Measurement of Supply Chain Performance in Manufacturing

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Abstract. Supply chain management has been a major component of a company’s strategy to compete each other through the increasing of organizational productivity and profitability. This paper is useful to provide an application of supply chain performance assessment in the manufacturing industry as an effort to increase the company profitability. Performance assessment metrics of supply chain provides information in the position of the company achievement. That condition capable to provide good management by an overview of the company achievements to meet customer demand. There is no measurement of supply chain performance in good condition of the company. Company problem found and finally caused by the company unable to meet demand leads the loss of customer trust. The Performance of Activity (POA) model is capable to describe the real conditions of the company’s supply chain performance. Measure the supply chain performance using POA model. POA model have 7 dimensions of assessment, namely cost, time, capacity, capability, productivity, utilization, and results. By using the performance of activity, there are two dimensions achieved, namely the availability of the company (90.8%) and machine utilization (75.1%), which is a dimension is not achieved well, namely the reliability (86.7%).

1. Introduction

The increasing development of the industrial world is very fast and causes intense competition between existing companies. SCM is needed when the industry wants to meet customer satisfaction by the availability of products. Consumers will be satisfied if the product is delivered in the right amount and on time. Service level is an important factor in supply chain design considerations. The solution of the problem with SCM approach is done in order to synergize all elements of SCM [1]. Companies need the role of all parties, starting from agent suppliers, as well as distribution networks that will deliver products to customers. The role of all elements in the supply chain is very important in achieving final customer satisfaction. The company's supply chain structure can cause problems if the company does not know the extent of the performance or supply chain performance that has been achieved. Supply chain management is a further integration of logistic management between related companies, with the aim of further increasing the smooth flow of goods, increasing the accuracy of demand estimates, increasing the efficiency of use of rooms, vehicles and other facilities, reducing inventory levels, reducing costs, and increasing other services required by end customers [2]. supply chain is a broader conception with a wider range which can be involved in other
similar subjects, such as network sourcing, pipeline management, value chain management, and value stream management [3, 4, 5].

Performance refers to the outputs that result from the processes of products and services that can be evaluated and compared relatively with goals, standards, past results, and other organizations [6]. Supply chain performance measurement is used as a basis to identify success and failure of the activities implementation in accordance with goals and objectives set by the company, which is in the end is expected to increase profits as the tangible results [7]. Supply chain performance measurement is very important to determine the achievement of current performance and the extent to which the success of supply chain management has been carried out. To correct the losses faced by the company, it is necessary to measure supply chain performance [8].

Supply chain performance measurement is carried out to provide information to management regarding the supply chain performance whether it is improving or decreasing. Supply chain performance measurement model carried out is related to supply chain activities in the company, including procurement activities, production planning, consumer orders meet, and product returns [9]. This measurement is important because it affects system behavior which impacts on supply chain performance [10]. Supply chain performance measurements in traditional industries are carried out by considering variable costs, flexibility, and customer responses [11]. However, measuring supply chain performance based on these variables is considered to be inappropriate. So that some researchers began to develop a supply chain management performance assessment framework. One of the supply chain performance measurement frameworks developed is at the strategic, tactic and operative level [12]. The measurement model of supply chain performance is also enhanced by a Performance of Activity (POA), that is able to identify the performance measures and metrics. The Performance of Activity model is also able to build a business process of the organization's mission into the supply chain [13].

Research to overcome problems such as measurement of supply chain performance has been done before. Research conducted by Rumbiati (2015) regarding supply chain performance measurement in Fresh Fruit Bunches. Palm oil supply chain management needs to consider costs and quality as part of decision making. These two factors are important to analyze because the operational supply chain faces quality assurance measures to obtain economies of scale. Supply chain performance depends on decisions related to stock, production and transportation. The supply chain in this company was analyzed descriptively using the POA (Performance of Activity) model, including seven measurement dimensions. It was seen that the performance of fresh fruit stems (FFB) from plantations was unsatisfactory where only two of the 12 months received reached a fixed budget target. However, the performance of sorting and extraction activities was concluded satisfactorily where the achievement was more than an average of 95% in 2013. After this, the CPO production performance was concluded to be satisfactory because it can be seen from the achievement of more than 80% target. In addition, the quality performance of CPO production was concluded to be very satisfying because it can be seen from the aspect of extraction rate, total loss / FFB, and the percentage of FFA, which can reach the monthly target correctly. However, the performance of machine utilities and production costs is concluded to be unsatisfactory because these items are not yet in accordance with the company targets set, where the number of machine utilities does not reach 80% in 7 months [14].

2. Methodology
The study was carried out on one of the industrial factories in the city of Medan that produces building materials. The type of research used in this study is descriptive research because solves a problem that exists systematically, factually, and accurately based on existing facts. This research began with observation to observe and see the state of the company. After observation, then data collection is needed to overcome the problems that occur. The data collected in the form of the number of product demands, product processing time, and other data. The collected data is then processed using a model of performance of activity. Supply chain performance measurement is a cycle that starts from
identifying problems, understanding the root causes of problems, responding to corrective actions, and continuously validating data, processes, and actions [15].

Identification of the company supply chain by observing the company supply chain activities and arranges a supply chain performance assessment framework, the next step is to determine and assess the Key Performance Indicator (KPI). The Key Performance Indicator (KPI) presents a set of measures focus on aspects of organizational performance are the most important of the success for this time and future organization. KPI is designed with a Performance of Activity (POA) approach. In this principle, POA is a performance measurement model for each activity which is a part of supply chain process. The stages of the supply chain performance measurement process begin with measurements based on 7 dimensions of POA, namely costs, time, capacity, capability, productivity, utilization, and outcome [16].

a. **Cost**

Cost appears in the execution of an activity. Cost appears because at each activity requires the resources used. This cost associated with labor, materials, equipment, and etc. Cost measured in absolute form or in form relative to a ignorance value.

b. **Time**

Time needed to do an activity. This measure is very important in the context of supply chain management, especially for supply chain competes on the basis of response speed. The response speed is generally determined by the time required at each activity and process in the supply chain. Time of developing new products, processing time of customer orders, the time to get raw materials from suppliers, and the set-up time for production activities are some of the important contributors in creating the response speed in the supply chain. This measure is very important in the context of supply chain management, especially for supply chains that compete on the basis of speed of response. The time that affects the supply chain is the time for sending customer orders and the time for production activities.

c. **Capacity**

Capacity is a measure of how much work volume of a system or part in supply chain can do in a given period. The size of the capacity needs known as the basis for planning production or delivery as a basis of appointments to customers. The amount of capacity relative to the average demand provides flexibility in supply chain information. In an era where supply chain networks are very dynamic, where outsourcing and subcontracting activities are usual, the capacity of a supply chain also be dynamic and not determined only by the resources owned by an organization. Capacity measures how much volume of work can be done by a system or part of a supply chain for a certain period.

d. **Capability**

Capability refers to the aggregate ability of a supply chain to carry out an activity. Some capability dimensions that are often used in measuring supply chain performance are reliability, availability and flexibility. Reliability measures the supply chain ability to consistently fulfill promises. Availability, measuring the supply chain ability to provide products in orders meet. Flexibility, measuring the time of supply chain’ ability to change the volume or product mix with a certain percentage or amount.

e. **Productivity**

Productivity to measure the extent to which resources in the supply chain are used effectively in converting inputs to outputs. Mechanically productivity is the ratio between effective output to the entire input consist of capital, labor, raw materials, and energy.

f. **Utility**

Utility is used to measure the level of resource use in supply chain activities. Utilization that measures the level of resource use in supply chain activities. In a supply chain product life cycle is relatively long and does not compete on the basis of innovation, utility becomes one of the important measure to be monitored.

g. **Outcome**
Outcome which is the result of a process or activity. In the production process the outcome can be added value given to the products produced. Outcome is not always easy to measure because it is often to be intangible. In the production process the outcome can be added value given to the products produced.

3. Result and Discussion
3.1 Supply Chain Process
Supply chain mapping contains implementation procedures from suppliers to consumers in running the production process. Supply chain mapping to process raw material orders to the delivery of finished products can be seen in Figure 1.

![Supply Chain System Mapping](image-url)

**Figure 1.** Supply Chain System Mapping.

Mapping the supply chain system in the industry produces building materials has 9 main components, namely suppliers, warehouses, Production Planning and Inventory Control, Purchasing, Finance, Production, Marketing, Distributors, and Consumer Department. Supplier serves to provide raw materials used in the production process. Suppliers receive information about the amount, specifications and cost desired by the company through the purchasing department and receive payments through the company finance department.

Warehouse serves to provide information about the amount of raw materials and finished products available in the warehouse. Warehouse plays an important role in the products distribution to distributors or to consumers and receipt of raw materials from suppliers. Information about the amount of raw materials and products is delivered to the PPIC (Production Planning and Inventory Control) Department. PPIC functions to create a production schedule based on the number of demand from the marketing department. Information about the number of orders needed from PPIC department is delivered to the purchasing department.

Purchasing Department serves to process the purchase of raw materials and search of suppliers at the appropriate cost and desired quality. Department of Finance functions to manage the financial of company, namely making payments to suppliers and receiving payments from customers. Production functions to produce nails according to the production schedule made by the PPIC department of
company. Department of marketing functions to receive orders from distributors and set sales targets. Information from the number of orders then submitted to the company's PPIC. The distributor functions to distribute the nails received from the factory to consumers in the distribution area. Consumers can buy finished products from distributors and who order products directly from the main factory.

3.2 Supply Chain Performance Measurement

The first step to measure supply chain performance in manufacturing industry is compare the total demand and total production. The comparison of data obtained by the number of demand and the amount of production. Demand data is obtained from the number of customer orders for building material products within a certain period. While the amount of production is obtained from products that are successfully produced according to the specifications of this industry every at certain period.

The comparison of data used to see the problem in supply chain. The number of demand and production can be seen in Figure 2.

![Figure 2. Comparison of Total Demand and Total Production.](image)

Performance measurement of nail product supply chain is analyzed using the POA (Performance of Activity) model. The comparison value used to determine the current level of performance is the target value that has been owned by the company. Supply chain performance measurement is done by observing the POA dimensions one by one.

The Cost appears in the execution of an activity. Data of costs used are ordering cost, inventory cost, and distribution cost. The company calculates several elements for ordering cost, namely the telephone cost, administration, and loading and unloading each order. Time needed to complete all of supply chain activities. The time needed for the company to send finished product to customers until generally is 5 days and the production time is 1 day. The production capacity for nail products up to 11,500 kg per day.

Dimensions of capability in measuring supply chain performance are reliability, availability and flexibility. The data used to calculate this reliability is the number of orders and the number of products sent are in accordance with the order. The company’s average reliability is 86,70%. The data used to calculate to this availability are the number of orders and the number of orders fulfilled. The average percentage of a company’s ability to orders meet is around 90,8%. Flexibility, measuring the
time of supply chain ability to change the volume of production or product mix with a certain percentage or amount.

The amount of output produced by the company from June 2017 to May 2018 is 3,495,568 kilograms. While the number of inputs used 3,622,000 kilograms. Company's productivity is 96.5%. The machines operation at the factory operate on average for 6 hours per day with active working hours of 8 hours per day, machine utilization is 75.10%. In the production process the outcome can be added value given to the products produced. The added value the company has now it converts wire of iron into nail products.

The results of the calculation of supply chain performance measurement in this nail industry can be seen in Table 1.

| Dimension | Measurement Results |
|-----------|---------------------|
| Fees      | The total ordering fee for the whole is IDR 3,549,000. The company's storage fee is IDR 315. The overall distribution cost is IDR 16,275,000 |
| Time      | Delivery time is generally 5 days and production time is needed 1 day. |
| Capacity  | Production capacity is 12,000 kg per day. |
| Capability| The company's reliability is around 86.7%, and the company's availability is around 90.8%. |
| Productivity | Average productivity is 96.5%. |
| Utilization | Machine utilization used by the factory is 75.1%. |
| Outcome   | Changing from wirerod iron to nail products |

3.3 Comparison of Supply Chain Performance and The Company Target
The current supply chain performance is compared with the company's target which can be seen in Table 2. In the capability dimension, namely the reliability of the company in consistency to fulfilling promises to customers is 86.7%. This value of reliability cannot reached the company's target (90%). The company must be searching the causal factors for not fulfilling this reliability dimension. The availability of the company to order meet is 90.8% and it works. The dimensions of machine utilization is 75.1% with the duration of the machine operating 6 hours per day, when the company's target for the utilization dimension is 75%, means for this dimension the company reaches the target.
Table 2. Comparison of The Result of Supply Chain Performance Measurement and The Company Target.

| Dimension | Measurement Results                                                                 | Company Target | Information                                      |
|-----------|--------------------------------------------------------------------------------------|----------------|--------------------------------------------------|
| Cost      | Ordering fee is IDR 3,549,000. Storage costs are IDR 315. Distribution costs are IDR 16,275,000 | -              | -                                                |
| Time      | Delivery time is 5 days and production time is needed 1 day.                         | -              | -                                                |
| Capacity  | Production capacity is 12,000 kg per day.                                             | -              | -                                                |
| Capability| The company's reliability is around 86.7%, and the company's availability is around 90.8%. | 90%            | Reliability hasn't been reached, while availability has been reached |
| Productivity | Average productivity is 96.5%.                                                        | -              | -                                                |
| Utilization| Machine utilization used by the factory is 75.1%.                                    | 75%            | Has been reached                                 |
| Outcome   | Changing from wirerod iron to nail products                                          | -              | -                                                |

From the table above, it can be seen that there is one sub-dimension that has not reached the target. Socompanies need to make improvements in capability dimensions and reliability sub-dimensions. POA model able to measure the performance of supply chain organization especially in manufacturing industry [14]. However, the weakness of this POA model is that it is unable to explain in more detail the size of the supply chain performance that is not achieved.

4. Conclusion
Supply chain performance measurement is done to see the achievement of current supply chain performance and problems in consumer demand fulfillment. Supply chain performance with POA model able to describe supply chain conditions in the manufacturing industry, especially building materials industry. The Performance of Activity model contributes to measure supply chain performance based on 7 dimensions namely cost, time, capacity, capability, productivity, utility, and outcome.

Based on the calculation of supply chain performance measurement based on the Performance of Activity model obtained there are seven influence dimensions, among the seven dimensions produced that the order cost is IDR 3,549,000, the storage cost is IDR 315 / year, and the distribution cost is IDR 16,275,000; delivery time is generally 5 days and production time is needed 1 day; production capacity is 12,000 kg per day; Company reliability is around 86.7%, and company availability is around 90.8%; average productivity is 96.5%; machine utilization used is 75.1%; and changes from wire rod iron to be nail products. By this result, one sub-dimension is obtained which is not meet the
company targets, namely the capability dimension and reliability sub-dimension (86.7%) with the company targets of 90%.

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