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THE FORMULATION OF DISTRIBUTION MODEL TO INCREASE SUPPLY CHAIN PERFORMANCE IN XYZ LTD. USING SYSTEM DYNAMIC

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Abstract

The formulation of distribution model is aimed to evaluate the efficiency of supply chain in XYZ Ltd, and to get a model of goods distribution from the main warehouse (Central Distribution Center ; CDC) to area warehouses (Distribution Centers ; DCs). The level of efficiency is measured using the costs generated by transport and storage activities.

The system dynamic model is used to arrange alternative distribution model that can be applied by XYZ Ltd. Scripted condition to be simulated is comparing the existing condition to CDCs addition from one into two. The arranged model consists of distribution sub-model from CDCs to DCs including safety stock and distribution cost sub models. The simulation result of the system dynamic model shows that the existing condition is more efficient than CDC addition. The distribution of existing condition spends IDR 893.98 billion, while CDC addition will spend IDR 940.83 billion.

Keywords : distribution cost, efficiency, distribution model, dynamic system

1. Introduction

One of critical factors in today's modern industrial world is goods distribution system. Basically, the distribution system starts from procurement of goods from manufacturers to major distributors which then distribute the goods to smaller agents which later forward it to consumers. In practice, there are a lot of manufacturers in Indonesia using services of distribution companies to market their products.

Manufacturers do not have to think any longer about marketing or product selling issues, so they can be more focused on production system. Generally, manufacturers will appoint a sole distributor for a country, and hand over subsequent distribution process to the sole distributor.

A fairly big consumer goods distributor can simultaneously handle the distribution and marketing of several types of products from different manufacturers. This sole distributor usually markets its products to only smaller distributors, local agencies, retailers or supermarkets, and rarely sells directly to consumers. For consumer goods in particular, this distribution process is quite complex, as the sole distributor connects to many smaller distributors or regional agents which reach hundreds or even thousands in number.

The XYZ Ltd. is a rapidly growing medium distributor which handles marketing process of several types of consumer goods in Indonesia. Some of the products are fairly well known by public, such as cooking spices, cheese, health supplement beverages, a variety of biscuits, and cooking oil. The XYZ Ltd. buys these products directly from their manufacturers (hereinafter referred to as principal), then markets them to a lower level distributors, regional agents, retailers, and supermarkets.

The management of XYZ Ltd. assesses that the distribution process currently happening in the

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company is less effective and efficient. This is proven from the length of time required to perform the delivery of a product from principal to customer, which sometimes takes up more than a month. In addition, the management also wishes to reduce the cost of transport of the goods distribution to improve cost efficiency.

In addition to principal and customer, there are three important components of the distribution process, the main warehouse (Central Distribution Center / CDC), the area warehouse (Distribution Center / DC), and sub-area warehouse. Basically, there happen three kinds of distribution channel, first is the goods delivery from principal to main warehouse, to be then forwarded to the distribution centers and sub-area warehouses. Second, the goods delivery from principal to distribution centers or sub-area warehouses without going through main warehouse. Third, the goods delivery from principal directly to customers without going through main warehouse, distribution centers, or sub-area warehouses.

The management of XYZ Ltd wishes to implement a new distribution model to increase efficiency and to reduce the cost of transportation. The proposed new distribution model is in essence adding the number of main warehouse that will be in charge of serving several distribution centers.

Before implementing the proposed distribution model, the management of XYZ Ltd wishes to compare both models performances. Therefore, the major problem being faced currently is whether the proposed new distribution model can provide better level of effectiveness and efficiency than the existing distribution model.

Several studies either in Indonesia or outside the country managed to draw up a distribution model using dynamic system. Dewi et al. [1] analyze the distribution policy of raw rattan cane using dynamic system approach, a case study of Indonesian rattan. The drawn up dynamic system model includes production sub-system, supply, transportation, marketing, and administration. The study shows that current policy is apparently not influential in stabilizing raw rattan cane supply condition and in improving the economy of rattan cane production areas in Indonesia. The scenario expected to overcome issues of raw rattan cane supply up to rattan national industry level is increasing farmers' and collectors' incomes by focusing on investments and scenarios of increasing the level of local revenue while maintaining the sustainability of natural resources.

Kristanto and Suryani [2] analyze the cost estimation, scheduling, and management of distribution, as well as impacts of information technology usage towards logistics performance, a case study of XYZ Ltd. The dynamic system model arranged includes sub-systems of delivery fleets, shipping costs, and delivery time. The research generates a new-route proposal that is more optimal than the existing route as it spends less cost.

Tifani et al. [3] take research on supply chain optimization of X Ltd paint products using dynamic system. The dynamic system model drawn up covers sub-systems of warehouse, transportation, and after-sales services. Scenarios prepared include increasing the number of maximum trips, increasing the number of trucks, and a combination of increasing the number of trips and trucks. The study shows that increasing the number of trucks is the most optimal results.

Vlachos et al. [4] study the formulation of dynamic model for capacity planning in a closed supply chain system. The limitation of his supply chain study is production, distribution, and sales. The success measurement of the model used is profit. The study result on the dynamic system model managed to be used to analyze various scenarios of long term production capacity planning.

Georgiadis et al. [5] study the use of dynamic system models to create strategies of supply chain management in the food chain. The modeled food chain is a fast food restaurant in Greece. The system studied includes inventory, supply, distribution strategy, outsourcing strategy, procurement, product design, and information technology needed. The success measurement of the model used is profit. The study result on the dynamic system model managed to be used to analyze various scenarios on the long-term transportation planning system of various fast food restaurants in Greece.

This study aims at evaluating the efficiency of existing distribution model using one CDC with the development planning of using two CDCs on XYZ Ltd. Model evaluation of efficiency is measured from distribution cost incurred due to distribution from CDC to DC. The discourse on the development of two CDCs on the distribution model of XYZ Ltd appears as part of observation made by the XYZ Ltd management, but has yet to be based on scientific studies.

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2. Methodology

2.1. Sources of data

This study uses secondary data derived from XYZ Ltd. Data and information developed in the study comes from the company's annual report and interviews with relevant sections.

2.2. Dynamic System Development Model

The dynamic system analysis stage built follows Sterman’s framework [6]. This includes apprehending the system, defining the problem, developing the concept of the system in a causal loop diagram, making the model formulation (identification, relationship, formulation and parameters assessment), building and validating simulation model on computer, analyzing the results of simulation model, and implementing the model. The dynamic system analysis stage is presented in Figure 1.

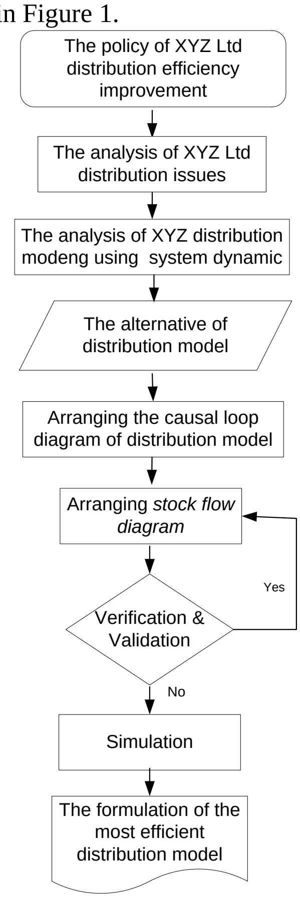

Figure 1. Framework of the dynamic system model development

The dynamic system model drawn up consists of two distribution sub-models (including safety stock) and distribution cost. The key variable sought in the distribution sub-models includes total demand forecasts, the number of goods delivery to CDC, the number of goods storage at CDC, the number of safety stock at CDC, the number of goods delivery from CDC to DC, the number of goods storage at DC, the number of safety stock at DC, the number of goods delivery from DC to initial consumers. The causal loop of distribution sub-models outlined in Figure 2.

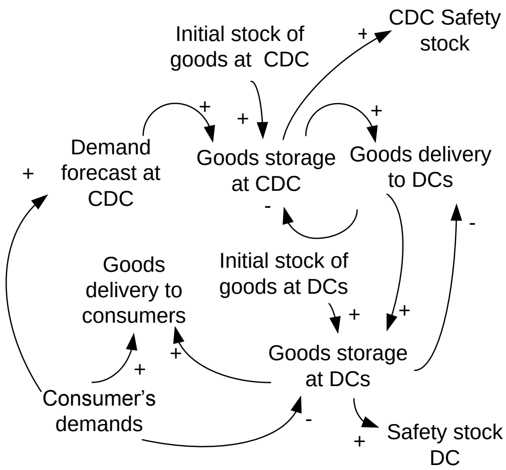

Figure 2. The causal loop diagram of distribution sub-models

The distribution model in XYZ Ltd consists of 5 DCs and 9 items of goods. The existing CDC is currently in Cileungsi, Bogor, while existing DCs spread over areas of Medan, Dumai, Lampung, Jakarta, and Surabaya. The alternative scenario is CDC addition in Medan that will delivers goods to DC Medan, Dumai, and Lampung. The delivered goods is coded as follows Ap, Ge, Opt, St, Su, GT, La, Opa, and CO.

The key variable defined in the distribution cost sub-model, and in line with the purpose of the study, includes goods storage cost at CDC and goods delivery cost from CDC to DC. The causal loop of distribution cost sub-model outlined in Figure 3.

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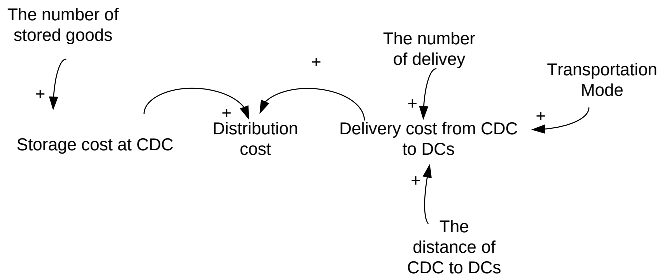

Figure 3. The causal loop diagram of distribution cost sub-model

Based on those causal loop diagrams of distribution and distribution cost sub-models, then are developed stock flow diagram for the nine items distributed by XYZ Ltd and two conditions, namely existing condition and CDC addition condition. The stock flow diagram is created using anylogic 7 personal learning edition software that can be downloaded from Internet. One of design results of the stock diagram of distribution sub-model in existing condition is presented in Figure 4 and distribution cost sub-model in Figure 5.

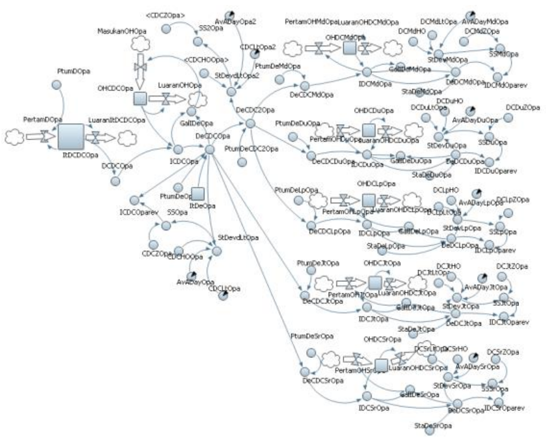

Figure 4. Stock flow diagram sub model distribusi

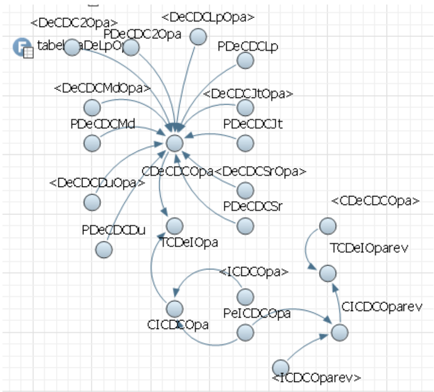

Figure 5. The stock flow diagram of distribution cost sub-model

2.3. Verification and Validation of Model

Verification of model is related to conformity between conceptual and mathematical models; while validation of model is related to suitability of output between mathematical model and the output of actual system as stated by Thacker et al. [7]. The software of dynamic system program such as anylogic or powersim provides facility to detect logical fallacy, so that by itself the verification is carried out.

Validation performed upon a distribution system model consists of validity tests on structure and on model behavior against the real system (quantitive behavior pattern comparison). Validity test on structure is conducted by examining the consistency of dimensions. It is run directly by the software used. The quantitive behavior pattern comparison test is conducted by entering a value based on yesteryears data to be simulated on the model; the results are then compared to available real data. Validation is presented in form of graphic comparison of simulation results with statistical data and tests. Statistical precision measurement used is Mean Absolute Percentage Error (MAPE) calculated by the formula of Makridakis et al. [8]:

$$MAPE = \frac{1}{n} \sum_{i=1}^{n} \frac{|X_t - F_t|}{X_t} \times 100\ \%$$

where: X_t is the actual data; F_t is the simulation result data, n the number of data

3. Result

Validation by using MAPE as one of the key variables, namely the goods delivery from CDC,

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generates MAPE value of 0.77%. Based on the MAPE value, the arranged dynamic model shows a very good accuracy. Verification and validation activities carried out against the relevant stakeholders representing model generates the model structure, and the results of model simulation have represented the real condition.

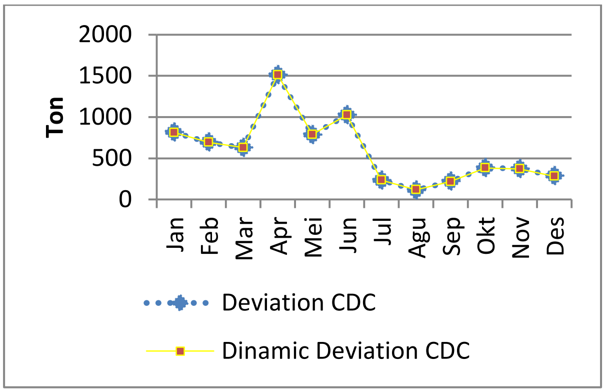

Figure 6. The comparison of data with model running results

Simulation using existing scenario generates a total distribution cost of IDR 893.98 billion for nine items in a year. The highest cost is intended to goods with St code, while the lowest is for goods with CO code.

Simulation using CDC addition scenario in Medan generates a total distribution cost of IDR 940.83 billion for nine items in a year. The highest cost is intended for goods with St code, while the lowest is for goods with Ge code. The comparison of distribution costs between existing condition and CDC addition scenarios is presented in Figure 7.

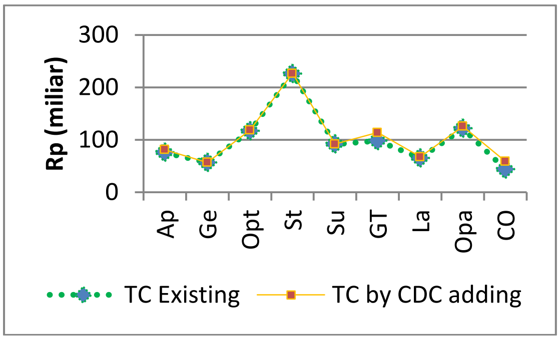

Figure 7. The comparison of simulation results of total cost between existing conditions and CDC addition

4. Conclusion

Results of this study illustrate – using patterns and amount of existing data – that the existing condition generates a lower distribution costs compared to CDC addition in Medan. The scenario of CDC addition in Medan generates higher costs as goods delivery to DC Medan, Dumai, and Lampung will be higher than the existing condition. The policy that must be taken by the company is maintaining the current existing distribution system.

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