Design of Supply Chain Performance Measurement Model Using Supply Chain Operation Reference (SCOR) in General Trading and Service Company

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Abstract. Supply Chain Management (SCM) plays an important role in keeping the company in the market by managing activities from suppliers to end customers effectively. SC performance measurement makes the supply chain better. SC performance measurement design is carried out in a general trading and service company, which is one of the suppliers of measuring instruments (balance and scale). The company has 23 branch offices so it is necessary to develop appropriate SC performance measures. This study aims to determine the appropriate key performance indicators (KPIs) of the SC based on the SCOR model approach. All SC processes are considered in the development of KPIs such as plan, source, make, delivery, and return. Finally, the results of the study demonstrate that there are four KPIs in the green zone (very good performance), twelve KPIs in the yellow zone (performance needs to be improved), and there are three KPIs in the red zone (very poor performance).

INTRODUCTION

Nowadays, especially in recent years, a number of companies have realized the potential of supply chain management. However, they often lack the insights for effective development of the performance measures and metrics needed to achieve a fully integrated supply chain [1]. In today's trading environment, Supply Chain Management (SCM) plays an important role in keeping the company in the market by managing activities from suppliers to end customers effectively [2]. Supply Chain Management (SCM) looks after and manages the business from raw material procurement to manufacturing to distribution, customer service, and finally product reprocessing and disposal. Every Supply Chain wants to improve its performance to achieve customer expectations. Therefore, performance measures and metrics are needed to measure the effectiveness and efficiency of the Supply Chain. Of course, the success of any Supply Chain or business depends on the Performance Measurement System (PMS). Therefore, an effective Performance Measurement System (PMS) is needed in the Supply Chain context file to measure the right thing at the right time [3].

Performance measurement is a process to measure the level of effectiveness and efficiency of an activity [4]. If the supply chain is the physical network, the companies involved in supplying raw materials, producing goods, or delivering them to end users. Supply Chain Management (SCM) is a method, tool, or approach to its management [5]. Key Performance Indicators or abbreviated as KPI is a type of Performance Measurement used to measure how well a company/organization, project, work unit, department or individual achieves the strategic goals and objectives that it has set. Company management generally uses these Key Performance Indicators (KPI) to track and analyze the

factors that are considered important for the success of their organization [6]. SCOR is a reference model of supply chain operations. This model is designed to help from inside and outside their company, besides this model has a strong and flexible framework that allows it to be used in all kinds of industries that have a supply chain [7].

The purpose of this research is to determine the proper supply chain Key Performance Indicators (KPIs) based on the core process on the SCOR approach (plan, source, make, deliver, return), evaluates Key Performance Indicators (KPIs) Supply Chain at the company uses the SCOR approach framework. The company where the research is conducted is a limited liability company engaged in general trading and services, also a supplier of measuring instruments (balance and scale), and others with 23 branch offices in Indonesia.

LITERATURE REVIEW

The SCOR model has been developed to describe the business activities associated with all phases to fulfill customer demands. The model itself contains several sections and is organized around the six main management processes of Plan, Source, Make, Deliver, Return, and Enable. By describing the supply chain using the building blocks of these processes, the model can be used to describe very simple or very complex supply chains using a common set of definitions. As a result, different industries can be linked to describe the depth and breadth of almost any supply chain. The model has successfully described and provided the basis for supply chain improvement for global projects as well as site-specific projects [8].

The most classic form of classification is ABC analysis, in its original form sorted by revenue (sales x selling price). According to Pareto's Law, aka the 80/20 rule, about 80% of the total revenue is earned with only 20% of the products because these products make a big contribution to the income. These products are then considered important and labeled A. Pareto's law further predicts that the next 15% of revenue is derived from the next 30% of products, and this product is labeled B. Finally, the last 5% of total revenue is derived from the remaining 50% of the product. These items only contribute to a limited amount of income and are considered less important which are labeled C. Two-sided ABC analysis or sometimes referred to as ABC/XYZ analysis, in this analysis not only revenue is considered, but simultaneously also considers second criteria such as sales or number of orders resulting in a 3x3 matrix. For each matrix square, different service level targets can be set [9].

Pairwise comparison compares the elements that have been arranged into a hierarchy, to determine the element that has the most influence on the overall goal. The step taken is to make an assessment of the relative importance of the two elements at a certain level in relation to the level above it. The results of this assessment are presented in the form of a matrix, namely a pairwise comparison matrix. To obtain a useful scale when comparing two elements, it is necessary to have a thorough understanding of the elements being compared and their relevance to the criteria or objectives studied. Commonly asked questions in constructing an importance scale are which element is more important (important, preferred, likely) and, how many times more (important, preferred, likely). Calculation of Element Weights Calculation of mathematical formulas is carried out using a matrix. For example, in an operating subsystem there are *n* operating elements, namely A_1, A_2, ..., A_n, then the results of the comparison of these operating elements will form a comparison matrix. A_n x *n* matrix is a reciprocal matrix. It is assumed that there are n elements, namely W_1, W_2, ..., W_n which will be assessed comparatively. Pairwise comparison values between (W_i, W_j) can be presented as the following matrix [10]:

$$\frac{\mathrm{Wi}}{\mathrm{Wj}} = \mathrm{a(i,j)}, \mathrm{i,j} = 1,2, \ldots \mathrm{n} \quad (1)$$

RESEARCH METHODOLOGY

As mentioned earlier, This research uses a case study approach which was conducted in a general trading and service company located in West Jakarta, Indonesia. The research begins by conducting field studies and literature studies, then determining identification and problem formulation, then proceeding to determine problem boundaries, primary data collection in the form of interviews with managerial parties, sales data, and stock data, and also secondary data collection company. The data taken were not tested for data adequacy using a statistical approach. This is done on the basis of consideration that the data used is original data from the company, and the calculation of ABC analysis of each item is determined by considering the cumulative percentage of sales and the number of items. In this study, ABC analysis is categorized into 3 classes, namely class A that represents 20% of total items and 0% - 69,99% revenue value, class B that represents 30% of total items and 70% - 89,99% revenue value, and class C that represents 50% of total items and 90% - 100% revenue value. If the calculation of ABC analysis and service level categorization is done, the next step is identification of KPIs using the SCOR approach and validating KPIs with the company. If the KPIs

data has been validated by the company, then proceed with the creation and distribution of the KPIs weighting questionnaire, processing and weighting the KPIs questionnaire data using pairwise comparison to gain the weight of each KPIs, so we can do calculation of the KPIs performance value using the Snorm de Boer method and then evaluation of the KPIs using the Traffic Light System (TLS).

RESULT AND DISCUSSION

As mentioned earlier, the beginning of the study is start with collecting sales data from January to December in 2020 at the branch office of the company (JKT-A) for calculation of ABC analysis and determination of service level process along with the company, which the calculation of ABC analysis is obtained 20 items that fall into class A, 27 items in category B, and 42 items in category C as shown in Table 1.

TABLE 1. Result of ABC Analysis

No.	Item Code	% Cumulative	Class	No.	Item Code	% Cumulative	Class	No.	Item Code	% Cumulative	Class
1.	A-1	**16,55%**	A	31.	B-31	**79,40%**	B	61.	C-61	**95,40%**	C
2.	A-2	**27,24%**	A	32.	B-32	**80,15%**	B	62.	C-62	**95,67%**	C
3.	A-3	**37,26%**	A	33.	B-33	**80,90%**	B	63.	C-63	**95,93%**	C
4.	A-4	**41,78%**	A	34.	B-34	**81,62%**	B	64.	C-64	**96,16%**	C
5.	A-5	**45,81%**	A	35.	B-35	**82,32%**	B	65.	C-65	**96,40%**	C
6.	A-6	**49,04%**	A	36.	B-36	**83,00%**	B	66.	C-66	**96,62%**	C
7.	A-7	**52,06%**	A	37.	B-37	**83,67%**	B	67.	C-67	**96,83%**	C
8.	A-8	**53,94%**	A	38.	B-38	**84,33%**	B	68.	C-68	**97,04%**	C
9.	A-9	**55,81%**	A	39.	B-39	**84,97%**	B	69.	C-69	**97,25%**	C
10.	A-10	**57,60%**	A	40.	B-40	**85,61%**	B	70.	C-70	**97,45%**	C
11.	A-11	**59,13%**	A	41.	B-41	**86,24%**	B	71.	C-71	**97,65%**	C
12.	A-12	**60,52%**	A	42.	B-42	**86,85%**	B	72.	C-72	**97,84%**	C
13.	A-13	**61,88%**	A	43.	B-43	**87,45%**	B	73.	C-73	**98,04%**	C
14.	A-14	**63,10%**	A	44.	B-44	**88,02%**	B	74.	C-74	**98,24%**	C
15.	A-15	**64,24%**	A	45.	B-45	**88,56%**	B	75.	C-75	**98,43%**	C
16.	A-16	**65,39%**	A	46.	B-46	**89,09%**	B	76.	C-76	**98,62%**	C
17.	A-17	**66,52%**	A	47.	B-47	**89,63%**	B	77.	C-77	**98,79%**	C
18.	A-18	**67,64%**	A	48.	C-48	**90,15%**	C	78.	C-78	**98,97%**	C
19.	A-19	**68,75%**	A	49.	C-49	**90,65%**	C	79.	C-79	**99,12%**	C
20.	A-20	**69,85%**	A	50.	C-50	**91,14%**	C	80.	C-80	**99,25%**	C
21.	A-21	**70,90%**	B	51.	C-51	**91,63%**	C	81.	C-81	**99,39%**	C
22.	B-22	**71,90%**	B	52.	C-52	**92,08%**	C	82.	C-82	**99,52%**	C
23.	B-23	**72,84%**	B	53.	C-53	**92,51%**	C	83.	C-83	**99,65%**	C
24.	B-24	**73,75%**	B	54.	C-54	**92,95%**	C	84.	C-84	**99,73%**	C
25.	B-25	**74,64%**	B	55.	C-55	**93,35%**	C	85.	C-85	**99,80%**	C
26.	B-26	**75,46%**	B	56.	C-56	**93,73%**	C	86.	C-86	**99,86%**	C
27.	B-27	**76,27%**	B	57.	C-57	**94,11%**	C	87.	C-87	**99,92%**	C
28.	B-28	**77,06%**	B	58.	C-58	**94,45%**	C	88.	C-88	**99,97%**	C
29.	B-29	**77,86%**	B	59.	C-59	**94,80%**	C	89.	C-89	**100,00%**	C
30.	B-30	**78,65%**	B	60.	C-60	**95,13%**	C				

The determination of service level criteria is carried out, where the determination of service level criteria is made together with the company to determine the percentage of each category of sales level and revenue contribution as described in Table 2.

TABLE 2. Company Service Level

Rate of Sales				
	Fast	95%	90%	70%
	Medium	90%	70%	60%
	Slow	70%	60%	10%
		High	Medium	Low
		Revenue Contribution		

In the discussion on supply chain performance measurement at the company is seen from the company's supply chain flow, where the flow starts from incoming orders from consumers received from sales at the head office and branches, then orders are forwarded to logistics at the head office where the ordered products will be seen for availability and where they are located, then if the goods are not in the warehouse, then the head office will place an order for the goods to the producer through the financial sector with the approval of the President Director. If the item already exists, it will be sent directly to the consumer from the head office, and if the product is in accordance with what is desired by the consumer, then the financial party will issue an invoice which will be given to the consumer through the sales field in accordance with the provisions of the initial agreement with the consumer so that the consumer can make payments before the end of the due date as illustrated in Figure 1.

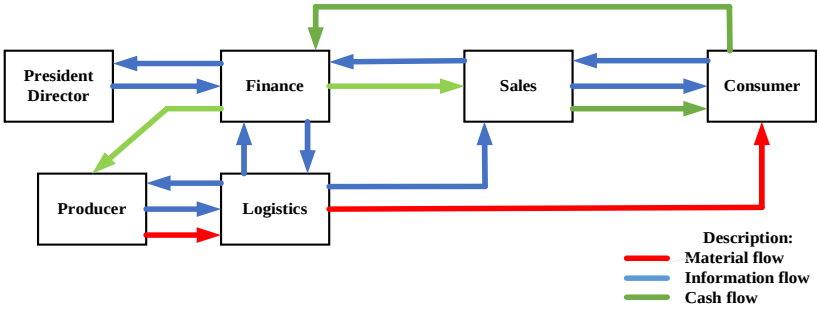

FIGURE 1. Supply Chain Flow

After mapping the supply chain flow of the company, the supply chain flow can be classified based on the 5 core processes of the SCOR model (plan, source, make, deliver, return) as can be seen in Table 3.

TABLE 3. Supply Chain Identification

No.	Supply chain flow	Supply chain identification				
		Plan	Source	Make	Deliver	Return
1.	Purchase order (PO)	✓			✓	
2.	Product procurement process	✓	✓		✓	✓
3.	Product procurement		✓	✓	✓	✓
4.	Product delivery	✓			✓	✓

The next step is to identify KPIs based on the classified supply chain flows, and validate KPIs together with the President Director of the company by conducting interviews and discussions. Of the 40 KPIs that have been identified, 19 of them are declared valid or valid by the President Director of the company. KPIs that have been declared valid by the company as can be seen in Table 4.

The weighting is carried out by distributing weighting questionnaires to the company representative who are experienced in their fields and indeed understand the supply chain flow that occurs. After getting the weights at each level and each KPIs, normalization calculations are carried out by Snorm de Boer on each KPIs in order to obtain a range of values from 0 to 100 to determine the assessment. The following is the Snorm equation from DeBoer[11]:

Larger is Better

$$\text{Snorm} = \frac{(\text{Si} - \text{S min})}{(\text{S max} - \text{S min})} \text{ x } 100 \quad (2)$$

Lower is Better

$$\text{Snorm} = \frac{(\text{S max} - \text{Si})}{(\text{S max} - \text{S min})} \text{ x } 100 \quad (3)$$

where, S_i is actual value obtained; S_{max} is maximum indicator value; S_{min} is minimum indicator value. Then, the calculation is done by multiplying the weights on each KPIs by the normalized value of each KPIs at each level to gain the performance value as can be seen in Table 5.

TABLE 4. Key Performance Indicators Based on SCOR Model

Process	Performance Atributte	KPIs Code	Key Performance Indicators	Unit
PLAN	RELIABILITY	PRL.1	Company internal relations	Scale 1 s.d. 5
		PRL.2	Reliability of workers in planning	Scale 1 s.d. 5
	AGILITY	PAG.1	Request change flexibility	Scale 1 s.d. 5
SOURCE	RELIABILITY	SRL.1	Percentage on time delivery from the head office	%
		SRL.2	Product accuracy from the head office	%
		SRL.3	Relations with the head office	Scale 1 s.d. 5
	RESPONSIVENESS	SRS.1	Order cycle time to head office	Days
		SRS.2	Level of assistance from head office	Scale 1 s.d. 5
MAKE	RELIABILITY	MRL.1	Worker reliability	Scale 1 s.d. 5
	AGILITY	MAG.1	Flexibility of changing the number of items	Scale 1 s.d. 5
DELIVER	RELIABILITY	DRL.1	On-time delivery	%
		DRL.2	Distribution planning reliability	Scale 1 s.d. 5
		DRL.3	Worker reliability	Scale 1 s.d. 5
	RESPONSIVENESS	DRS.1	Delivery Lead Time	Days
RETURN	RELIABILITY	RRL.1	Deffect from head office	%
		RRL.2	Consumer complaints	%
		RRL.3	Replacement product accuracy	%
	RESPONSIVENESS	RRS.1	Consumer product replacement	Days
		RRS.2	Time to complete the complaint	Days

TABLE 5. Measurement Results of KPIs

Level 3			Level 2			Level 1			Overall Value
KPIs Code	Norm. value	Perf. value	Perf. Attributes	Perf. Index	Perf. value	Process	Perf. Index	Perf. Value	
PRL.1	81.25	34.14	RELIABILITY	80.04	57.68	PLAN	80.38	33.36	75.99989
PRL.2	79.17	45.90							
PAG.1	81.25	81.25	AGILITY	81.25	22.69				
SRL.1	**46.84**	10.26	RELIABILITY	56.43	12.54	SOURCE	69.24	17.63	
SRL.2	**55.46**	34.25							
SRL.3	72.92	11.92							
SRS.1	71.53	43.24	RESPONSIVENESS	72.90	56.70				
SRS.2	75.00	29.67							
MRL.1	77.08	77.08	RELIABILITY	77.08	44.69	MAKE	77.08	13.07	
MAG.1	77.08	77.08	AGILITY	77.08	32.39				
DRL.1	**58.32**	25.28	RELIABILITY	67.11	18.07	DELIVER	69.22	5.76	
DRL.2	75.00	18.92							
DRL.3	72.92	22.91							
DRS.1	70.00	70.00	RESPONSIVENESS	70.00	51.15				
RRL.1	72.05	17.65	RELIABILITY	87.89	16.40	RETURN	79.67	6.18	
RRL.2	77.27	17.90							
RRL.3	100.00	52.34							
RRS.1	71.30	27.06	RESPONSIVENESS	77.78	63.27				
RRS.2	81.75	50.72							

The analysis of the calculation results is carried out using a traffic light system to determine the KPIs that need to be improved. The traffic light system uses three colors as indicators, namely green which represents satisfactory performance (performance score is greater than 80), yellow for marginal performance (performance score is 60 to 80), and red for poor performance (performance score is smaller than 60). From the analysis of the traffic light system, it can be seen that there are three performance conditions in each KPIs so that the company knows the conditions that require attention for improvement planning [11].

CONCLUSION

Based on the research above, the company's supply chain flow starts from incoming orders from consumers received from sales at the head office and branches, then orders are forwarded to logistics at the head office where the ordered products will be seen for availability and where they are located, then if the goods are not in the warehouse, then the head office will place an order for the goods to the producer through the financial sector with the approval of the President Director. If the item already exists, it will be sent directly to the consumer from the head office, and if the product is in accordance with what is desired by the consumer, then the financial party will issue an invoice which will be given to the consumer through the sales field in accordance with the provisions of the initial agreement with the consumer so that the consumer can make payments before the end of the due date. Based on the 19 number of KPIs declared valid or valid by the President Director of the company, where the KPIs have as many as 3 KPIs based on the plan perspective, 5 KPIs based on the source perspective, 2 KPIs based on the make perspective, 4 KPIs based on the deliver perspective, and 5 KPIs based on the return perspective. Overal value can be said to be good at 75.99989. Where, a total of 4 KPIs have a value greater than 80, and are stated to be in the green category, a number of 12 KPIs have a value of 60 to 80, and are stated to be in the yellow category, and there are 3 KPIs which are stated to be in the red category which has a value less than 60.

The limitation in this research is that there is no evaluation or performance assessment carried out by the company so that this research can be the basis for the company to conduct a supply chain performance measurement in the future, and for future study the researcher can evaluate supply chain performance based on ABC analysis and create a more integrated system so that if there is a problem from the supplier, it can be identified directly and reduce the occurrence of problems, and the existing KPIs continue to require updating, if the KPIs currently used are no longer representative of the conditions and company goals to meet consumer demand. This is because supply chain activities are always changing according to the needs of the time.

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