Performance measurement using supply chain operation reference (SCOR) model: a case study in a small-medium enterprise (SME) in Indonesia

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Abstract. Nowadays, measuring supply chain performance is a topic that attracts many researchers. Performance measurement can be used as a reference to improve performance in order to compete in the market. This study aims to measure the supply chain performance in a small and medium enterprise (SME) producing sports clothes in Yogyakarta. This research utilizes the performance attributes from the Supply Chain Operation Reference Model (SCOR). The business process is identified as the baseline to determine performance metrics on each process (plan, source, make, deliver, return and enable) and performance attributes, i.e. reliability, responsiveness, agility, cost, and asset management efficiency. According to the experts within the company, there are only 27 of 40 performance metrics obtained valid. The overall performance score is at a good level with a value of 77.89. Among the metrics, it is found 9 metrics in marginal and average level while the remaining metrics gained the value of more than 70. This supply chain performance analysis can support the company decision making in order to improve its performance at an excellent level.

Keywords: Performance metric, Supply chain performance measurement, SCOR, SME

1. Introduction

Supply chain management system is a set of approaches utilized to efficiently integrate suppliers, manufacturing, warehouse, and stores, so that the product is produced and distributed at the right quantities, to the right location, and the right time in order to minimize system-wide cost while satisfying service level requirements. [1]. Supply chain performance measurement is a management action that needs to be done the company can continue to grow and excel in competition. Performance measurement is systematic learning to find out the company's potential capabilities in creating management, products, or services. Performance measurement provides results on whether companies achieve their goals and mission [2]. Regarding the goals and mission of a company, revenue and consumer have a correlation. The company will gain high revenue if the company has many customers, this becomes challenging among company to acquire many customers. According to [3] the company has to give full attention to this concept because it is very important in order to meet customer satisfaction. Customer satisfaction is a concept applied by the company to gain many customers. A common customer can change to become a loyal customer. A loyal customer is important for the success and continuity of the company [4]. The analysis performance and measurement is an assessment of activities, then the result used to know the performance whether still effective and efficient to fulfill or increase customer satisfaction [5]. Analysis performance of supply chain management is an important aspect for the successful [6]. Thus, it is required to measure the supply chain performance related to determining a business strategy to achieve the company’s goals.
There are various models in measuring supply chain performance, but there is no agreement on which model is most appropriate to be used. Some of the most widely used models include performance-based measurement, Balanced Scorecard (BSC), Total Cost of Ownership and Life Cycle Assessments (TCO/LCA), Maturity Assessments, SCOR model [7,8,9,10,11]. In this research, the SCOR model is employed to measure the performance of the supply chain. SCOR is a model developed by the supply chain council [12]. SCOR has the characteristics to manage business activities to meet customer demand. SCOR is updated regularly to adapt changes to supply chain business processes. This makes SCOR more suitable for other products than other methods for measuring supply chain performance. According to [13] the SCOR model is mostly used in manufacturing companies and also [14] which can be used by all companies including service companies.

Some research in supply chain performance measurement using the SCOR model has been conducted in different industries such as manufacturing, convection, construction [11,15,16,17] and provide many benefits for industrial development. All of the performance measurement was conducted to maintain competitiveness in the market and take the advantages [18]. Supply Chain Operation References (SCOR) is a powerful tool for evaluating, communicate supply chain management when taking a decision within the company, supplier, and customers, then SCOR link it all the business process, performance metrics, practices, and people skills into the unified structure. SCOR is the most promising model for supply chain management decision making [10,19]. SCOR is a process reference model that the purpose of the reference model is to define process architecture in a way that aligns with key business functions and goals. The scope of SCOR describes the business activities can be linked to each other with all phases of satisfying customer demand. The model support by six primary management processes that is Plan, Source, Make, Deliver, Return, Enable. By describing these processes, the model can be used to describe the level of complexity of the supply chain. Each industry can be known how the depth and breadth they are with all of the supply chain members. SCOR describe the process, not the function, the model focused on the activity involved, not the person or organization element that performs the activity.

The company where this study conducted produces sportswear such as Hoodie, T-shirt, and Jersey as their main product. As an SME enterprise established in 2014, it is necessary to perform well regarding customer demand fulfillment as well as business competition. Supply chain performance deals with expanded supply chain activities in meeting end-customer requirements, including product availability, on-time delivery, and all necessary inventory and capacity in the supply chain to deliver such performance responsively [20]. Improvement can not be applied without a measurement. The measurement is important to see how well the supply chain is doing started from the suppliers’ suppliers until the product comes to the end-user. However, this company does not understand the term of supply chain nor the performance measurement. Therefore, for supporting this small enterprise, the objective of this research is to identify key performance indicators and measure them by utilizing the SCOR model. The result of the measurement is urgently needed as guidance to initiate an action of improvement.

2. Research methodology
This research consist of the following steps:

1. Identifying the business process. In order to measure performance, the business process needs to be identified. Each process will be measured according to the 5 activities, plan, source, make, deliver, and return.
2. Identifying and validating performance metrics. Identify performance metrics that are suitable for SME and validating performance metric aims to select the metric that is valid for SME based on expert judgment. The questionnaires are distributed to experts and ask them to rate 1 until 5 to show their level of agreement (from strongly disagree to strongly agree) with the given statement (items) on a metric scale [21]. Based on the score result, the performance metric that possesses a score of less than 4 will be rejected, and do not apply for the performance measurement process [22].
3. Measuring performance and propose improvement. Measuring the performance is conducted through observation and interview. The result will be normalized using SNORM de Boer. Calculation of normalization value that aims to equalize the unit of value (parameter) of each measurement matrix. Indicators normalized by SNORM, which valued from a range of 0 – 100 [23,24], with the interpretation of the result as presented in Table 1.

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\text{Larger is better: } SNORM = \frac{(S_i - S_{\text{min}})}{(S_{\text{max}} - S_{\text{min}})} \times 100
\]

\[
\text{Lower is better: } SNORM = \frac{(S_{\text{max}} - S_i)}{(S_{\text{max}} - S_{\text{min}})} \times 100
\]

Si = Average value  
S\text{max} = The value of achieving the best performance indicators  
S\text{min} = The value of achieving the worst performance indicator

Table 1. Performance indicator

| System Monitoring | Performance Indicator |
|-------------------|-----------------------|
| <40               | Poor                  |
| 40 – 50           | Marginal              |
| 50 – 70           | Average               |
| 70 – 90           | Good                  |
| >90               | Excellent             |

Source:[25]

3. Results and discussion
The business process is shown in Figure 1 below. When orders come from customers both online and offline, the administration will check the fabric inventory in the warehouse. If the inventory is sufficient, the order will be continued to the design. Yet, if it is less than the safety stock (SS), the administration will order a certain amount to the fabric supplier. Then the fabric supplier will send fabric orders to the warehouse. The company design a logo for the clothes ordered in the design section to be sent to the third party called the printing section together with the fabric (material). The fabric that has been printed will be delivered to the confection for sewing. After completion, all order is delivered to the company’s warehouse for the pressing process of name and number requested on Jersey, then the orders are packed. Finally, they are ready for shipping to the customers. Fabrics are sent from suppliers to administration, continue sending them to the printing process.

![Figure 1. Business scope diagram](image)

3.1. Identifying and validating performance metrics
The metrics were obtained by the sub-processes identified which they were measured by particular performance metrics stated on SCOR. For example, of 5 sub-processes within plan process (sP), it was found only plan source (sP2) due to the actual plan process conducted in the company. Performance metrics obtained, in Table 2, were linked to the sub-processes so identifying the sub-process involved becomes the most important part of quantifying the supply chain performance. Since this study focuses on make-to-order (MTO) sportswear products, all sub-process involved was related to the company’s business process. The sub-processes are plan source (sP2), source make-to-order products (sS2), make-to-order (sM2), deliver make-to-order products (sD2), source return defective product (sSR1), deliver return defective product (sDR1), manage supply chain human resource (sE4), and manage supply chain assets (sE5).

There are 40 performance metrics identified through literature reviews. These metrics were validated by distributing a questionnaire to 3 experts who have been working for more than 3 years in the company. The validation example of the reliability performance attribute is presented in the following Table 2 applying Likert Scale. Performance metric scores more than 4 are necessary and will be quantified. There are only 27 performance metrics selected by the experts while the rest eliminated. The definition and formula of 27 performance metrics are taken from SCOR. According to the perceived scores provided in Table 1, inventory accuracy, the defect rate of raw material, meeting with a customer, and packaging error were not quantified due to the score of less than 4. Before scoring each metric, the experts have explained the definition of the metrics in order to ensure the validity of those scores given. The definitions were taken from SCOR including the formula as shown in Table 2 below. Reliability becomes the most metrics gained in each sub-process following by responsiveness, cost, and agility. Yet, asset management was not measured since it did not meet the business process within the company.

| Table 2. Sub-process, performance attributes, and performance metrics |
|---------------------------------------------------------------|
| **Level 1** | **Level 2** | **Performance Attributes** | **Performance Metrics** | **Definition** | **Formula** |
| (sP) Plan | (sP2) Plan | Responsiveness | Time Identify new product specification | The number of times to finish new product identification | Time used started from customer’s request received by the company until product design ready for production |
| | Source | | | | |
| | | Responsiveness | Lead Time Product | The average time associated with the agreed time of product sent/ready to pick | How long the product ready to pick by customer |
| | | | | | |
| | Cost | Cost for plan | Cost used to make a plan | The total cost to make a plan |

Table 3. The example of reliability perceived importance scores
| No | RELIABILITY PERFORMANCE METRIC | Expert 1 | Expert 2 | Expert 3 | Average |
|----|--------------------------------|---------|---------|---------|---------|
| 1. | Inventory Accuracy             | 3       | 3       | 5       | 3.67    |
| 2. | Source Fill rate               | 5       | 4       | 5       | 4.67    |
| 3. | Defect rate of raw material    | 4       | 2       | 4       | 3.33    |
| 4. | Delivery item accuracy         | 5       | 3       | 5       | 4.33    |
| 5. | Deviation of arrival schedule  | 4       | 5       | 5       | 4.67    |
| 6. | Yield/ product defect          | 4       | 4       | 5       | 4.33    |
| 7. | Schedule achievement of production | 5   | 5       | 5       | 5.00    |
| 8. | Fill rate/ fulfillment customer order | 5 | 5       | 5       | 5.00    |
| 9. | Perfect condition              | 5       | 5       | 5       | 5.00    |
| 10. | Delivery quantity accuracy     | 4       | 5       | 5       | 4.67    |
| 11. | Achievement of schedule delivery | 3   | 4       | 5       | 4.00    |
| 12. | Customer complaint             | 4       | 4       | 4       | 4.00    |
| 13. | Warranty and return            | 4       | 3       | 5       | 4.00    |
| 14. | Meeting with customer          | 2       | 2       | 3       | 2.33    |
| 15. | Packaging error                | 3       | 2       | 2       | 2.33    |

Table 4. Normalization of Plan Processes (sP)

| No | Performance metrics | Actual | Smin | Smax | Snorm |
|----|---------------------|--------|------|------|-------|
| Plan (sP) | Responsiveness |        |      |      |       |
| 1. | Time Identify new product specification | 2 Days | 3 days | 1 ½ days | 66    |
| 2. | Lead Time Product   | 14 Days | 30 days | 10 days | 80    |

Based on the interview’s result, it took 2 days for identifying the new product process. Thus, the actual score of this metric is 2. The owner of the company said that he gives a half days and the worst time is 3 days to time to finish identifying. Both of them are affected by the condition of the job at that time. Thus the normalization calculation of time identify new product specification is:

\[
\text{Time Identify new product specification: } \frac{2 - 3}{1.5 - 3} \times 100 = 66. 
\]

3.2. Discussion

It was identified 27 selected metrics through the interview with production and supply chain manager. The final score was obtained by normalizing the actual score using SNORM shown in Table 4. Each process comprises different performance metrics related to the business process. The performance score of supply chain management reached 77.89. The value shows that it is at a good level of performance. According to the performance metric indicator in Table 1, there are 9 performance metrics reached marginal and poor levels while the remaining metrics are at a good level with the minimum value of 70 presented in Table 5.

Delivery item accuracy, for instance, means that supplier always delivers with the right quantity and never run out of stock. It is also supported by good communication. Other good level metrics are Additional Order to Supplier, Fill Rate/ Fulfillment customer order, and Manage Capital Asset Cycle Time. On the other hand, some lower-level performances require further investigation and improvement. Metric time identify new product specification got a low score because the design operator has more than one job simultaneously, thus it needs to be improved by proposing better
scheduling. The cost for the plan metric is the lowest score because there is no cost control for overhead cost when the process plan takes place. Source flexibility can be improved by doing research in sourcing to find more vendors. Current manufacturing cycle time took a long route for distribution to the company’s warehouse which can be optimized. Since customers tend to choose the cheaper price, it has affected the calculation of cost for finish product metrics. The company must persuade the customer when meeting them for the first time to choose the best offering.

Table 5. Supply chain performance

| No | Performance metrics                          | Performance Score | No | Performance metrics                          | Performance Score |
|----|---------------------------------------------|-------------------|----|---------------------------------------------|-------------------|
| 1. | Time Identify new product specification    | 66                | 15.| Cost for Finish Product                     | 40                |
| 2. | Lead Time Product                           | 80                | 16.| Fill Rate/ Fulfilment customer order        | 100               |
| 3. | Cost for Plan                               | 40                | 17.| Perfect Condition                           | 99                |
| 4. | Source Fill Rate                            | 92                | 18.| Delivery Quantity Accuracy                 | 86                |
| 5. | Delivery Item Accuracy                      | 100               | 19.| Achievement of Delivery Schedule           | 93                |
| 6. | Deviation of Arrival Schedule               | 85                | 20.| Shipment Product Cycle Time                | 66                |
| 7. | Source Cycle Time                           | 85                | 21.| Customer Complaint                         | 93                |
| 8. | Additional Order to Supplier                | 100               | 22.| Warranty and Return                        | 99                |
| 9. | Source Flexibility/ alternative supplier    | 50                | 23.| Warranty Cycle Time                        | 66                |
| 10.| Cost for Order to Supplier                  | 71                | 24.| Days Payable/ Customer Payment             | 55                |
| 11.| Yield/ Product Defect                       | 99                | 25.| Warranty Cost                              | 70                |
| 12.| Achievement of Production Schedule          | 81                | 26.| Manage Capital Asset Cycle Time            | 100               |
| 13.| Current manufacturing cycle time            | 50                | 27.| Man power capability                       | 42                |
| 14.| Manufacturing Product Flexibility           | 75                |     |                                             |                   |

Long shipment product cycle time is caused by consolidating all orders before the delivery process. To improve the warranty cycle time, the company should increase communication with the customer regarding the warranty of the product. It takes on average of 14 days to do payment for Days Payable/ Customer payment because the customers are required to pay the Down Payment when ordering a product then they are allowed to finish it later before delivering the orders. Manpower capability happened due to the lack of focus by the operators that they must complete more than one job in time. These metrics require a depth investigation in order to identify the root cause which can lead an improvement strategy. This analysis can assist the company to determine proper action for each process. The source process has 7 metrics followed by delivery, make, return, delivery, plan, and enable. Of 7 processes, only 1 process obtained the marginal level while the others were good. This process
performance is at a good level with an average value of 83.25. Even though delivery (sD) was measured by 5 metrics, it achieved a higher average value than the source process (sS). Return (sR) performance was better than the making process (sM) because of the performance was almost excellent. Overall, the process performance of the supply chain was good according to the performance indicator in Table 1 above since only 30% of metrics were less than 70. However, these performances were not compared to other SMEs for benchmarking. It can not yet be concluded whether the scores were the best in class. Moreover, it was found metrics at marginal, average, and poor levels for each process particularly performance attribute of cost in plan (sP) and make (sM) processes. The smaller the cost the better performance while the actual condition was slightly reaching the maximum limit (Smax).

Responsiveness, reliability, and agility refer to customer-focused. Responsiveness comprises 7 metrics to be measured and it was at a good level. Responsiveness is the speed at which tasks are performed regarding providing products to the customer by the supply chain. The speed is the cycle time. The smaller the cycle time the better performance achieved. The company’s responsiveness performance have been conducted properly that it must be maintained for company sustainability. Reliability is the ability to perform tasks as expected focusing on the predictability of the outcome of a process. It relates 3 main points considered in reliability: to be on-time, the right quantity, the right quality. It was at an excellent performance that aligned with the customer-focused target. Meanwhile, there were only 2 metrics identified in agility attributes and they are also at a good level. It can be concluded that these performances were able to follow the roles of keeping customer satisfaction. The company must continue its performance in order to win the business competition.

Besides customer-focused, SCOR explains that cost and asset management are part of internal-focused. In order to conduct a well supply chain, it must be supported by a healthy financial represented by cost and asset management. In this study, cost consisted of only 2 metrics measured while asset management was quantified by a metric in enable process (sE). These 3 metrics were at marginal and poor levels. This condition was aligned with the metrics identified for both cost and asset management. It was difficult to determine the metrics involved since the company has not put its attention on controlling cost and asset management. It was concluded that they did not yet have knowledge about it. To increase the performance scores particularly for these attributes, knowledge transformation is highly required related to control and manage cost and asset management. Thus, more metrics can be added in the future. This situation will gain a better level if it can be compared to other companies running a similar business, sportswear confection. So, this company can learn, copy, and apply the best-in-class process from others.

4. Conclusion

Supply Chain Operation Reference Model (SCOR) is a comprehensive process-based model to measure the performance process of the supply chain. The measurement can inform the company position among other companies running a similar business as well as a benchmark to the best-in-class company. Utilizing the SCOR model, it is identified a list of 27 metrics spread into six performance attributes, i.e. reliability, responsiveness, agility, cost, and asset management efficiency to measure performance. According to the result, the supply chain performance is at a good level of 77.89. Further research can measure the supply chain performance considering the risk management and personnel capabilities stated in the latest SCOR 12. It can be combined with a depth interview to investigate the root cause of each metric calculated on the average, marginal, or poor level. Particularly internal-focused performance attributes, cost, and asset management, they can be explored to gain more information on how SMEs control and manage these attributes. By conducting benchmarking research of the supply chain performance score, the company can set a better strategy in order to achieve its business goals.

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