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Land transportation model for supply chain manufacturing industries

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Abstract. Supply chain is a system that integrates production, inventory, distribution and information processes for increasing productivity and minimize costs. Transportation is an important part of the supply chain system, especially for supporting the material distribution process, work in process products and final products. In fact, Jakarta as the distribution center of manufacturing industries for the industrial area. Transportation system has a large influences on the implementation of supply chain process efficiency. The main problem faced in Jakarta is traffic jam that will affect on the time of distribution. Based on the system dynamic model, there are several scenarios that can provide solutions to minimize timing of distribution that will effect on the cost such as the construction of ports approaching industrial areas other than Tanjung Priok, widening road facilities, development of railways system, and the development of distribution center.
Keywords: Land Transportation, Supply Chain, material distribution process

1. Background

Jakarta is the capital city of Indonesia and the distribution center of various manufacturing industries area, such as Cikarang, Cikampek and Tangerang. Tanjung Priok is the entry point for material supply for industries, especially at Port Tanjung Priok, where almost 60% of export import activities are done through this Port.

[11] published in Logistics Performance Index (LPI) has reviewed the national logistics force, position of Indonesia is ranked 53rd from out of 160 countries surveyed. Compared to other ASEAN countries, Indonesia's performance has been relatively low in terms of the competitiveness of the country's logistics system. Indonesia's logistics competitiveness ranking is still below neighboring countries, such as Singapore (5), Malaysia (25), Thailand (35), and Vietnam (48). Studies conducted by Asia Foundation and The Institute for Economic and Social Research, University of Indonesia (2008), attribute this to the following: (1) the cost of logistics in Indonesia is very high, averaging 14.08% of total sales; (2) problems include not only high of average logistics costs, but also the potential loss of revenue due to the lack of the role of a national shipping Company in overseas transport. Logistics costs per 55 Kilometers in Indonesia is 550 USD; whereas in Malaysia it costs only 300 USD. Several types of export products, account total cost before shipping and land transport in the country to reach more than 40% of the total cost of logistics and transport costs [12].

It has been noted that Transportation is the most expensive logistics activity, representing over 40 percent of most corporate logistics expenses and over $400 billion in annual expenses in the United States alone. The strategy of substituting transportation and information for inventory has yielded big productivity dividends [5].

All the problems that arise in relation to the performance of Indonesian Logistics, originated from the low performance of the transport handling and distribution activities. Transportation for distribution in Indonesia mostly uses road as the main facility for distribution. Road transport of goods is expected to reach 91.25% according to Directorate General of Land Transportation of the Republic of Indonesia (2006).

Jakarta as the entry point of manufacturing industries distribution continuous to experience problems with its transportation system. Jakarta is the most congested traffic city in the world. The Start-Stop Index estimates the average number of starts and stops per vehicle in 78 cities around the world. It was noted that Jakarta drivers had 33,240 starts and stops annually according to the survey [2]. Congestion problem gave considerable influence on the transport and distribution system, aggravated by the fact that the port of Tanjung Priok as a distribution center for manufacturing industries is located in the northern part of the Jakarta.

The manufacturing industries acts as consumer that should be served by the system government design. Customer satisfaction is the main focus that will support the viability of a business system especially in manufacturing system. It is necessary to conduct in-depth study of the physical condition to the current distribution process located in the areas of around Jakarta, such as: Cikampek, Cikarang and Tangerang. Mapping of current situation will give a figure of the main cause inefficiency for distribution process.

A number of questions arise, such as:

a. "What is the influential variable that causes the transport and distribution problem in Jakarta, especially for manufacturing industries ?"
b. "What are the related cost figures of the recent transport and distribution system in Jakarta ?"; and
c. "What kind of model, if any, can possible minimize the potential loss of revenue caused by the low performance of transportation and distribution system in Jakarta ?"

Distribution process from Tanjung Priok Port to the industrial area in a significant variable of supply chain in manufacturing industries. Supply chain is a network of facilities and distribution options that performs the following functions; the procurement of materials, transformation of these materials into intermediate and finished products; distribution of these finished products to customers. Supply chain management is a strategy through of these different functions can be achieved [6]. The objective of supply chain management (SCM) is to integrate the different function of procurement, transformation and distribution for improving the performance of organizations to achieve efficient fulfillment and customer satisfaction. The organization of supply chain is the manufacturing industries.

Model for land transportation will use System Dynamics approach. According to [3] System Dynamics associated with time which depend on how the behavior of the system describes system for reaching the main goals using qualitative and quantitative models, how information feedback will effect the behavior of the system, and design for the information feedback structure and controlling policies through simulation and optimization.

Therefore, the intended research will focus on the most efficient design of transportation and distribution model in relation to the expected reduction in delays, considering the characteristics of the region, hand in hand with the needed involvement of various stakeholders and their expected involvement and contribution to the implementation of supply chain management.

2. Problem Statement

There is a tremendous need of optimal model for land transportation in manufacturing industries around Jakarta. Model will develop based on the problem that arise by current situation of distribution. There are 2 obstacles regarding the distribution process complaint by the manufacturing industries such as: inefficiency of the distribution process and long delivery time.

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to the current distribution process located in the areas of around Jakarta, such as: Cikampek, Cikarang and Tangerang.

3. Objectives

The followings are the perceived objectives of the study :

- To obtain full perspective of the present condition of transportation and distribution system for manufacturing industries in Jakarta.
- To determine the main variables that become the causes of delay in transportation and distribution activities.
- Designing model for transportation and distribution by implementing system dynamics to reduce the level of delay, optimizing strategy that can minimize potential loss of revenue caused by the mentioned low performance system.
- Developing and validating improvements in the transportation and distribution model.
- Supporting the strategic decision making aspects of the government resulting strategic policy in transportation and distribution control system which can provide positive effect on Logistic Performance Index of Indonesia.

4. Methodology

The methodology used in this activity is a system approach. This approach was chosen, because the development of a region is influenced by many interrelated elements are dynamic [7]. The system approach is the right choice, because this approach is able to solve a problem that has characteristics [7] as follows :

a. Complexity, which is quite a complicated interaction between all the elements.
b. Dynamic, in the sense that there are factors that change every time and forecasting in the future.
c. Probabilistic, need for opportunities in the inference functions conclusions and recommendations.

One thing that stands out from the system approach is the searching of key factors in the assessment of the problem to obtain an appropriate settlement, with the use of quantitative models for assist in the rational decision-making process. System approach can solve the problems of high complexity.

Region is made based on two sub-systems, as follows :

a. Infrastructure
b. Information Technology
c. Regulation

Sub-systems can be studied and analyzed to produce the most optimal model of land transportation system for manufacturing industries.

System approach in policy model, performed using soft system and a hard system. Model Policy called Soft System, because the model is designed based on recent quantitative data, as well as data in the past time, such as Gross Domestic Product and Human Development Index. The model also entered into the category of soft systems, because after the simulation process, the results are used to make qualitative policy scenarios.

In an effort to achieve the desired objectives of this activity, there are several approaches to implement, as follows:

1. Identification of potential Infrastructure sub-system consisting of several factors such as : Road, Railway system, Distribution Center, Port, which can be an indicator support of the added value to maximize transportation model.
2. Identification of information technology and regulation, which is a reflection of the improvement of supporting distribution model. The results of this analysis can be reflected the extent of the model can improve to minimize delivery time.

3. Identification of prime factors based on criterias that can describe the advantages of these factors, the sub-systems of production, as follows :
   - How far the factors can reduce delivery time, logistic cost and inefficiency ?
   - Analysis of the government's commitment to the improvement of infrastructure.
   - Identification of information and technology for the development of Land transportation system.
4. Analysis of linkages between sub-system.
5. Policy Analysis of infrastructure, modes of transport, roads, public facilities, facilities, and social, which can describe the existence of infrastructure, so that it appears the advantages and disadvantages of the road transportation system.
6. Identify physical potential of port development, to analyze the potential and challenges of natural resource development, support and institutional factors.
7. Analysis of the relationship between four main sub-systems, carried out by using a system dynamic.

Correlation between each sub-system and the influence of the sub-systems to the minimize the delivery time, implemented as a policy option that needs to be tested in a system linkages. Results of these analyzes are formulated in the form of alternative development policies. The sequencing of policy priorities using multiple criteria set by the experts and all stakeholders associated with the development policy of regional integration. Visually, the conception of the study can be shown in Figure 1.

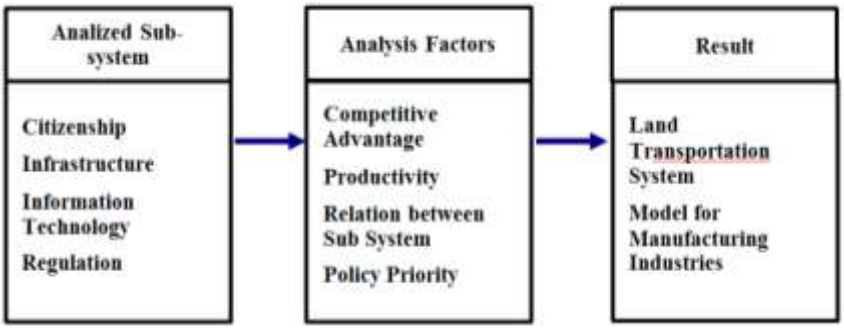

Figure 1. Conception Activity

In order to provide supporting data of the study and examine the main questions raised, the following methodology will be employed. Research methodology used as follows:

a. Participant Observation
   Participant observation with a group of manufacturing industries logistics manager will be carried out. The aim is to collect more qualitative information about the perceived impact, critical point and the cause of delay due to supply chain agent point of view as the users of transportation and distribution system in daily activity.
b. Individual Interviews
   There will be an attempt to interview stake holders and experts connected to the logistic system in Jakarta. Individual interviews by a way of structured questionnaire will also be used to collect information about the alternative solution for developing policy in order to develop improvements in transport and distribution system for manufacturing industries in Jakarta . The solution will be based on the perception of the environment. The interview is especially important for examining questions like "What kind of logistic system policy can be encouraged to make the rational choice' for the delay and loss revenue?". Participanta in the individual interviews based on Purposive Sampling Methods.
c. Analysis of Official Statistic

In order to gain a fuller picture of recent transportation and distribution condition in Jakarta and fullfil conpliance data in system Dynamics, a comprehensive analysis of the official statistics will also be undertaken aside from the official data, other sources of statistical data produced by agencies such as Badan Pusat Statistik (Statistic Central Board), Direktorat Lalulintas Polda Metro Jaya (Traffic Directorate Police Force of Jakarta), PT. Pelindo, and Pemda DKI Jakarta (Government of Province DKI Jakarta). Special attention to information about all variables that have correlation with the performance of logistic system in Jakarta will be given due consideration.

d. Data Collection
Quantitative data will largely be gathered through existing database and datasets in the field of transportation and distribution. Datasets publicly available in official Indonesian Statistics Board as well as logistics database of manufacturing industries which have distribution chain in Jakarta.

Figure 2. Research Methodology

5. Model Development

Systems dynamic approach has an excellent prospects, as a tool to answer a change of paradigm in the development model for transportation of manufacturing industries. Through this approach the expected prediction of the Implementation various policy scenarios regional development, both spatial and non-spatial, can be done [8]. In other words, this approach can serve as an early warning system of the implementation of a land transportation model, so can choose the most optimal policy scenarios. If there are certain consequences as a result of the implementation of these policies, can be prepared measures to anticipate as soon as possible. Stages for model development shown in figure 2.

Forrester is known as the founder of system dynamics, which deals with the simulation of interactions between objects in dynamic systems. System Dynamics will study problems with the system point of view, in which the elements of the system interact in a feedback relationship that will produce a particular behavior. Interactions in this structure is translated into the mathematical models were subsequently using computer simulation to obtain historical behavior. System Dynamics factors is the concept of feedback information from the behavior system, a mathematical model of dynamic interaction, and computer simulation, will a conduct a series of controlled experiments concerning the state of the system in a "laboratory" [4]. In Industrial Dynamics, [4] presented a methodology for the simulation of dynamics models, which is the origin of systems dynamics. The main objective of system dynamics is to understand the structural causes that bring about the behavior of a system [10].

System Dynamic that will be done to make a model of regional integration policies, consists of several stages (Figure 2), as follows :

1. Mapping of the Real System
   Current system which components consist of various problem mapping, so it would appear the existence of such a system overview.
2. Formulate a mental model. The relationship between sub-systems, causal, and behavior between each sub-system, and the development of model.
3. Making Causal Loop Diagrams
   This diagram will express about the causal relationship between subsystem models of land transportation and the factors within each sub-system, into the language of a particular image. This diagram is used to form the structure of the model policy which represent in the form of the circumference of a causal diagram

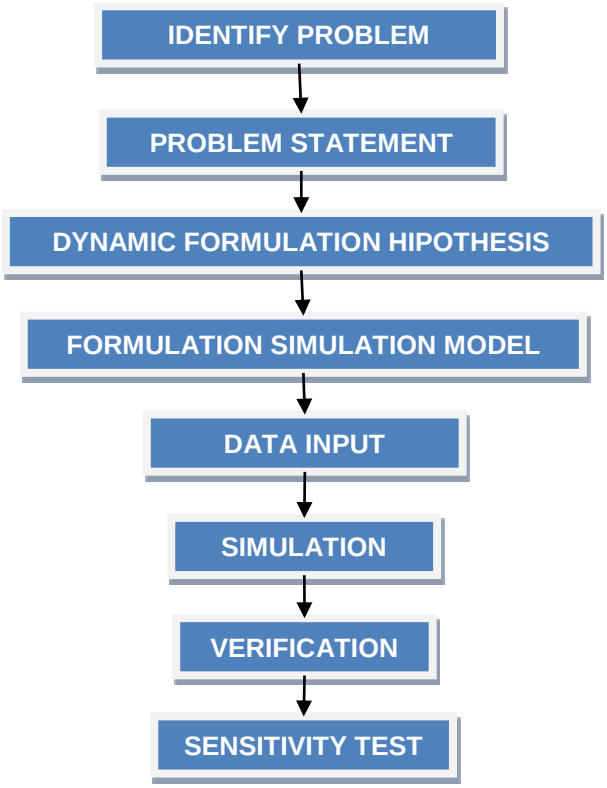

Figure 3. Stage for Model Development

4. Preparation of the model, which is done by building Soft Floor Diagram (SFD)
   Model of land transportation system is the basis of the investigation experimental relatively inexpensive and time saving than if you held a direct experiment on a real system. Modelling Process is done in making the policy model, as follows :
   a. Identify the problem (determination of limit)
      At this stage will be selected on the policy model based on need, which is accelerating the growth of the port area, and determine variables that affect the growth of the industrial area. This stage will define the problems encountered in the growth of the region in the form of dynamic models.
   b. Dynamic formulation hypothesis
      Done by sorting the initial hypothesis and mapping (limit diagram models, subsystem diagrams, causal diagram, mapping stock and flow, policy structure diagram).
   c. Formulation of Simulation model
      The relationship between the sub-systems model of transportation integration policies can be described in the form of the formulation, wherein the formulation will be used as input to the simulation models. The formulation can be obtained from :
      - Bibliographic from sub-systems and factors used in the model of Land transportation policy.
      - Justification of relevant experts
      - Trends of the data sub-systems and factors of the data in the past, in order to obtain a pattern that can be formulated to predict the model of land transportation today and in the future.

      At this stage also made estimates of parameters that affect the purposes of the study, and the relationship of behavior and the initial conditions of parameters.

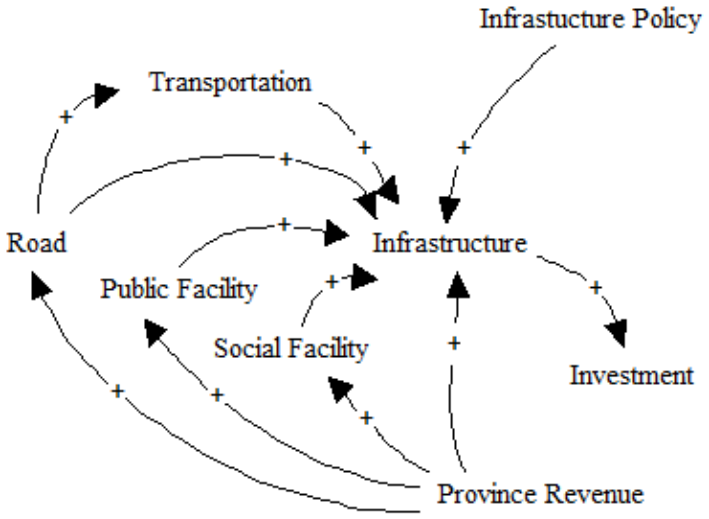

Figure 4. Causal loop subsystem infrastructure

Figure 5. Causal Loop Subsystem Information Technology

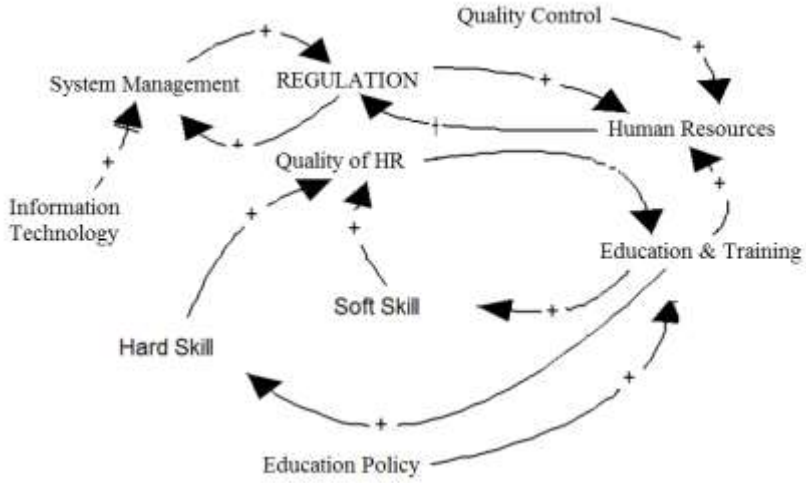

Figure 6. Causal Loop Subsystem Regulation

d. Assessment
   Policy model which has been formed to be tested by comparing the results of model calculations with the real conditions which should be obtained through a real phenomenon, as well as references from relevant experts.
e. Data Input
   This activity will be done by filling the data and defining all relations between the sub-systems with other subsystems, as well as the relationship between the factors with other factors, both of which are in a sub-system, and which are beyond the sub-system.
f. Simulation
   Simulation is a dynamic process behavior models done by running models, and will show in resulting graphs and data tables behavior models.
g. Verification
   A test of consistency and behavior models, through testing and evaluation activities, if the result is not verified, then should do the implementation of CLD, if the results are valid will continue on the next process. Policy model will be tested through the simulation process and the results will be compared with the conditions that should logically be obtained through a real phenomenon, as well as references from relevant experts. Verification of this activity is also carried out by the workshop, so the assessment of the workshop will appear on the simulation results, if the results are considered relevant, the process continues,
h. Sensitivity Test
   Goal of the test is gaining leverage point and the output is in the form of the dominant factors that influence the development of each sub-system A model of regional integration policies.

Based on the observation, land transportation categorized in two facility, such as: Road and Rail. Road transport offers “door to door” transport flexibility through Full Truck Loads (FTL) and Less Truck Load (LTL) options. Road Tonnage per kilometers has increased greatly in recent times and is still increasing around the globe as India and China become wealthier [9]. In today’s activity, truck transport system has the best position and opportunity in Jakarta. Truck businessman has good relationship with the stakeholders in supply chain system including government. This situation will stop the development of other transportation facilities, such as railway system. Rail is excellent for high density products over long distance and suitable for low value, non time sensitive deliveries. The downside to rail transport is that transport routes are limited to fixed-track and terminal facilities, which may differ in gauge size when railing internationally [9]. Very difficult to build the railway system into the Tanjung Priok Port, because because a group of truck businessman will lose of demand if the port of Tanjung Priok have those facilities.

6. Conclusion

Simulation shows the result that the main problem of land transportation facility in servicing the manufacturing industry as follows:

a. Capacity of the road is too small compared to the number of road transportation mode.
b. Railway system is difficult to develop, because the monopolize of trucks business activities and their relation with stakeholders in supply chain of manufacturing industries.
c. Lack of Information Technology support and inspection system for human resources activity in regulation implementation.

Based on the model development, stake holders of supply chain in manufacturing industries should implement the following activities :

a. Planning for distribution infrastructure should be in long term base, to compete with the increasing of the transportation mode.
b. Government should develop railway system into the Port Tanjung Priok.
c. Government should build distribution center.
d. Implementation of Information Technology System for decreasing delivery time.

e. Develop open service system to public, and inspection for human resources activities.

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