

# **System Dynamics as a Solution in Increasing Regional Cash of Daerah Istimewa Yogyakarta by Considering Employment Availability and Traffic Congestion**

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## **Abstract**

The Region of Yogyakarta (DIY) is one of the regions in Indonesia. Community growth in Yogyakarta reaches 1.34% in 2017 which can cause various problems such as unemployment community that continues to grow every year. In addition, another serious problem in Yogyakarta is high congestion which is implicated by the increasing number of population in DIY. Those problems have a bad influence on regional cash which is very useful in the development of the area. This study aims to increase regional cash of DIY by considering available employment and traffic congestion. Because the problem is so complex, a system dynamics approach is used to solve it. Based on the simulation results using Powersim 2005, the main cause of unstable regional cash is the high cost of building new roads, the cause of high cost of building new roads is congestion, and the cause of congestion is the high demand for vehicles by residents of the Yogyakarta area. Therefore, it is necessary to reduce the level of demand for vehicles to increase the cash of the DIY area. By reducing the demand for vehicles to 0.00003, which initially 0.00005 has succeeded in making the regional cash stable and increasing continuously. In addition, to increase employment in order to eliminate the population unemployment in Yogyakarta, it can be done by increasing the growth rate of new companies. By increasing the growth rate of the new company to 1.2 which initially 1 has succeeded in making employment increased continuously.

## **Keywords**

Employment Availability, Regional Cash, Simulation, System Dynamics, Traffic Congestion

## **1. Introduction**

Every region in the world has its own diverse problems. Some of the most common in this modern era are the problem of unemployment due to the absence of available employment opportunities, congestion due to the large demand for vehicles that are comparable to the population in the area, and unstable regional cash, in which regional cash/regional income is an important indicator in development or advancement of a region.

One area in Indonesia is the Special Region of Yogyakarta (DIY). Data from the Central Statistics Agency (BPS) shows that community growth in Yogyakarta reaches 1.34% in 2017 which can cause various problems if it is not wise to regulate other components in this area. In addition, the increasing population has implications for unemployment that continues to grow every year. Unemployment continues to increase in line with population growth and lack of employment opportunities (Amelia, 2005). It was proven that in 2003, the number of unemployed people in Yogyakarta was 96,084 people (Tukiran & Mustar, 2005).

In addition, another serious problem in Yogyakarta is high congestion. Citing the official Inrix website from Kompas (2017), the average of Indonesian community spends in vain time on the road (stuck in traffic) for up to 47 hours in one year, which occupies the country of Indonesia as the world's second largest country. In Yogyakarta, according to

Golkari Made's Head of Traffic in the Yogyakarta City Transportation Office cited from Tirta (2017), the average level of traffic density compared to the capacity of the city in Yogyakarta or the volume capacity ratio value is almost close to the saturation point of 0.8 maximum 1 so that it must be followed up immediately to reduce the congestion, with the high congestion, the construction of new roads will be even higher, and the construction of new roads will be quite costly, which can reduce regional cash. More and more vehicles also force the amount of fuel production to increase which each vehicle requires fuel to be used. Fuel production requires costs that can reduce regional cash.

Thus, the purpose of this study is to be able to increase the cash of the DIY region by considering the subsystem of employment availability and traffic congestion. To overcome complex problems as explained, a good systemic approach is needed. System Dynamics (SD) is one method that can be used to solve complex problems. System Dynamics can consider all the elements involved in a system along with the relationship between one element and the other elements so that it is very suitable for modeling very complex problems. Therefore, in this study the System Dynamics approach will be used which is simulated using PowerSim 2005. The implementation of the simulation needs to be done because direct testing of the system will take considerable time and costs (Rizqi & Aulia, 2019).

## **2. Methods**

### **2.1 Data Collection Method**

There are several data taken in this study, namely the variables of the system, the relationship between variables and the magnitude of the value of each variable. In getting the variables and their relationships, they are obtained through Focus Group Discussion with experts, namely members of the DIY government who know the conditions of DIY. In addition, to get the value of each variable obtained through interviews with experts, reports that provide reliable data, several assumptions, and journals that have discussed similar things.

### **2.2 Conceptual Modeling**

In creating a conceptual model, Causal Loop Diagrams (CLD) are used to help researcher understanding the system by providing a general picture through the cause and effect relationships in the system (system conceptualization). By using Causal Loop Diagram, researcher can quickly structure the model based on the assumptions used. In the causal loop there are two things that need to be considered, namely the variables and their relationships represented by arrows. Relations that occur can be plus (+) or minus (-). Positive relationship occurs if one variable gives the same effect as the other variables, while the negative relationship is the opposite.

### **2.3 Computer Modeling**

In computer modeling, a flow diagram will be created using the help of Powersim 2005 software. Flow diagram is a representation of a detailed form of drawing the system. The main purpose of flow diagram is to represent the flow and structure of the system in detail to facilitate mathematical modeling.

Flow diagram is a continuation of CLD. Flow diagram is used to overcome ambiguity in CLD by modeling the system and simulating it (Ford, 1999). The simpler difference in CLD with flow diagrams is if causal loop diagrams only provide a qualitative relationship by providing various causal perspectives so as to produce a conceptual model, while Flow Diagram will provide quantitative solutions so that they can provide real solutions according to the wishes of the modeler.

In making flow diagram, the variables of the causal loop diagrams need to be classified to the requirements of variable in the flow diagram. It is also possible to eliminate variables or add variables from variables that already exist in the conceptual modeling stage because of the limitations of flow diagrams. Therefore, the knowledge of the types of variables is needed. Variables in flow diagram can be classified as follows (Sterman, 2000):

1. Level (Stock): This variable is an accumulation of other variables. This variable will be influenced by in rate and out rate. Levels of variables are often the focal points in solving problems.
2. Rate (Flow): Variable types that will directly affect level variables. It can contain both mathematical calculations and constant variables.

3. Auxillary: Variable types which contain basic calculations on other variables. In this variable it contains mathematical calculations so that they have changing values.
4. Constant: Variable type which contains a fixed value that will be used to calculate the auxiliary variable or flow variable.
5. Link: A tool that connects one variable to another. Links can be distinguished as link and delayed link.

## 2.4 Model Validation

Validation is the stage to prove that the model created can represent the actual system so that experiments can be carried out and reliable results are obtained. In this study, model validation was done twice. First, face validity is done on the causal loop diagram that has been made. Face validity is a qualitative technique for testing models that resemble real systems or not based on expert opinion directly. The experts in this study were members of the DIY government who understood well about the system.

In addition, statistical tests are also carried out by comparing the output of the simulation model with the actual system. The variables used to compare are the number of DIY population. Because the system is dynamic, which means that the population is not stable and the historical data is limited, one sample T-Test is chosen to compare the average number of real system populations with 30 simulation results along with 1 population variance test to test the difference in variance.

## 3. Results and Discussion

### 3.1 Causal Loop Diagram (CLD)

Based on the results of the FGD with the expert, several variables and their relationships were obtained which were described in the form of CLD. After that CLD is validated with face validity. The valid CLD is shown in Figure 1.

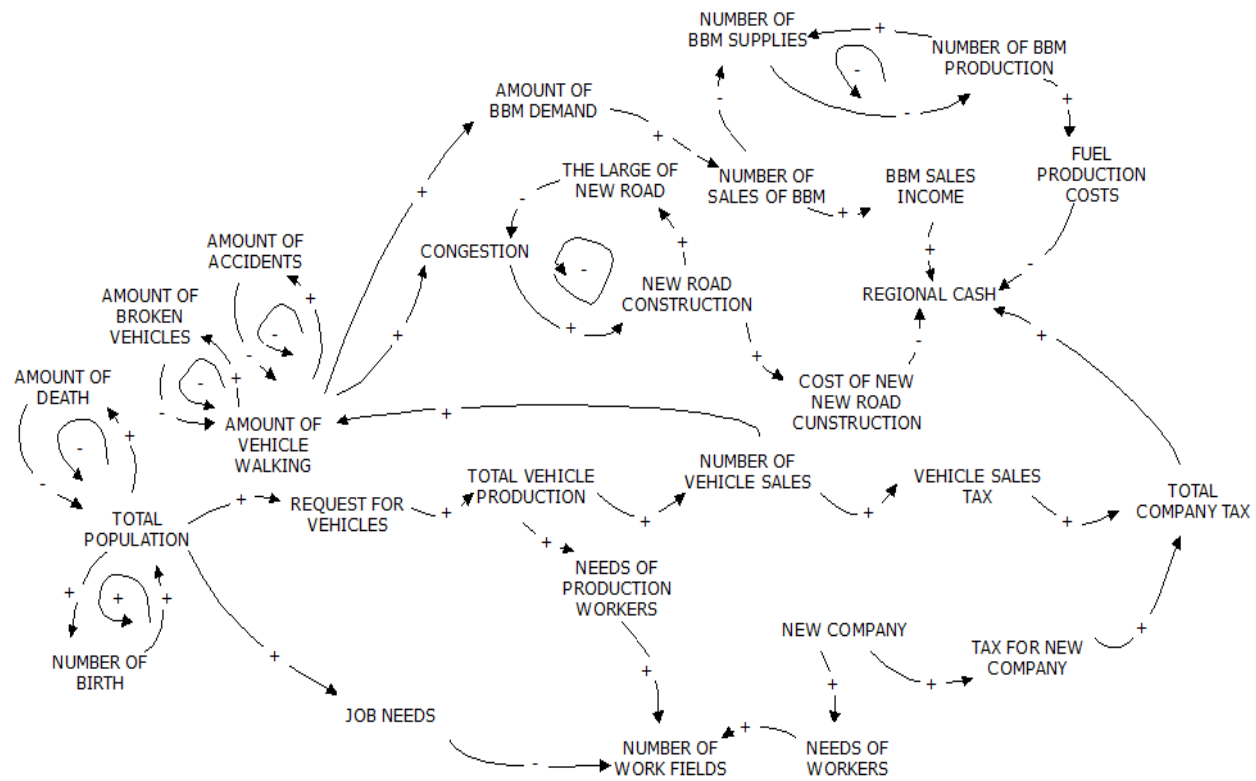


Figure 1. Causal loop diagram

### 3.2 Flow Diagram

The variables contained in CLD are classified based on the types of variables in the Flow Diagram whether they are included in Stock, Rate, Auxillary, or Constant and then modeled into Powerim 2005 software. Then the appropriate mathematical equations are made. Figure 2 shows the flow diagram that has been made.

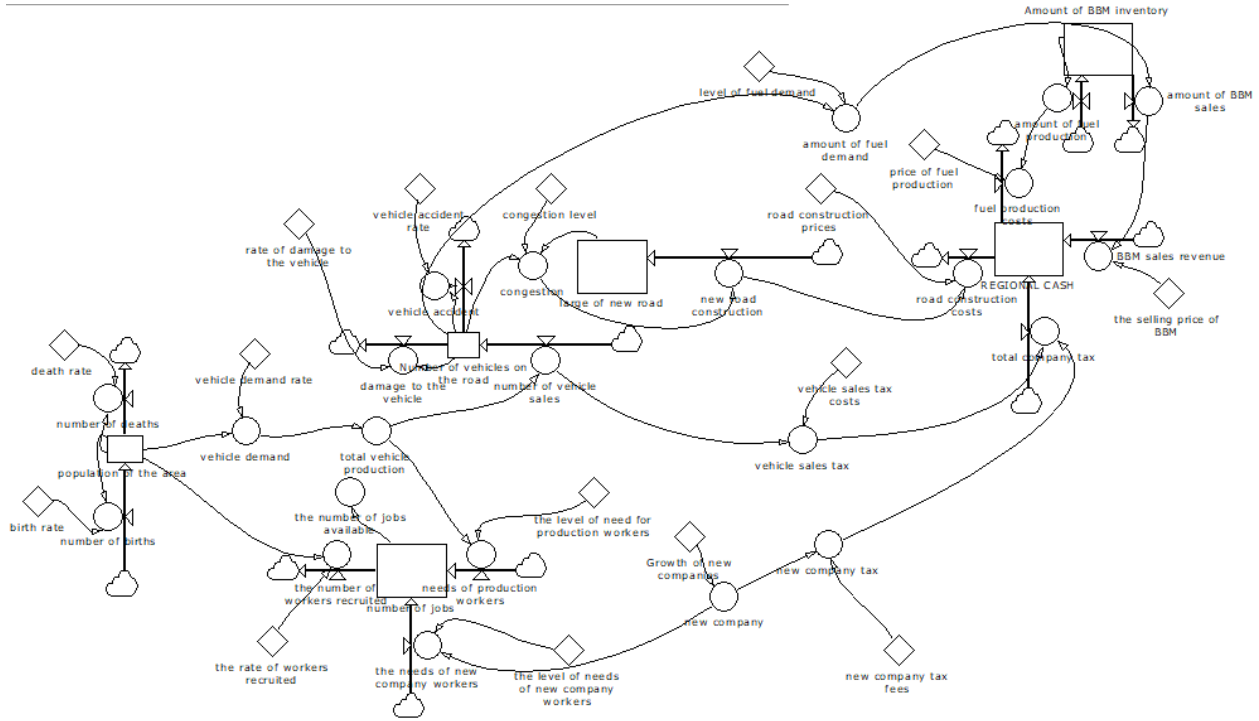


Figure 2. Flow diagram

### 3.3 Validation

Statistical tests are used to validate the model by comparing the output of the number population model with the actual system. By using 95% confidence level, it was found that the average between models with real systems did not differ significantly. Also conducted a one population variance test using a 95% confidence level found that the variance between models with real systems did not differ significantly. Therefore, the model can be experimentally carried out and further analysis is carried out.

### 3.4 Report Analysis

As explained earlier, the purpose of this study will be to increase regional cash by considering the level of congestion which has implications for the width of new roads and also considers the availability of employment which has implications for the growth of new companies. Figure 3 shows the simulation results for 1 year.

Time	Large of New Road (meter <sup>2</sup> )	REGIONAL CASH (rupiah)	Number of jobs availability
01 Jan 2018	0,00	1.000.000.000,00	0,00
01 Feb 2018	0,00	2.554.441.437,59	365,93
01 Mar 2018	500,00	3.131.125.398,61	0,00
01 Apr 2018	1.500,00	3.025.830.198,09	0,00
01 May 2018	2.500,00	2.970.519.612,87	0,00
01 Jun 2018	3.500,00	2.980.051.586,99	0,00
01 Jul 2018	4.500,00	3.021.492.548,52	0,00
01 Aug 2018	6.000,00	2.369.180.326,22	0,00
01 Sep 2018	7.000,00	2.285.408.514,05	234,77
01 Oct 2018	8.000,00	2.475.973.421,16	198,13
01 Nov 2018	9.000,00	2.453.962.203,77	0,00
01 Dec 2018	10.500,00	1.770.720.679,74	0,00
01 Jan 2019	11.500,00	1.872.569.260,06	0,00

Figure 3. Simulation result for 1 year

From the Figure 3, it can be seen that the regional cash is unstable, in the initial period the regional cash increases but starting in April the regional cash begins to decline even though sometimes it increases, even if left continuously can cause the regional cash to run out because the tends to decrease. This is due to an imbalance between income and expenditure in the regional cash. The cause of this problem is too high the cost of constructing new roads, where new road developments continue to increase due to road congestion while regional cash revenues are low. Because the cost of building a road cannot be changed, what must be changed is the cause of the congestion, thereby reducing the construction of new roads that continue to increase rapidly, so that needs to be improved is the level of demand for the vehicle. By fixing this variable, the regions have at the same time been able to reduce the making of new roads due to congestion as well as increasing regional cash.

For employment problems, it can be seen that available employment is often worth 0 even though sometimes there are jobs available, which means that many local residents lack jobs which ultimately creates unemployment problems. Therefore, improvements are needed to eliminate this problem. The most realistic thing to be applied is to increase the growth of new companies in the Yogyakarta area.

### 3.5 Experimental Design

The cause of the problem of high regional cash is the large cost of building new roads, and the cause of the problem of the construction of new roads is congestion and the cause of congestion is the large demand for vehicles by residents of the Yogyakarta area. Therefore, the researcher will try to fix the two problems above, namely by reducing the level of demand for vehicles such as Figure 4. After the vehicle demand level is reduced to 0.00003 which is initially 0.00005, the results are showed in Figure 5.

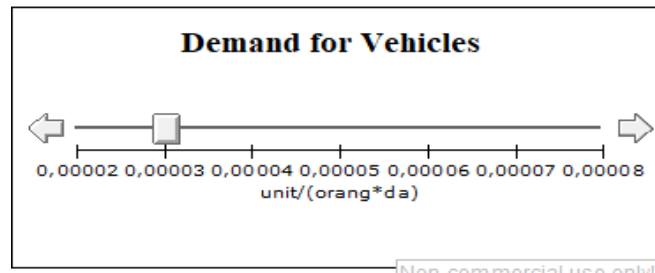


Figure 4. Reducing the level of demand for vehicles

Time	Large of New Road ( meter <sup>2</sup> )	Regional Cash ( rupiah)	Number of Jobs Availability
01 Jan 2018	0,00	1.000.000.000,00	0,00
01 Feb 2018	0,00	2.443.509.749,51	0,00
01 Mar 2018	0,00	3.670.986.326,58	0,00
01 Apr 2018	0,00	5.160.900.305,13	0,00
01 May 2018	1.000,00	4.937.004.279,00	0,00
01 Jun 2018	1.500,00	5.495.004.565,50	0,00
01 Jul 2018	2.000,00	6.083.270.837,46	0,00
01 Aug 2018	3.000,00	5.947.204.606,79	0,00
01 Sep 2018	3.500,00	6.356.437.015,26	0,00
01 Oct 2018	4.500,00	6.286.940.932,59	0,00
01 Nov 2018	5.000,00	6.990.506.343,74	0,00
01 Dec 2018	5.500,00	7.724.950.672,58	0,00
01 Jan 2019	6.000,00	8.241.496.168,95	0,00

Figure 5. Experimental result of reducing demand for vehicles level

It can be seen from Figure 5, after reducing level of demand for the vehicles there was a change in the regional cash and the extent of the construction of new roads. Regional cash is more stable and tends to increase without loss due to an imbalance between income and expenditure in the regional cash. For the construction of new roads, a drastic decline can also be seen which was from 11,500 meters<sup>2</sup> repaired to 6,000 meters<sup>2</sup>. Reducing the level of demand for vehicles can be done by the government, for example by promoting programs to get used to traveling on foot, so that the health of the body will become better so that people are interested in reducing the need for vehicles.

In addition, improvements are also needed on available jobs to reduce the number of unemployed people in the DIY area. In this case, researcher advises the government to increase the growth of new companies so that employment increases due to the needs of workers needed. Next the researcher will try to increase the growth rate of new companies that initially 1 to 1.2 as shown in Figure 6. The results are showed in Figure 7.

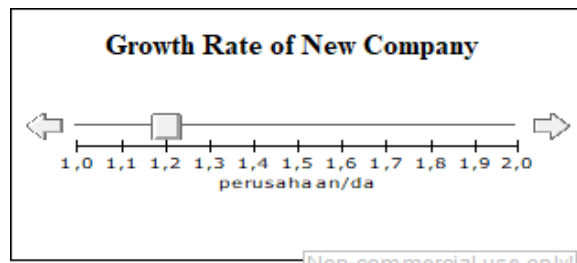


Figure 6. Reducing the level of demand for vehicles

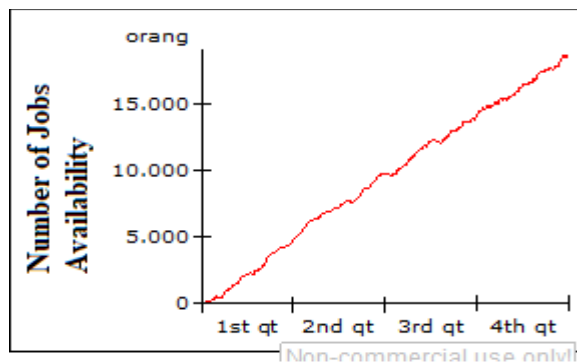


Figure 7. Experimental result of increasing the growth rate of new companies

Based on Figure 7, by increasing the growth rate of new companies that employment is no longer in shortage, it means unemployment will decrease and there will be no more unemployment in the community due to lack of jobs. Increasing the growth rate of the company can only be realized by the government, for example by helping to lend initial capital if needed, facilitated in the steps of entrepreneurial affairs, providing training to the community on how to entrepreneurship well, being also informed about the benefits to be acquired by entrepreneurship so that people are attracted to opening a business which ultimately creates jobs becomes available and reduces unemployment.

#### **4. Conclusions**

Based on the discussion above, it can be concluded that the Yogyakarta regional cash is experiencing fluctuations that are quite large due to the imbalance of income and expenditure of regional cash, even the longer the regional cash decreases until it can show the number 0 means that the regional cash will run out for a long time if no repairs. The main cause of unstable regional cash is the high cost of building new roads, the cause of the problem of the construction of new roads is congestion, and the cause of congestion is the high demand for vehicles by residents of the Yogyakarta area. Therefore, it is necessary to reduce the level of demand for vehicles to increase the cash of the Yogyakarta area. By reducing the demand for vehicles to 0.00003, which initially 0.00005 has succeeded in making the regional cash more stable and increasing continuously, so has the construction of new roads which were initially 11,500 meters<sup>2</sup> repaired to 6,000 meters<sup>2</sup>. This can be realized by the government, for example by promoting programs to familiarize people traveling on foot, so that the health of the body will become better, so that the community is interested in reducing the need for vehicles. Whereas to increase employment in order to eliminate the population unemployment in Yogyakarta, it can be done by increasing the growth rate of new companies, researchers increased the growth rate of the new company to 1.2 which initially 1 and succeeded in making employment increased continuously. This can be realized by the government, for example by helping to lend initial capital if needed, facilitated in the steps of entrepreneurial affairs, providing training to the community on how to entrepreneurship well, being also informed about the benefits to be gained by entrepreneurship so that people are interested in opening a business.

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#### **Biography**

**Zakka Ugih Rizqi** is an Industrial Engineering student at the Department of Industrial Engineering, Faculty of Industrial Technology, Islamic University of Indonesia, Yogyakarta, Indonesia. He is an undergraduate student and has a great grade in his university. His research interests in modeling and simulation, risk management, project management, production planning & inventory control, supply chain management and logistics management. He also works as a laboratory assistant of industrial modeling and simulation in Islamic University of Indonesia. He also activates in the competition of industrial engineering and writes many researches published in proceedings and scientific journals.