth has not been evenly distributed, population growth is centered on the District Bojong Loa Kaler with 39.738 inhabitants / km². As long as population growth, the use of motor vehicles also increased. There are 1,320,749 units of vehicles within the city of Bandung, the motorcycle the most most users. As many as 994 477 units and followed by private cars manifold mini buses as much as 188.721 units.

Congestion in Bandung occur due to several factors. The amount of use of the vehicle is not in accordance with the capacity of roads (total length of roads 1,236.8 Km) are available in the city of Bandung. Stacking vehicles occurred at a particular time. It Causes most of the inhabitants of Bandung has the same activity. Stacking vehicles occurred during the morning and afternoon, where most residents use the road to go or return of activity.

II. Basic Theory

2.1 Bandung Traffic Developments

Bandung district was formed more or less in the middle of the 17th century. Under the current government Wilem Daendels Herman, is built roads Anyer - Panarukan that cross Bandung. Among them is the Jalan Sudirman, Jalan Asia Afrika and Jalan A. Yani.

At this time, Jalan Raya Bandung has grown and divided into 4 hierarchies, including:

1. Primary Artery Road

Road with this type of hierarchy is the main road connecting all parts of Bandung. The roads which were included on this hierarchy is Jendral Sudirman Street, Asia Afrika Street, Jendral Ahmad Yani Street, Raya Ujung Berung Street, Sukarno Hatta Street, Doktor Junjuran Street, Cikapayang Street, Jalan Surapati Street, and Penghulu Haji Hasan Mustofa Street.

2. Primary Collector Road

The road which were included on this hierarchy is Raya Setia Budi Street, Sukajadi Street, Haji Omar Said Cokrominoto Street (Pasirkaliki Street), Gardujati Street, Astana Anyar Street, Pasir Koja Street, Kiai Haji Wahid Hasyim Street (Kopo Street), Mohammad Toha Street, Terusan

Buah Batu Street, Terusan Kiara Condong Street, Mohammad Ramdan Street, Terusan Pasir Koja Street, Rumah Sakit Street, dan Gede Bage Street.

3. Secondary Artery Road

The road which were included on this hierarchy is Jamika Street, Peta Street, Barisan Keamanan Rakyat Street (BKR Street), Pelajar Pejuang 45 Street, Laswi Street, Sukabumi Street, Sentot Ali Basyah Street, Diponegoro Street, Wage Rudolf Supratman Street (W.R. Supratman Street), Jakarta Street, Terusan Jakarta Street, Pasir Koja Street, dan Abdul Muis Street.

4. Secondary Collector Road

The road which were included on this hierarchy is Insinyur Haji Juanda Street, Dipatiukur Street, Merdeka Street, Ciumbuleuit Street, Setiabudi Street, Cihampelas Street, Siliwangi Street, Gegerkalong Hilir Street, Tubagus Ismail Street, Sadang Serang Street, Cikutra Barat Street, Cikutra Timur Street, Antapani Lama Street, Pacuan Kuda Street, Ciwastra Street, Rajawali Barat Street, Rajawali Timur Street, Kebonjati Street, Suniaraja Street, Lembong Street, dan Veteran Street.

2.2 Causes of Bandung Congestion

Population growth is increasing every year. Needs of each resident to drive runs in line with population growth. On the other hand the growth of Bandung public road is not easy. It takes agreement between the government and the population concerned. This will cause the density of vehicles that will cause serious traffic congestion.

The growth of private vehicles go together with population growth. Because the public transportation is not convenient. Public transport driver often reckless, stop in any place, and common criminality within the vehicle. On the other hand the requirements to obtain a personal vehicle more easily. Requirements to obtain a driver's license or certificate of motor vehicle easily obtained by giving bribes. Installments without interest of the bank also provides ease of ownership drive.

2.3 Mathematical Equation

Traffic is influenced by many parameters. This parameter is used for simulation modeling measurable. Some parameters related to simulation modeling is described as follows.

1. Velocity

Processing the data that has been collected, it takes equations to determine the average speed. There are two methods to calculate the average speed. That method is the Mean Time and Space Mean Speed. Mean Time Speed method is a method of summing up all the data speeds available (v_i) then in the number of vehicles. The method equation shown in equation 2.1.

$$v_t = (1 / m) \sum_{i=1}^m v_i \quad (2.1)$$

While the method of Space Mean Speed is the multiplication of the number of vehicles passing through the road section (n) with a total of pace for the regions each vehicle (v_i) then inverse. This method equation shown in equation 2.2.

$$v_s = n \left(\sum_{i=1}^n (1 / v_i) \right)^{-1} \quad (2.2)$$

Data processing in the manufacture of this simulation method, the Space Mean Speed. Due to the results of this method is closer to the actual conditions.

2. Traffic Density

The traffic density is the ratio between the number of vehicles in a road with the length of these roads. The calculation of the density of traffic can use the equation 2.3.

$$k = \frac{1}{s} \quad (2.3)$$

3. Traffic Flow

Traffic flow is the number of vehicles passing through a road every interview time. Traffic flow calculation using equation 2.4.

$$q = k.v \quad (2.4)$$

2.4 Modeling Bandung Simulation Of Urban Mobility

Bandung traffic simulation consists of three main models. Among them are models of maps, traffic light models, and models of vehicles. Map and traffic lights is a means of testing and vehicle were be entered randomly as test equipment.

Map used in traffic simulation models the city of Bandung, derived from web www.openstreetmap.org. This file is edited by changing the way that one line with two lines with each lane using Java OpenStreetMap. This is done so that the vehicle running in accordance with traffic regulations.

Modelling of traffic lights is assumed to have 60 seconds for the green light, 5 seconds for the yellow light and a multiple of 60 seconds from the number of intersections for red.

Vehicle modeling performed by entering the vehicle randomized into the simulation. The number of vehicles incorporated into the simulation, based on the number of vehicles in the city of Bandung and the number of vehicles in a traffic jam.

III. Design

Making the simulation is divided in four main parts. Among them is getting osm files from the web www.openstreetmap.org, edit maps using Java OpenStreetMap, convert the file, then run the file.

1. Openstreetmap

On the web www.openstreetmap.org Bandung maps can be downloaded. In the web maps can be downloaded by pressing the Export button at the top of the web page. Getting osm files can be done by directly pressing the export button or by choosing the "manually select different areas" in advance. By selecting "manually select different areas" in advance, the selection of a map can be done to focus on an object researche.

2. Edit Openstreetmap

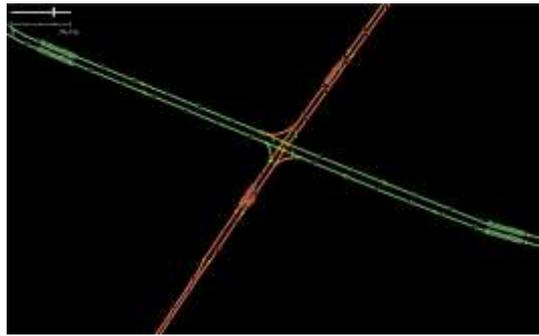
Osm files edited using the Java OpenStreetMap. This process is done by replacing some forms of roads that do not fit. Some of these are is shown as Figure 3.1.

Figure 1. Examples of Open Street Map Maps have not been Edited.



In the figure 1 explains the maps that have not been edited. On the map it looks red road consists of only one line. This condition can directly convert by adding the command `-lefthand` on `netconvert` process. However, this will lead to new problems when the vehicle passes through the intersection. For example, the vehicle will be pulled into the left lane before turning right or do a U-Turn.

Figure 2. Examples of Open Street Map Maps after Editing.



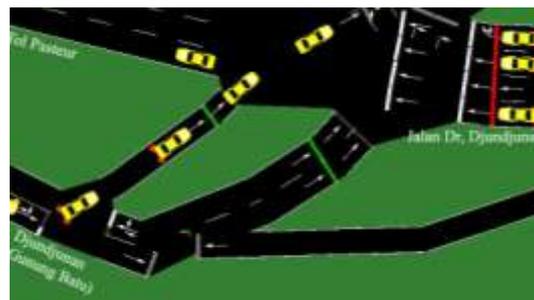
In Figure 2 shows the addition of the red line. By adding the line of the road, do not need to add -lefthand on netconvert process. Vehicles will run resemble actual conditions. The other condition that the shape does not match with the actual condition. For example, shown in figure 3.3.

Figure 3. The Mistake Vehicle Lane part One



Figure 3 shows the intersection which is located at Djundjuman street with Suriasumantri street. This is one of the effects the use of -lefthand on NETCONVERT process. Vehicle passed on the left of the road. In certain circumstances, the vehicle will be stuck and cause congestion.

Figure 4. The Mistake Vehicle Lane part Two



In the figure 4 is one of the road that does not match the actual conditions. To resolve the mismatches that occurs, then the editing process as in show in Figure 5.

Figure 5. Vehicle Lane after editing.

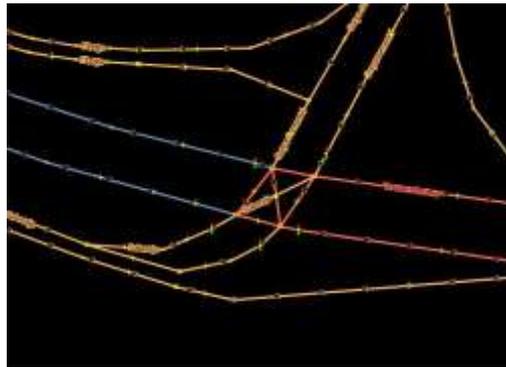


Figure 5 shows the line on roads that have been edited. After converting maps, simulations can be run. Intersection that has been edited is shown in Figure 6.

Figure 6. Street View after Editing on Simulation of Urban Mobility.



Figure 3.6 shows a map view that has been edited on Simulation Of Urban Mobility. The vehicle has been run in accordance with the actual conditions, but the queue happens is still not in accordance with actual conditions. In the real conditions of the three lanes coming from the queue Road Suriasumantri turn on the Toll Road Pasteur. Meanwhile queue of street Gunung Batu, on actual condition of the two lines met by a queue of vehicles.

3. Convert osm file.

This process is carried out in 3 stages. Starting from NETCONVERT, POLY-CONVERT, and entering a random vehicle using PYTHON.

NETCONVERT used to change the street in digital form on net.xml form. This file will be executed on Simulation Of Urban Mobility. Command written in the command prompt is shown as follows.

```
“netconvert --osm-files bandung.osm --o bandung.net.xml”
```

POLYCONVERT used to transform geometric shapes into digital form manifold poly.xml file. Command at the Command Prompt indicated as follows:

```
“polyconvert --net-file bandung.net.xml --osm-files bandung.osm --typemap.xml --o bandung.poly.xml”
```

PYTHON programming language used to enter vehicles in the simulation randomly. To that end this programming language needs to be installed first and then add the address into the path of this program on a computer. PYTHON use the operating system Windows 7 is recommended to use the 2.7.10 version. PYTHON can be directly downloaded on the web address www.python.org. After installing the program and put the address on the computer

path, the order to randomize the vehicle on the simulation can be directly used in the Command Prompt as in the show below:

```
“python          "C:\Users\Pin_Panji\Dropbox\Institut          Teknologi
Bandung\[TESIS]\SUMO\SUMO\[windows] sumo-  0.21.0\tools\trip\randomTrips.py"  -n
bandung.net.xml -e 50000 -l”

“python          C:\Users\Pin_Panji\Dropbox\Institut          Teknologi
Bandung\[TESIS]\SUMO\SUMO\[windows]sumo-  0.21.0\tools\trip\randomTrips.py"  -n
bandung.net.xml -r bandung.rou.xml -e 50000 -l“
```

Both of these commands are equally randomize vehicle that will run on the simulation. However, the first and second order differences. The first command will produce bandung.rou.xml, while the second will produce bandung.rou.alt.xml. Bandung.rou.xml just shuffle existing vehicles that will run the simulation, while bandung.rou.alt.xml has the characteristics of the vehicle can be adjusted individually.

4. Run simulation

To run the simulations need to merge several files that have been created in the previous point. they are bandung.net.xml, bandung.poly.xml and the latter is the duo .rou.xml. To simplify the writing on the Command Prompt is to create a file containing auxiliary commands as shown as follows:

```
<?xml version="1.0" encoding="iso-8859-1"?>
<configuration xmlns:xsi="http://www.w3.org
/2001/XMLSchema-instance" xsi:noNamespace
SchemaLocation="http://sumo.sf.net/xsd/
sumoConfiguration.xsd">

<input>
  <net-file value="bandung.net.xml"/>
  <route-files value="bandung.rou.xml"/>
  <additional-files value="bandung.poly.xml"/>
</input>

<time>
  <begin value="0"/>
  <end value="60000"/>
  <step-length value="0.1"/>
</time>

</configuration>
```

This file can be saved with the name bandung.sumo.cfg. Command therein describes file types to be combined Net named Bandung.net.xml. The second file which come together in the running Simulation Of Urban Mobility is bandung.rou.xml on file type and file additional rou is bandung.poly.xml. Afterwards this file can be used by typing the command on the Command Prompt as follows :

```
“sumo-gui -c bandung.sumo.cfg”
```

IV. Testing and Analysis of Data

4.1 Highway Capacity Testing Bandung

The test is performed by inserting a vehicle randomized into the simulation to determine the congestion that occurs in the simulation. Vehicles entered in a certain amount simultaneously. This amount is obtained based on the data of vehicles in the city of Bandung. In the category of vehicles with the data type of the car is as much as 74.079 units of passenger cars, freight cars as much as 64.443 units, medium and large buses as many as 6.313 units, 32 801 units jeep, as well as mini buses as much as 195.636 units. This amount already includes common and uncommon vehicles.

Tests carried out on each type of car by taking three examples of the way. Then the final test on this section to test the total existing vehicles, as many as 340.471 units.

Results of the testing has been a long queue, starting from the number of vehicles jeep entered into the simulation. As well as on the number of vehicles passenger cars and freight cars. In the figure 7 to figure 9 is the result of capacity testing simulated by the number of of vehicles entered is 340.471 vehicles.

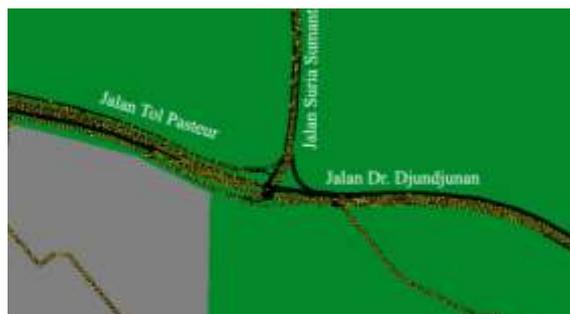
Figure 7. The Results in Total Vehicle Test that Occurred on Garuda Street with Abdul Rahman Saleh Street



Figure 8. The Results in Total Vehicle Test that Occurred on Ir. H. Djuanda Street with Dipatiukur Street.



Figure 9. The Results in Total Vehicle Test that Occurred on Dr. Djundjuran Street dan Suria Sumantri Street



4.2 Bandung Road Testing with Scenarios

This testing is done by analyzing the number of vehicles and traffic flow congestion occurs in the real compared to what happened in the simulation. Congestion that occurs is divided into two parts, namely congestion in the morning and afternoon. The graph of the results of calculating the data congestion on the actual conditions than the congestion that occurs in the simulation, shown in Figure 4.4 to figure 4.7.

Figure 10. Line Charts Comparison between the Actual Number of Vehicle with a Simulation in the Morning

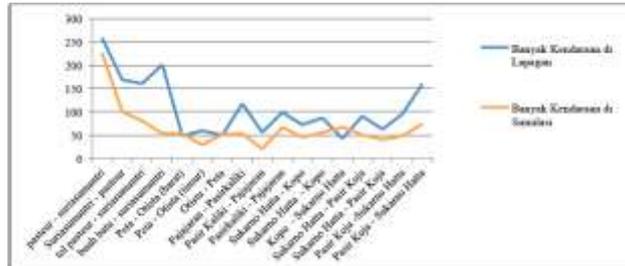


Figure 11. Line Charts Comparison between the Actual Traffic Flow of Vehicle with a Simulation in the Morning

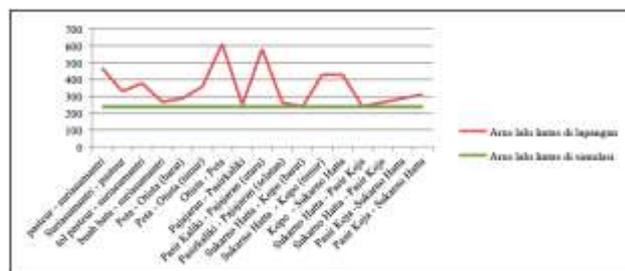


Figure 12. Line Charts Comparison between the Actual Number of Vehicle with a Simulation in the Afternoon

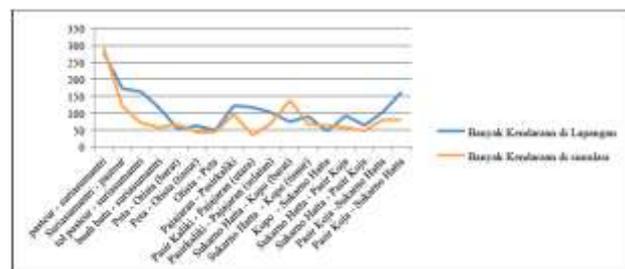
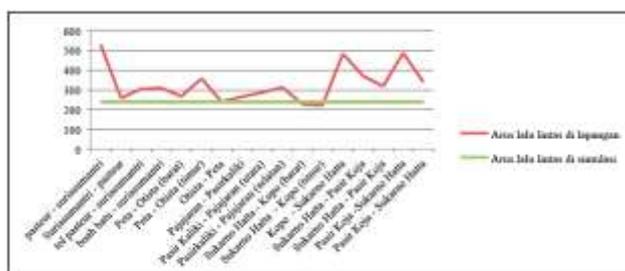


Figure 13. Line Charts Comparison between the Actual Traffic Flow of Vehicle with a Simulation in the Afternoon



V. Conclusion and Suggestions

Conclusions from the manufacture of Bandung Simulation Of Urban Mobility is:

1. Availability road in Bandung for today's vehicles are not fulfilled. This is evidenced by the results of Bandung Simulation Of Urban Mobility.
2. To overcome the congestion at this time needed a policy that aims to reduce the number of vehicles public road users.

Suggestions for the development of the Simulation Of Urban Mobility is:

1. Small road or alternative roads could be considered to complement the simulation, so testing on the simulation may include at the roads greater.
2. The availability of a program to produce a pattern on the simulator vehicle with the purpose of the addition is much more practical vehicle.
3. Variations at the simulation vehicle allowing it to become one of the obstacles at the road in Bandung. possibly by including large vehicles like large containers, Buses, Trucks and other large vehicles.

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