Measurement of Material Supply Chain Performance Using SCOR Method

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Abstract. The purpose of this study is to measure performance of material supply chain to determine the direction of improvement in the fulfillment of worker needs. The measurement of Material Supply Chain Performance variables is carried out based on the 5 core processes of the SCOR model and is described in each variable dimension and presented in the form of *Key Performance Indicators (KPI)*. The result of this research is that the total value of each dimension is *plan* 69.93, *source* 65.00, *make* 65.49, *deliver* 53.28, and *return* 53.28 which are included in the category *average*. So that total performance value supply chain is 61.40 which is included in the category average. However, there are still several performance indicators that fall into the categories *average* (50-70), *marginal* (40-50), and *poor* (<40) which are priorities for improvement. These improvements are given based on the implementation of *best practices* in the SCOR model.

Keywords : Performance Measurement, SCOR Model, Supply Chain, Material

1   Introduction

Industrial projects always involve workers and materials in the work plan. Material availability is closely related to the project work process, to get a good supply of goods the organization must determine the supply chain network. Supply chain is a system coordinated by various parties involved either directly or indirectly in the entire course of the project, to produce construction products. The various parties in question are project owners (clients), architects, contractors, subcontractors, construction workers, project material suppliers, service providers, and construction tools, and so on. One of the companies in Batam that prioritizes its supply chain is PT Global Automation.

The overall cost of the project is 50% of which is the cost for material procurement. The availability of materials is also very influential on the progress of a project. Project costs can increase by up to 10% if the supply chain is not managed properly (Maddeppungeng et al., 2018). Emerson Arun project is one of the projects undertaken by PT GA by becoming a subcontractor of electrical work and installation of instrumentation tools in Gas Metering Skid period September - October 2020 starting from fabrication work, support installation,

termination process, and instrumentation. Many challenges and obstacles are faced when the project lasts until complaints arise from workers and supervisors. Several problems occur in the procurement process, fulfillment, and delivery. In the procurement process, sometimes delays in the delivery of materials occur so that it affects the time of the project work process. In addition, there is also no thorough assessment of supply chain performance indicators presented in the Key Performance Indicator (KPI) at PT. GA. So that there is a benchmark to evaluate the performance of the company's supply chain.

To optimize the supply chain PT GA needs to pay attention to the supply chain performance of a network. The method that can be used is Supply Chain Operation Reference (SCOR) as in chotimah's research, et al., (2017) to measure supply chain performance in urea fertilizer delivery units using the SCOR method approach. The results showed that all KPIs fall into the good category. But there are still some performance indicators that are still in the average and marginal categories. Based on the above statement it can be known that through the SCOR model a supply chain network can be known the level of performance achievement on variables through KPIs.

Based on the above explanation, researchers are interested in researching with the title "*Measurement of Material Supply Chain Performance Using SCOR Methods on the Emerson Arun Project*" in this study.

The problem formulations in this study are:

1. How is the flow pattern of the supply chain of Global Automation Company on the Emerson Arun project.
2. How to measure KPIs using the SCOR method in the supply chain of Global Automation Company.
3. How the supply chain performance of Global Automation Company on the Emerson Arun Project.

2　Literature Review

2.1　Supply Chain Operation Reference (SCOR)

The reconciliation was introduced by the Supply Chain Council (SCC) is an analytical method used to measure the performance of a supply chain. A concept that was initiated by business process reengineering which to describe the expected process in the future by analyzing current processes (Rizqi Rahmawati Chotimah, Bambang Purwanggono, 2017).

Next, Benchmarking is the stage where you look for data on companies operating in the same field and then compare the technical performance data. Then, process measurement provides results by improving ineffective business processes. SCOR is a supply chain performance measurement that consists of five perspectives, namely a plan to provide capacity for future demand, make is the process of processing raw materials into finished goods according to customer requests, source fulfills requests through the process of procuring goods and services, deliver is an activity distribution of goods and services on orders from

consumers and return is a return procedure if the goods are not suitable for certain reasons (Apriyani et al., 2018).

2.2 Supply Chain Management

Supply chain is a series of connections formed by companies and activities that carry out the distribution of the supply of goods or services from the beginning to the end to the buyer or customer (Petrus Tumade, Magdalena Wullur, 2016). Supply chain is a series of activities that have a flow with decisions to efficiently integrate suppliers, manufacturers, warehouses, transportation services, retailers and consumers. Distributing goods and services in accurate and precise quantities, times and locations can reduce excess costs and cut activities that can cause costs, but still prioritize what customer needs.

According to Ndiba (2016), the supply chain is a series of connections formed by companies and activities that provides the distribution of the supply of goods or services from the beginning of the process until the end unto the buyer or customer. The activity of managing the procurement of materials and services, transforming them into semi-finished goods and final products in providing products through a distribution system is also called Supply Chain Management (Petrus Tumade, Magdalena Wullur, 2016).

2.3 Supply Chain Performance

Performance of the Chain Supply Management integrates and controls the flow of goods, services and information so that the supply chain is more responsive in providing customer needs, then management is set to create a strategies to help reduce the total costs. Now that customer needs are getting higher, this can be seen from the development of a growing market, the role of suppliers is very much needed in managing and distributing products to the Costumers (Petrus Tumade, Magdalena Wullur, 2016).

2.4 Supply Chain of Construction Services

The supply chain of the construction service business is the correlation between the process and the source consisting of the flow of information between the parties, materials and financial in the construction service business. In a construction supply chain there are parties who work together to support the success of a project. The main contractor is the core of the construction supply chain, with client partners and planning consultants to support the projects. Sub-contractors can be regarded as suppliers for the main contractor, and also have their own suppliers to fulfill the needs of the work. The identification results in this supply chain, there are eight main business processes in the construction supply chain that are cross-organizational, including project management, client service management, supplier relation management, demand management, order fulfillment, construction flow management, environmental management, and research and development. (Aripin et al., 2020).

3 Research Method

3.1 Design/Types of Research

This research uses a quantitative descriptive approach where the data obtained from the sample of the research population is analyzed according to the method used. This study uses a supply chain operation reference (SCOR) analysis model, because in a single variable there are variable dimensions which are the stages of the SCOR model.

3.2 Sample Quantity Determination Technique

Population is the total number consisting of research subjects/objects that have characteristics and qualities within a certain scope and time. The population is determined by the researcher to be studied in answering the existing problems so that we can drawn the right conclusions. (Sugiyono, 2019). The population of this study is 30 people consisting of several workers and superiors who have a different positions and factions at PT. Global Automation Batam.

The research sample is a large part taken from the population because it has certain characteristics that are considered to represent the research population (Sugiyono, 2019). The number of samples in this study was the entire population of PT. Global Automation consisting of 30 people. The sampling method used in this study is the census sample method.

3.3 Data Types and Sources

The types and sources of data that used in this study are primary and secondary data. The instrument in this study is inseparable from data collection techniques (Sugiyono, 2019). Data collection is a technique used by researchers to collect data through questionnaires and observations. There are two sources of data in this study, which is:

a. Primary data is a data obtained directly from the respondents in the form of a questionnaire to measure the performance of PT GA's supply chain from the results of the answers given by respondents to the questions contained in the questionnaire.
b. Secondary data is a data obtained indirectly by researchers. The secondary data used in this study are the data related to the supply chain, such as supply chain subjects, supply chain flows, and material procurement cycles.

4 Result And Discussion

4.1 Validity and Reliability

1. Validity Test

The questionnaire statement is declared valid if it obtains a value of r arithmetic > r table and vice versa. This test is held by comparing the calculated r value with r table. The validity technique that chosenare the type of product moment Karl Pearson validity. The formula is:

$$rxy = \frac{N \sum XY - \sum X \sum Y}{\sqrt{N \sum X^2 - (\sum X)^2} . \sqrt{N \sum Y^2 - (\sum Y)^2}}$$

(1)

Annotation:

Rxy : correlation coefficient

X : item score

Y : total score

N : subject quantity

Table 4.1 Validity Test Results

Dimensions	Item	*r* value	*r* table	Conclusion
Plan	1	0.518	0.361	Valid
	2	(-)0.045	0.361	Invalid
	3	0.522	0.361	Valid
	4	0.469	0.361	Valid
Source	5	0.568	0.361	Valid
	6	0.674	0.361	Valid
	7	0.662	0.361	Valid
	8	0.663	0.361	Valid
Make	9	0.375	0.361	Valid
	10	0.583	0.361	Valid
	11	0.134	0.361	Invalid
	12	0.430	0.361	Valid
Deliver	13	0.474	0.361	Valid
	14	0.163	0.361	Invalid
	15	0.363	0.361	Valid
	16	0.481	0.361	Valid
Return	17	0.449	0.361	Valid
	18	0.573	0.361	Valid
	19	0.331	0.361	Invalid
	20	0.693	0.361	Valid

(Source : SPSS Processing Result, 2021)

In this study, the number of samples was 30 people with an r table value of 5% significance, so the r table value was 0.396. After the validity test, it was found that 16 statement items were declared valid, while 4 statement items were declared invalid so they were not used to the next stage.

2. Reliability Test

A questionnaire is said to be reliable if a person's answer to a statement is consistent from time to time. The reliability coefficient was obtained by using the Cronbach's Alpha

reliability test. The testing technique uses the Cronbach's Alpha technique.Cronbach's Alpha formula as such:

$$r = \left(\frac{k}{k-1}\right)[1 - \frac{\sum \sigma b^2}{\sigma t^2}]$$

(2)

Annotation :

r : reliability coefficient of cronbach alpha

k   : number of questions

$\sum \sigma b^2$: number of question's variations

σt^2 : total score variance

If the value of Cronbach's Alpha < 0.60 then it is declared unreliable and the opposite is said to be reliable. The following are the results of the reliability test as such:

Table 4.2 Reliability Test Result

Variable	Test Result	Explanation
Material Supply Chain Performance	0.836	Reliable

(Source : SPSS Processing Result, 2021)

The results of the data test for 30 respondents resulted in the Cronbach's Alpha coefficient value for the Material Supply Chain Performance variable being greater than 0.60. Thus, it can be concluded that the questionnaire used in this study is reliable in describing the consistency of respondents' answers.

4.2   Supply Chain Pattern

Supply chain is a series of relations formed by companies and activities that carry out the distribution of supplies of goods or services from the beginning to the end to the buyer or customer (Petrus Tumade, Magdalena Wullur, 2016). The arrangement of the supply chain pattern can be seen in the following figure:
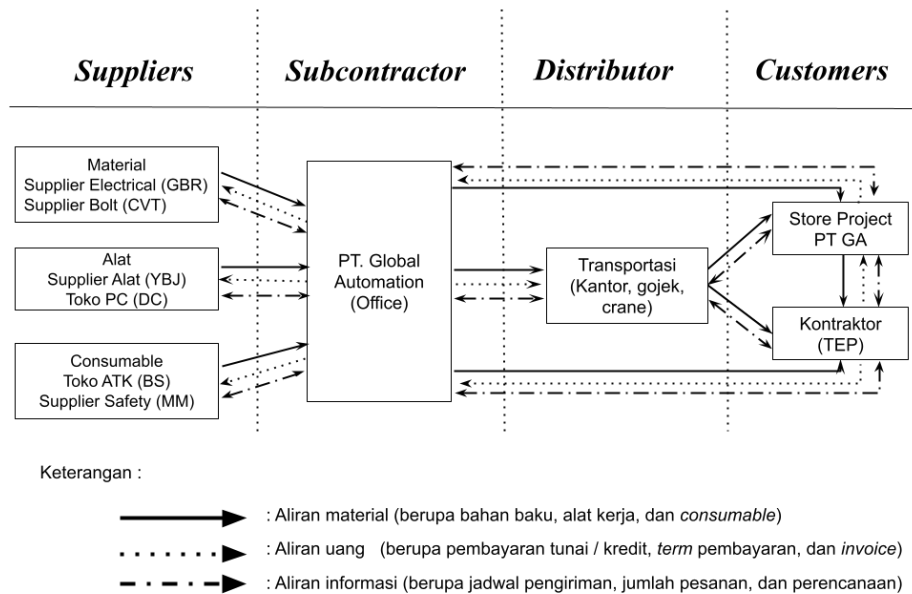
Figure 4.1 Supply Chain Pattern

Based on the observations made by the author has described the supply chain flow pattern of PT. GA from upstream to downstream and downstream to upstream. There are parties involved in the supply chain such as suppliers who act as suppliers of goods, the procurement department as a provider of goods to meet work needs in their role as subcontractors, transportation services as providers of goods distribution services, and contractors as service users. There are several suppliers of goods, namely the material category consisting of electrical suppliers (GBR) that supply electricity needs and bolt suppliers (CVT) as suppliers of bolt needs, in the category of tools there are suppliers of work tools (YBJ) that can meet the needs of work and PC stores (DC) as providers of office equipment, then the consumable category there is an office stationery store (BS) as a provider of office needs and safety suppliers (MM) which will meet the needs of office equipment. consumable field workers. PT. Global Automation as a subcontractor that will supply contractor goods through transportation that can be selected as needed such as office vehicles, gojek, and cranes. Then the goods are sent to the PT GA store project and also to the contractor (TEP) where the Emerson Arun project is carried out.

In supply chain activities, the process of procurement of goods can be seen through several stages of SCOR, namely a plan which is a planning from material to financial to fulfill the needs during the project. Next is the source stage, which is to ensure the availability of goods to fulfill work needs including the scheduling process. Then the make stage is the process of fulfilling orders for goods until they are ready to be shipped. Entering the deliver

stage, namely the distribution of goods to the hands of workers, this process requires the store as an inventory manager. Then the return stage which is a procedure that is carried out when there are problems with the ordered goods.

4.3 Supply Chain Operation Reference (SCOR)

The results of the measurement of the total supply chain performance value of PT. Global Automation was obtained through a questionnaire of 20 questions, 16 of which became Key Performance Indicators (KPI) and have been validated through validity testing. KPI results are validated on the Material Supply Chain Performance variables as such:

Table 4.3 KPI Validated

KPI	Dimensions	Indicator
1	*Plan*	The amount of goods sent is in accordance with the number of worker's orders
2		Capacity planning
3		Supply chain performance to fulfill workers tool
4	*Source*	% goods standard suitability
5		Supply chain performance in fulfilling demands
6		Item order volumes
7		Goods availability for daily needs
8	*Make*	% item packaging security
9		Fast order fulfillment performance
10		Supply management
11	*Deliver*	Number of orders that arrived on time
12		Order quantity fulfilled without waiting process
13		Transport management
14	*Return*	% complains about goods
15		Goods return cycle time
16		Volume return of the remaining goods

The level of performance in the SCOR model can be defined by the normalization of these performance indicators. Each indicator has different weights with different size scales. Therefore, a parameter equalization process is needed, namely by normalization (Chotimah, et

al., 2017). Normalization plays an important role in order to achieve the final value of the performance measurement on the SCOR model. The normalization process is carried out using the Snorm De Boer normalization formula, such as:

$$\text{Snorm} = \left(\frac{(Si - S\,min)}{S\,max - S\,min} \; X \; 100\right)$$

(3)

Annotation :

Si = Actual indicator value that has been achieved

S min = The value of the worst performance achievement of the performance indicators

S max = The value of the best performance achievement of the performance indicators

From the validated KPIs, it can be seen that there are 16 supply chain performance measurement indicators. Each indicator will be measured so that its value will represent the existing criteria. Indicator values have their own criteria.

Table 4.4 Performance Indicator Monitoring Value

Monitoring Value	Performance Indicator
<40	Poor
40-50	Marginal
50-70	Average
70-90	Good
>90	Excellent

(Source : Chotimah, 2017)

The results of the supply chain performance measurement can be seen in table 5.

Table 4.5 Results of KPI Measurement

KPI	Weight	Score	Total Points	Total Dimension Value
1	0.333	66.67	22.20	69.93 (*Average*)
2	0.333	70.00	23.31	
3	0.333	73.33	24.42	
4	0.250	76.67	19.17	65.00 (*Average*)
5	0.250	66.67	16.67	
6	0.250	60.00	15.00	
7	0.250	56.67	14.17	
8	0.333	70.00	23.31	65.49 (*Average*)
9	0.333	60.00	19.98	
10	0.333	66.67	22.20	

KPI	Weight	Score	Total Points	Total Dimension Value
11	0.333	56.67	18.87	53.28 (*Average*)
12	0.333	53.33	17.76	
13	0.333	50.00	16.65	
14	0.333	70.00	23.31	53.28 (*Average*)
15	0.333	60.00	19.98	
16	0.333	30.00	9.99	

(Source : SPSS Processing Result, 2021)

Table 4.6 Supply Chain Performance Total Score

Dimension	Score	Weight	Total Score (Score x Weight)
Plan	69.93	0.200	13.99
Source	65.00	0.200	13.00
Make	65.49	0.200	13.10
Deliver	53.28	0.200	10.66
Return	53.28	0.200	10.66
Total Score Supply Chain			61.40 (Average)

(Source : SPSS Processing Result, 2021)

Based on the measurement results in table 5, from the answers to the questionnaires that have been filled out by the respondents, there are 16 questions that are declared valid and become key performance indicators (KPI), which means that each answer is an indicator of each performance. The plan dimension got a value of 69.93 which was included in the average indicator, source got a value of 65.00 which was included in the average indicator, make got a value of 65.49 which was included in the average indicator, deliver got a value of 53.28 which was included in the average indicator, and return with a value of 53.28 which was included average indicator. From all these dimensions, the total performance value obtained is 61.40 which includes the excellent indicator (*Average*). After getting the value integrity, the indicators are given an explanation of strategies for future improvements.

4.4   Analysis of Performance Indicators and Recommended Strategies

Table 4.7 Analysis Performance Indicators

KPI	Problems	Strategy	Recommendation

KPI	Problems	Strategy	Recommendation
1-2	The amount of goods sent is in accordance with the number of worker orders and capacity planning	*Planning*	Make a detailed list of material, tools, and consumable needs along with spares for supplies.
5	Supply chain performance in meeting demand	*Coordination*	The procurement section needs to reconfirm to the orderer the demand for goods
6	Goods ordering volume	*Information Management*	Run a system that has been integrated with ordered goods so that they can be tracked for its use.
7	Availability of goods for daily work needs	*Flexible Supply Base*	Choose a supplier or store that is not too far from the location and sells quality goods.
8	Packaging security	*Coordination*	Make documentation on every order that comes, this is also as evidence to the seller.
9	Fast order fulfillment performance	*Flexible Supply Base*	Always follow up to the procurement section, then choose the right supplier or can also determine a particular store as a supplier of goods.
10	Supply management	*Supply Management*	Create an inventory of goods integrated with the system that can be traced in real time.
11	Total of goods that arrive on time	*Flexible Supply Base*	Determine the right supplier or store with an affordable location for urgent needs.
12-13	Order quantity fulfilled without waiting process, Transportation management	*Distribution Planning*	Determine the transportation of goods according to conditions, such as heavy equipment using cranes. For items that can be taken will be picked up by the driver.

KPI	Problems	Strategy	Recommendation
14	Complaint about goods	*Coordination*	Making a complaint should be accompanied by evidence such as photos of goods so that they can be accepted by the procurement section.
15	Goods return time cycle	*Planning and Scheduling*	Coordinate with the planning with the project for the project goods, while if in the office can contact the supplier directly.
16	The volume of return of the remaining goods (materials and tools)	*Information Management*	Do the distribution of information to the store for project workers, and for office workers can by making written regulations.

According to the results of the research, the problems experienced in the supply chain of PT. GA is a lack of coordination between management and workers, as well as suppliers. For this reason, in order to improve supply chain performance to be more effective and efficient, the author recommends several strategies, such as:

1. *Coordination* between teams to avoid misunderstandings.
2. *Flexible supply base* namely the change of suppliers in order to be able to adjust the goods needs of the project.
3. *Supply management* or inventory management capable of managing inventory to fulfill the work needs.
4. *Planning and scheduling* is the planning and scheduling of all supply chain activities from ordering to distribution of goods, then.
5. *Information management* which is useful for conveying and distributing information to all workers clearly.
6. *Distribution planning* namely the order fulfillment process that unites demand with inventory until there is distribution of goods that can meet project needs.

The results of this supply chain performance research are parallel with the results of previous studies which also used the SCOR method to determine the performance of supply chain performance, that the research conducted by Chotimah, et al. (2017) which recommended several improvement strategies such as *flexible supply base, strategic stock, supply management, manufacturing, planning and scheduling, information management, coordination,* and *activity based costing* based on best practice in the SCOR method.

5   Conclusion

Based on the results of the research on supply chain performance measurement using the SCOR method on the Emerson Arun project, the following conclusions can be drawn:

1. Based on the results of the research on the supply chain pattern of PT. GA in the Emerson Arun skid metering project there are parties involved in the supply chain consisting of suppliers, subcontractors, distributors, and customers. Supply chain observation activities include the stages of the SCOR model, such as the plan, source, make, deliver, and return processes. As well as the scattered flows in the supply chain, namely the flow of materials, the flow of cash, and the flow of information.
2. Based on the results of the supply chain performance measurement of PT. GA on the Emerson Arun project from 16 selected company supply chain performance indicators, after the process of weighting the total value of each dimension achieved by supply chain performance of PT. GA for plan dimensions is 69.93 with average indicator, source is 65.00 with average indicator, make is 65.49 with average indicator, deliver is 53.28 with average indicator, and return is 53.28 with average indicator. So that total performance value supply chain is 61.40 which is included in the category average.
3. Based on the results of research conducted after being evaluated one by one, there are 14 performance indicators that are still in *average (50-70), marginal (40-50),* and *poor (<40)* conditions, meaning that they have not reached a good enough condition. Therefore, the strategies recommended in this study include *coordination, flexible supply base, supply management, planning and scheduling, information management, and distribution planning.*

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