Analysis of Supply Chain Management Performance Measurement: A Case Study in an Indonesian Manufacturing Company

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Abstract: Various factors, including supply chain risk, can impact an organization's performance. This risk affects both economic and environmental aspects. Achieving goals requires cooperation among stakeholders: suppliers, raw material converters, transportation, and distributors. Therefore, a supply chain management (SCM) strategy is important to achieve the goals and development of the company's supply chain business processes. PT SI is a company that focuses on the production of plastics consisting of garbage bags and plastic food storage bags. The purpose of this study is to calculate the supply chain's overall performance value and make improvement recommendations. Measurement of performance value is measured by the Supply Chain Operation Reference (SCOR) method and Analytical Hierarchy Process (AHP). The final result of the company's performance related to supply chain management (SCM) is "89.6". The value of the company's current performance is in the satisfactory category.

Keywords: Supply Chain, Performance Measurement, Supply Chain Operations Reference (SCOR), Analytical Hierarchy Process (AHP), Key Performance Indicators (KPI).

1. Introduction

Every company needs to know whether its supply chain system is working well in the business it runs or not. The supply chain function in the company must include planning, evaluation, and control processes. But first, it's important to evaluate how well the supply chain is performing [1]. Due to the importance of the supply chain in company activities, measurements are needed to measure performance, identify what indicators need to be improved increase competitiveness, and loyalty to consumers, and reduce non-optimal costs to increase company profits. According to [2] the assessment and evaluation of performance will provide benefits to the company because it can evaluate and analyze all existing activities, to reduce supply chain costs. PT SI is one of several companies that focus on the production process in the manufacturing industry. The company focuses on the production of plastics consisting of garbage bags and plastic food storage bags. The company officially obtained an operational permit on 20 September 1991, precisely in the Batamindo Industrial area. Overall PT SI produces products made from plastic. Performance measurement on the supply chain at PT SI has never been done, so the research aims to determine the total performance value of each indicator on the supply chain according to the company's situation. Indicators with low values are expected to be improved more effectively. Performance measurement serves to measure the extent to which the company has succeeded in achieving the set performance targets. Performance measurement on the supply chain at PT SI using the SCOR method. The SCOR method is one of the models used to measure

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performance [3]. The SCOR method includes the functions of supply chain management as a whole, operational processes, market interactions, interactions with customers, and direct (physical) transactions. The SCOR model is considered better when compared to other performance measurement methods that generally only measure internal companies, the SCOR method can describe performance measurement in detail [4].

2. Theoretical Review

2.1 Performance Measurement

Performance measurement is one of the many important things in the company's business activities, with the application of performance costing or performance value calculation, it is expected that performance escalation will be achieved through improvements made [5]. Calculating the value of performance is important to do this aims to reduce costs, fulfill customer satisfaction, increase company profits, and know the company's performance to what extent the targets set can be achieved [6]. The calculation of performance value in a company or organization must be based on KPI (key performance indicator), the information used to perform the calculation can be actual data, target data, and company performance data in the previous period. Table 1 below is the performance assessment used in this research.

Table 1. KPI Value and Performance Assessment [7]

Score	Performance Assessment
< 40	Poor
40-50	Marginal
50-70	Average
70-90	Satisfactory
> 90	Very Satisfactory

There are three color indicators in the Traffic Light System (TLS), namely red, yellow, and green. The red indicator is given if the Snorm De Boer value produces a performance value ≤ 50, meaning that the performance is poor, if the indicator is yellow, it produces a performance value between 50 and 70, which means it is marginal. The green indicator if Snorm De Boer produces a performance value ≥ 70 which means very good or satisfactory [8].

2.2 Supply Chain Management (SCM)

SCM is a relationship or series of companies that cooperate to produce and deliver products to consumers [9]. This activity involves production plants, suppliers, distributors, and retailers and involves supporting companies, namely logistics services. Supply Chain Management is a logistics activity as part of supply chain management. It also involves sourcing, procurement, and manufacturing activities. Supply chain management can be defined as a systematic process to obtain the unity of various aspects of an efficient and effective organization from the supplier and consumer levels. The integration in question is managing various flows ranging from raw materials (raw materials) from suppliers, the production process to finished products, the process of conducting planning (inventory) and control, and the process of delivering finished products to retail consumers and individual consumers.

2.3 Supply Chain Operation Reference (SCOR)

The Supply Chain Council (SCC) is credited with developing and first putting forth the SCOR technique. The SCOR approach allows for the measurement and improvement of a company's complete supply chain. The model takes into account elements that have an impact on the complete supply chain, such as supply forecasting, delivery, demand fulfillment, inventory and asset management, production flexibility, assurance, process costs, and others (SCC, 2012) in [4]. Five primary elements serve as a guide for supply chain activities when SCOR is implemented. Plan (A process that balances demand and supply to determine the best course of action), Source (The process of procuring goods or services to fulfill demand), Make (The process of transforming raw materials or components into a product that customers want), Deliver (The process of fulfilling customer demand for goods or services), and Return (The process of returning or accepting the return of products for various reasons by consumers) [10]. The SCOR model can also describe performance attributes and indicators in supply chain measurement. The performance attributes in question are supply chain criteria that can analyze and evaluate the supply chain.

2.4 Analytical Hierarchy Process (AHP)

Thomas L. Saaty created the decision support technique known as AHP. According to [11] AHP is a measurement theory by conducts pairwise comparisons and takes expert measurements to obtain a priority scale. The method addresses complex multi-criteria problems in a hierarchy. This hierarchy is a description of a complex problem in a multi-criteria structure, where level 1 is the goal, followed by the level of factors, criteria, sub-criteria, and so on until the last level of alternatives.

2.5 Normalization of Snorm De Boer

Snorm de Boer normalization is a formulation for measuring snormalisation, in measuring performance, normalization is needed for each indicator to align the parameters in each work indicator, this is because each work indicator and its weight have different parameters so Snorm de Boer normalization is needed to align. According to [12] Normalization has an important role in achieving the final value of performance measurement, there are several ways to measure performance, and performance fulfillment is defined by normalizing performance indicators. Normalization calculations can use the following formula:

$$\text{Snorm (Score)} \frac{(Si - Smin)}{(Smax - Smin)} \times 100\%$$

Lower is Better

$$\text{Snorm (Score)} \frac{(Smax - Si)}{(Smax - Smin)} \times 100\%$$

Equation 1Snorm De Boer formula

Information:
Si = Value of real indicator achieved
Smi*n* = Lowest performance gain score
S*max* = The highest performance gain value of the performance indicator.

2.6 Conceptual Framework

The conceptual framework serves to determine the KPIs that will be the basis and basis for measuring GSCM performance in the company, the score of each KPI will be used as a reference for improving the company's GSCM performance. The following conceptual framework in this study can be seen in Figure 1 below.

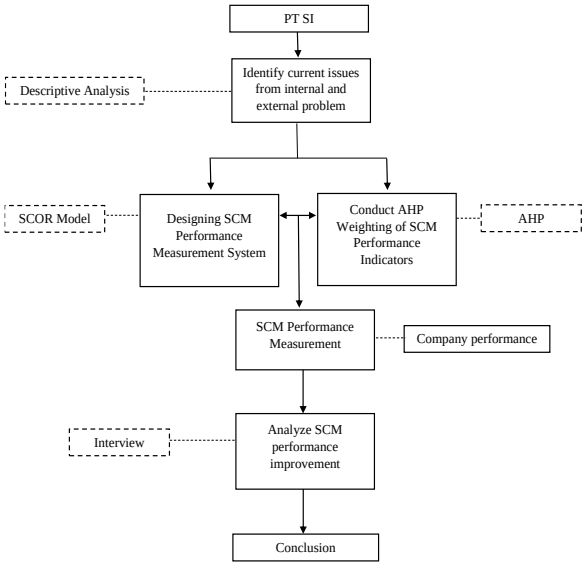

Figure 1KPI Hierarchy

2.7 Hierarchy of Key Performance Indicators (KPI)

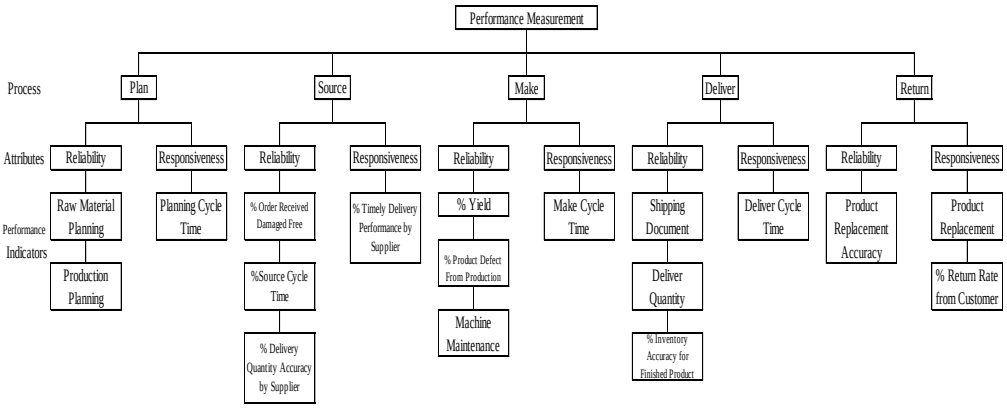

Figure 2KPI Hierarchy

The figure presented above, denoted as Figure 2, offers a comprehensive illustration of the hierarchical structure governing the implementation of Key Performance Indicators (KPIs) within the company. This visual representation delineates three distinct levels of indicators: Level 1 – Process Indicators, Level 2 – Attribute Indicators, and Level 3 – Performance Indicators

3. Research Methods

This research is evaluative research with a quantitative approach. In a quantitative approach, there are research suggestions, hypotheses, observations, analyzing data, and concluding data, including the preparation of aspects of measurement, calculation, formulas, and provisions of numerical data [14]. Quantitative research is more systematic, planned, structured, and clear from the beginning to the end of the research and is not influenced by the circumstances that exist in the field [15]. The measurement method in this research uses SCOR and the analytical hierarchy process (AHP).

3.1 Data Types and Sources

The data used in the research are mainly divided into primary data and secondary data.

1. **Primary data**
   Primary data is data obtained directly from the object of research. Primary data in this study authors obtained by conducting interviews, observations, and filling out questionnaires by company experts to obtain data.
2. **Secondary Data**
   Secondary data is data obtained indirectly which is intended to support research. In this study, secondary data were obtained from various literatures related to this study.

3.2 Sample size determination technique

This study has a sample of 4 experts who have a close relationship with the company's supply chain activities including Production Planning Managers, Production Managers, Quality Assurance Managers, and shipping and Inventory Control Managers.

3.3 Sampling Technique

In this study, the sampling technique used was purposive sampling. This technique is a sampling technique from data sources with prior consideration [16]. The following are the criteria for determining the sample, namely employees who are experts in the company know the company's supply chain activities thoroughly, and have jobs related to key performance indicators.

4. Results and Discussion

4.1 AHP Performance Indicator Weighting with Expert Choice Software

Weighting Key Performance Indicators (KPI) is used to determine the level of importance of each KPI because each KPI has a different level of importance. All KPIs obtained have gone through the validation stage through a questionnaire distributed to company experts. Weighting uses an Analytic Hierarchy Process (AHP) and is processed by expert choice software. The first stage of weighting consists of collecting data through a questionnaire in the form of pairwise comparisons. Filling out the questionnaire was carried out by 4 expert company managers. The

following Table 2 shows the results of weighting between criteria processed using expert choice software.

Table 1AHP weighting

Business Process	Weighting Level 1	Attribute	Weighting Level 2	Key Performance Indicator (KPI)	Weighting Level 3
Plan	0,222	Reliability	0,634	Raw Material Planning	0,366
				Production Planning	0,634
		Responsiveness	0,366	Planning Cycle Time	1
Source	0,195	Reliability	1	Order Received Damaged Free	1
Make	0,207	Reliability	0,500	Yield (Material Efficiency)	0,430
				Product Defect From Production	0,335
				Machine Maintenance	0,236
		Responsiveness	0,500	Make Cycle Time	1
Deliver	0,222	Reliability	1	Shipping Document Accuracy	0,345
				Deliver Quantity Accuracy	0,333
				Inventory Accuracy For Finished Product	0,322
Return	0,154	Responsiveness	1	Customer Claim	1

4.2 Calculation of Key Performance Indicator (KPI) Data

Next is to calculate the Key Performance Indicator (KPI) data that has been obtained from company (see Table 3), all data processed is data related to the supply chain and Key Performance Indicator (KPI), data compiled from July to December 2022. Here is one of the calculations of the company KPI for Raw Material Planning:

$$\text{July} = 100 - \left(\frac{302\,Ton}{2403\,Ton} \times 100\%\right) = 87{,}4\%$$
$$\text{Aug} = 100 - \left(\frac{324\,Ton}{2022\,Ton} \times 100\%\right) = 80{,}5\%$$
$$\text{Sept} = 100 - \left(\frac{295\,Ton}{2107\,Ton} \times 100\%\right) = 85{,}9\%$$
$$\text{Oct} = 100 - \left(\frac{190\,Ton}{2220\,Ton} \times 100\%\right) = 91{,}4\%$$
$$\text{Nov} = 100 - \left(\frac{234\,Ton}{2072\,Ton} \times 100\%\right) = 89{,}0\%$$
$$\text{Dec} = 100 - \left(\frac{237\,Ton}{2089\,Ton} \times 100\%\right) = 88{,}6\%$$

Table 2Key Performance Indicator Data

Process	Performance Indicators	Actual Value (Year 2022)					
		Jul	Aug	Sept	Oct	Nov	Dec
Plan	Raw Material Planning	87,4%	80,5%	85,9%	91,4%	89,0%	88,6%
	Production Planning	98,0%	97,3%	99,4%	99,6%	99,3%	99,7%
	Planning Cycle Time	4	4	4	4	4	4

Process	Performance Indicators	Actual Value (Year 2022)					
		Jul	Aug	Sept	Oct	Nov	Dec
Source	Order Received Damaged Free	99,9%	99,9%	100%	99,9%	99,9%	99,9%
Make	Material efficiency (Yield)	96,0%	97,0%	95,5%	95,2%	96,0%	95,3%
	Product Defect From Production	2,9%	2,9%	2,9%	2,9%	2,9%	2,9%
	Machine maintenance	11 Days	14 Days	11 Days	12 Days	14 Days	12 Days
	Make cycle time	3,3 Hours	3,3 Hours	3,3 Hours	3,3 Hours	3,3 Hours	3,3 Hours
Deliver	Shipping document accuracy	0	0	0	0	0	0
	Deliver quantity accuracy	99,9%	100%	99,9%	99,9%	99,9%	100%
	Inventory Accuracy For Finished Product	100%	100%	100%	100%	100%	100%
Return	Customer claim	100%	100%	100%	100%	100%	100%

After processing data using the SCOR method on all KPIs, all data obtained will be normalized using the Snorm de Boer method, here is an example of the calculation:

Snorm (Score)$\left(\frac{Si-Smin}{Smax-Smin} \times 100\right)$

Raw Material Planning $\left(\frac{88-80}{91-80} \times 100\right) = 73$

4.3 Supply Chain Management (SCM) Performance Measurement

After calculating the final performance and processing data on all KPIs using the SCOR method and then normalizing it with Snorm de Boer (see Table 4), a performance value of **89.6** is obtained so that the performance of PT SI is in the good or satisfactory category.

Table 3Final Performance Score Results

Business Process	Weighting Level 1	Attribute	Weighting Level 2	Key Performance Indicator (KPI)	Weighting Level 3	Snorm	Final Weighting	Normalization x Final Weight
Plan	0,222	Reliability	0,634	Raw Material Planning	0,366	73	0,05	3,8
				Production Planning	0,634	67	0,09	6,5
		Responsiveness	0,366	Planning Cycle Time	1	100	0,08	8
Source	0,195	Reliability	1	Order Received Damaged Free	1	100	0,20	20
Make	0,207	Reliability	0,500	Yield (Material Efficiency)	0,430	100	0,05	4,5
				Product Defect From Production	0,335	60	0,04	2,4

Business Process	Weighting Level 1	Attribute	Weighting Level 2	Key Performance Indicator (KPI)	Weighting Level 3	Snorm	Final Weighting	Normalization x Final Weight
				Machine Maintenance	0,236	67	0,02	2
		Responsiveness	0,500	Make Cycle Time	1	67	0,10	7
				Shipping Document Accuracy	0,345	100	0,08	8
Deliver	0,222	Reliability	1	Deliver Quantity Accuracy	0,333	70	0,07	5
				Inventory Accuracy For Finished Product	0,322	100	0,07	7
Return	0,154	Responsiveness	1	Customer Claim	1	100	0,15	15,4

4.4 Analysis of SCOR Performance Matrix Calculation Results and Recommendation of Improvement Suggestions

To make it easier to identify and perform descriptive analysis on the results of performance measurements, it is necessary to apply the Traffic Light System (TLS) method. The Traffic Light System (TLS) uses red, yellow, and green as its three color indicators (see Snorm column in Table 5). A red indicator is displayed if the Snorm De Boer value yields a performance value of 50, indicating poor performance and a yellow indicator is displayed if the performance value is between 50 and 70, indicating marginal performance. A green indicator will appear if Snorm De Boer generates a performance value of more than 70, which denotes very good or satisfactory performance.

Table 5. ***Traffic Light System***

Business Process	Attribute	Key Performance Indicator (KPI)	Actual Value (Si)	Min	Max	Snorm
Plan	Reliability	Raw Material Planning	88	80	91	73
		Production Planning	99	97	100	67
	Responsiveness	Planning Cycle Time	4.0	1.0	4.0	100
Source	Reliability	Order Received Damaged Free	100	99,9	100	100
Make	Reliability	Yield (Material Efficiency)	96	95	97	100
		Product Defect From Production	2.7	2.4	2.9	60
	Responsiveness	Machine Maintenance	13	11	14	67
		Make Cycle Time	3.3	3.1	3.4	67
Deliver	Reliability	Shipping Document Accuracy	100	0	100	100
		Deliver Quantity Accuracy	99,7	99	100	70
		Inventory Accuracy For Finished Product	100	0	100	100
Return	Responsiveness	Customer Claim	100	0	100	100

4.5 Plan Process Analysis

Three Key Performance Indicators (KPI) raw material planning, production planning, and planning cycle time—are used in the planning process. The raw material planning KPI has a green indicator with a score of 73 which can be said to be satisfactory. Furthermore, the production planning KPI has a yellow indicator with a score of 67 or it can be said to be marginal or quite good, this is because production forecasting and actual total production have differences even though they are not significant. The last is planning cycle time which scores 100 with a green indicator which means it is satisfactory, this is because the time needed to carry out production planning is on time

4.6 Source Process Analysis

In the source process, there is 1 Key Performance Indicator (KPI) namely Order Received Damaged Free has a green indicator with a score of 100 which can be said to be satisfactory, this is because the percentage of material that does not experience difficulty or reject from the total material available tends to be small.

4.7 Make Process Analysis

In the "make" process, there are 4 Key Performance Indicators (KPI) namely yield (material efficiency), product defect from production, machine maintenance and make cycle time. In the yield KPI (material efficiency), the indicator is yellow with a score of 70 which can be said to be marginal or quite good, this is because the use of materials in the production process can be said to be efficient. In the KPI product defect from production, the indicator is yellow with a score of 60 which can be said to be marginal or quite good because there are still defective products in the production process even though with an insignificant amount. Furthermore, the KPI machine maintenance with a yellow indicator with a score of 67 can be said to be marginal or quite good. Finally, the KPI "make cycle time indicator" in yellow with a score of 67 can be said to be marginal or quite good. is yellow with an acquisition score of 67 which can be said to be marginal or good enough.

4.8 Deliver Process Analysis

In the "deliver" process there are 3 Key Performance Indicators (KPIs) namely shipping document accuracy, deliver quantity accuracy, and inventory accuracy for finished products. The shipping document accuracy KPI has a green indicator with a score of 100 which can be said to be satisfactory, this is because all documents can be fulfilled for administrative purposes. Furthermore, the KPI deliver quantity accuracy has a yellow indicator with a score of 70 which can be said to be marginal or quite good. The last KPI inventory accuracy for finished products has a green indicator with a score of 100, this is because the percentage of availability of finished goods in the warehouse is recorded correctly.

4.9 Process Return Analysis

In the return activity, there is one Key Performance Indicator (KPI), namely the "customer claim" has a green indicator with a score of 100 which can be said to be satisfactory, this is because all customer claim reports can be handled.

5. Conclusions and Suggestions

5.1 Conclusion

It may be determined through a study using the Supply Chain Operation Reference (SCOR) and Analytical Hierarchy Process (AHP) methodology on the effectiveness of supply chain management (SCM) at PT SI that:

1. The results of the performance measurement carried out at PT SI using the SCOR and AHP methods obtained a value of 89.6 with this value PT SI is in the good or satisfactory category.
2. Of the 12 Key Performance Indicators (KPIs), 5 KPIs have yellow indicators so it is necessary to improve these indicators, namely production planning, product defect from production, machine maintenance, make cycle time, and deliver quantity accuracy.

5.2 Suggestion

For companies, it is necessary to improve on the five indicators that are colored yellow. The following are suggestions for improving the five indicators:

1. The production planning process improves the activities of handling incoming orders, determining the delivery time of production results, determining the production planning time, determining when to order materials, and considering the capacity of machines, people, and sub-materials in the production process.
2. Indicators of product defects from production increase attention to established production procedures or SOPs and check the production process regularly.
3. Machine maintenance indicators pay attention to the production machine maintenance schedule by considering the production schedule and need to increase communication between the maintenance and production departments so that the machine maintenance carried out does not interfere with production activities.
4. The make cycle time indicator increases the effectiveness of the entire production process by minimizing bottlenecks in production activities.
5. The deliver quantity accuracy indicator improves control over all deliverables by matching items and quantities with shipping documents.

For further researchers, it is recommended to use the development method of AHP, namely Fuzzy AHP which is used as a weighting criterion to obtain more complex results.

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