MODEL RESTRICTIONS ON THE USE OF MOTOR VEHICLES TO REDUCE CONGESTION AND AIR POLLUTION IN ORDER TO ACHIEVE SUSTAINABLE CITY IN JAKARTA

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Abstract

Traffic congestion in major cities such as Jakarta, is a major problem that also plagued other cities in the world. Restrictions on the use of motor vehicles based on exhaust gas emissions has become a surefire tool to solve the problem of congestion and air pollution especially downtown. Determination a passing grade that applied in motor vehicles will related with the amount of capacity planning of the number of vehicles that allowed enter in the city center. Through the Dynamic System Model is set a value to maintain the balance in any time with the V / C equal to 0.5 to 0.6 in order to construct a sustainable city in transport.

Keyword: emissions, congestion, motor vehicle, passing grade

1. INTRODUCTION

Declaration of Environmental Earth Summit in Rio de Janeiro in 1992, has been approved in principle the construction decision must consider the environmental and human dimensions. According Suryani (2012), environment can be divided into three, namely the natural environment, social environment and artificial environment. Community life of the city (metropolitan) is largely depends on the results of industries, information, services and technologies that more influence on the built environment, although it is also not possible free from their effect on the social and natural environment that accompanies it.

The artificial environment such as roads generally in big city, are no longer sufficient because of so many vehicles. The natural environment in the city such as air space has been filled with toxic gas emissions from motor vehicle exhaust, and social environment in the form of human relation has caused bored, stress, high cost economy, and health problems as a result severe congestion and air pollution. Environment in Jakarta could not be no longer sustained. There is no scheme of work with the conservation target of artificial environmental, therefore the road and air space that is not currently feasible used will be a more sustainable condition

Motor vehicle's growth is now much greater than the increased availability of the way, then Istianto (2009) illustrate the addition of a motor vehicle versus the availability of street's facilities would make the total traffic jam that will be occur in 2014. That mean, the conditions such vehicles had to be parked at home, because there is no space (roads) that can be passed again in the Jakarta city due to the road are covered by physical of motor vehicle.
Initially transportation serve convenience and travel time savings, however in fact, has now turned into a big problem in cities that are not well-organized in transportation, which in this condition is always known as term "strategy of the commons".

Bappenas (Indonesian's State Ministry of National Development Planning) in the assessment of Study on Integrated Transportation Masterplan for Jabotabek (sitrampr) reminds the estimated of economic losses due to congestion could rise to Rp 28.1 trillion, and the loss of travel time to reach Rp 36.9 trillion. Study of the Asian Development Bank (ADB), report due to air pollution in 1998 released funds amounting to Rp 1.8 trillion in Jakarta. When no concrete steps to reduce the level of air pollution in Jakarta, the economic losses in 2015 will be Rp 4.3 trillion. (Ari Muhammad Muhammad, A., & Nurbianto, B. 2006).

Based on the above conditions, it is necessary to develop a model for the motor vehicle restriction to maintain the balance of vehicles used on the road from day to day. For that reasons, keeping the balance between the number of motor vehicles (V) with a capacity of roads (C) is the best transportation solutions to resolve bottlenecks and rebuild sustainable city. The purpose of this paper is to develop an alternative model of vehicle restrictions that can be used as submissions to local goverment to maintain the sustainable city on transportation system policies

2. MATERIALS AND METHOD

The model’s restriction generated starts with an evaluation of vehicle exhaust emissions of motor vehicles. Test vehicle gas emissions (hydrocarbons and carbonmonoksida) with method the idle test using equipment of Horiba, AVL emission test or other similar products. There are 293 units of motor vehicles used as a test samples from various types and ages of vehicles operated in Jakarta.

Processing of primary data from motor vehicle emissions results are grouped from the most clean up until the dirtiest. Excel program is used to calculate and separate the value of emission test result of hydrocarbons and carbon monoxide in the two groups following the emission regulations of Jakarta city. Subsequently, the value of test results are made an emission map that generate a passing grade for motor vehicles in accordance with the allocation of the available road capacity. The value of passing grade may change every 6 months that associated with an alteration of design capacity of a city centre in order to plan the sustainable transportastion. Vehicles that do not pass the passing grade are not allowed enter in the city center and get an opportunity to do retest in the next period.

In order to maintain a balance between the use of a motor vehicle volume (V) and the street capacity (C) will be used PowerSim software as a Model of Dynamic System, which uses the assumption of smoothness of motor vehicles in Jakarta with the ratio V / C equal to 0.5

3. RESULTS AND DISCUSSION

3.1 Motor Vehicle restrictions

Humans are social beings, who daily perform economic transactions and social activities, so it requires a transfer of a group of people and goods from one place to another. Transportation is an integral part of the humans life and humans will employ them to start activity when out of house.
General phenomenon occurring in several big cities show that personal transportation instantly increasing, so the ownership and use of motor vehicles are rising too, which eventually flow of traffic occur congestion. Particularly Jakarta as metropolitan, the congestion already being felt 20 years ago, so since 1992 has been imposed restrictions on motor vehicles with the concept of three in one (3in1). However, by 2012 the program of 3in1 will be replaced with ERP (Electronic Road Pricing) or odd-even (Ganjil-Genap), because the condition of congestion in Jakarta are getting worse. Actually, City of Jakarta have been too many motor vehicle used on a very limited road facilities. Increase in the number of motor vehicles in Jakarta up to 11%, while the addition of road is not more than 1%.

The term of "too many vehicles in Jakarta", should be given a more universal clarification. Compared with Germany, the ratio of vehicle ownership by citizens is 1:1.5 meaning 2 cars for 3 people, and Americans 1:1.3. Meanwhile, the ratio to the total area (road ratio) in Jakarta is still to low around 6.2%, compared to road ratio of Singapore, Tokyo and London respectively 12%, 20% and 25%. Observed from the above condition, Jakarta could not yet be said too many vehicles compared with the dynamics of the activities that should be feasible facilitated in Jakarta.

Despite of development system of city transportation in Jakarta has been going on is not in controls, so the number of vehicles operating beyond limited road capacity (6.2%). Understanding of Jakarta conditions, the instant ways to maintenance human activities using transportation is keep running the motor vehicle restrictions, so that the artificial environment (roads) do not immediately occurs total congestion.

3.2. An alternative model of vehicle restrictions based on exhaust gas emission

City center of Jakarta is defined as the populous areas in the daytime, which is visited by many people who do activities, therefore it should be given a priority for taking care of congestion and environmental damage.
In Figure 1, City Center in Jakarta have been designed according to the town planning (RTWR 2030) that link interchange: several stations Manggarai, Dukuh Atas, Tanah Abang, Harmoni, Gambir, and Manggarai.

In reality, the desire of reducing the number of motor vehicles operated in Jakarta has adopted the idea of articulated buses that can accommodate 160 passengers, whereas when using a private vehicle will only employ 80 cars or more. As illustrated in Figure 2.

![Comparison between Unproductive Infrastructure and Productive Transportation System](image)

**Figure 2.** Private car vs Public transport

A model of motor vehicles selection based on exhaust gas emissions that allowed to enter in the City Centre is much more scalable than model 3in1 or ERP. This model gave a priority for vehicles that meet the "passing grade of emission standard" can be entered in a certain road.

The initial passing grade can follow the Local Government Regulation as stated on PerGub No.32/2008 (for motor vehicles produced above year 2007, CO = 1.5%, HC = 200ppm). Test samples of motor vehicle emissions taken as many as 293 units that were running in the region of central Jakarta. The variations of the emission test result are carbon monoxide (CO) from 0 to 3.9% while hydrocarbon (HC) from 8 to 890ppm, and only 43% of motor vehicles that could pass "the passing grade". This means that only 43% of motor vehicles allowed into the city center, and 57% will comply with "Park & Ride" program in the borders of city center.

In the next rule, the value of passing grade will play an important role to rearrange the volume of motor vehicle that permitted in region of Jakarta. When this model will reduce the volume of motor vehicle in certain road or region in Jakarta, the value of passing grade be pressed to be minimum. By
doing trial and error as a fundamental method of solving problems, have found relationship between changing of CO and HC against prosentase of reduction of motor vehicle used, as shown in tabel 1

Tabel 1: Relationship between changing of CO and HC against prosentase of reduction of motor vehicle used

<table>
<thead>
<tr>
<th>independent variable</th>
<th>Volume of motor vehicle</th>
<th>Awal, Regulasi DKI 2007, No:31/2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>HC</td>
<td></td>
</tr>
<tr>
<td>1,5</td>
<td>200</td>
<td>43%</td>
</tr>
<tr>
<td>1,4</td>
<td>190</td>
<td>41%</td>
</tr>
<tr>
<td>1,4</td>
<td>180</td>
<td>40%</td>
</tr>
<tr>
<td>1,3</td>
<td>170</td>
<td>38%</td>
</tr>
<tr>
<td>1,2</td>
<td>160</td>
<td>36%</td>
</tr>
<tr>
<td>1,2</td>
<td>150</td>
<td>34%</td>
</tr>
<tr>
<td>1,0</td>
<td>140</td>
<td>33%</td>
</tr>
<tr>
<td>1,0</td>
<td>130</td>
<td>32%</td>
</tr>
<tr>
<td>1,0</td>
<td>120</td>
<td>31%</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>30%</td>
</tr>
</tbody>
</table>

When passing grade (CO, HC) enforced strictly then only 43% were able to enter into the city centre. When next year there is an increase to 9% of the new vehicles number, plus 4% (includes vehicle repaired from the old vehicle, that did not pass last time), then to get balance V/C equal 0.5 until 0.6 are used CO = 1.0% HC = 100ppm as a new passing grade.

3.3. Model of Sustainable Transport in the Jakarta City Centre

Without any significant action on traffic management in Jakarta that allow growth in the number of vehicles 11% per year, it can be proved in 2014 will occur a severe congestion as described in the Figure 3a.
In 2012, the program started to limit the population of motor vehicles with maintaining the balance of motor vehicle number against road available by employing smoothness-factor = 0.5 as shown in Figure 3b. Therefore, the total congestion does not occur in 2014 and traffic goes back normally within the variation of V/C ratio equal to 0.5 until 0.6.

Presented the following Stock-Flow diagram (SFD) as shown in Figure 3c:

Figure 3c: Stock-Flow diagram of Dynamic System Model

Selected "number of cars" and "the addition of the road" as a stock, 6 auxiliary and 3 constant. Meanwhile, Powersim equation can be seen in figure 4:

Figure 4: Powersim equation
Figure 3b, 3a shown the total congestion in Jakarta that should be happened in 2014, can be overcome by reducing the number of motor vehicles in 2013 with a model-based restrictions on motor vehicle exhaust emissions.

In 2013 occurred drastic reduction the number of motor vehicles, which was followed the next year a balance between the addition of a new motor vehicle with a reduction of vehicle being used.

CONCLUSION

Refer to the discussion above, it presented some conclusions as follows:
1. To resolve the traffic congestion in big cities it nowaday is possible can be done by emission tests of motor vehicle
2. Vehicle's restriction based on motor vehicle exhaust emissions can be used as a tool / model sophisticated associated with keeping a balance of use of motor vehicles in a big city
3. By changing the passing grade, will be found a surefire way to keep the balance v / c equal 0.5 until 0.6. In this case by reducing CO 1.5% to 1% and HC 200 ppm to 100 ppm, it can be reduced 11% of vehicles allowed to enter the Jakarta city center
4.

REFERENCES