

Green Supply Chain Management Performance framework (Case Study in Defense Company in Indonesia)

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Abstract—Green supply chain management practices are now increasingly being applied in companies in Indonesia. Corporate responsibility for environmental issues is part of achieving the company's sustainability. PT. X is a defense company, which one of its products is special vehicle. In each production process, it will always produce waste. Based on waste data in 2018, there are several wastes produced, one of the waste is expired chemical waste. Actually it can be prevented by managing good inventory. This issues indicate that there is an implementation of Green Supply Chain Management (GSCM) that needs to be addressed. In applying the GSCM concept, a performance evaluation is needed to monitor the performance that has been done, and needed to determine the right solution according to the measurement results. Therefore, this research propose green supply chain management performance measure framework. The framework will be based on Supply Chain Operation Reference (SCOR) model. Case study will be applied in special vehicle division of PT. X, the defense company in Indonesia. PT. X has its own performance measurement system, but this measurement system is still focused on controlling the quality assurance and health safety environment. Based on the results, the performance value is 86.54, it indicates that GSCM's performance at PT. X falls into the Good category. Of the 19 KPIs used, 1 KPI was included in the red category, 4 KPIs were in the yellow category, and 14 KPIs were in the green category. To improve performance in the bad category that is the number of suppliers with ISO 14001, it is necessary to provide guidance to current suppliers about the importance of environmental certification. PT. X need to include environmental certification standard into supplier selection specifications to increase supplier with ISO 14001 certified.

Keywords—*Green Supply Chain, Management, Performance framework*

I. INTRODUCTION

Today, environmental issues have become a critical issue and requires immediate treatment, given the impact can affect the survival of living beings in the world. There are 2 (two) factors that can cause environmental problems, there are human factor and natural factors [8]. Based on data from the

Central Bureau of Statistics is known that in 2017, industrial sector is the highest energy consumption compared with other sectors, the energy consumption is about 1.427.810 million Terajoule[1]. Not only in terms of energy consumption, all the activities that occur in an industry have risk to environmental change. All of the process in supply chain affects the environmental change, starts from resource extraction, manufacturing, distribution, product use, waste disposal and other activities. Environmental risks associated with, among others: the use of excessive water and energy without conservation, the use of hazardous chemicals, pollution, contamination, etc [3]. As a sector that has a great impact on the environment, industry players should consider the concept of environmentally friendly (Green) in their business processes, especially in their supply chain activities. Green Supply Chain Management (GSCM) is a concept that integrates environmental perspectives into supply chain management, which includes product design, procurement and selection of raw materials, manufacturing processes, delivery of final products to consumers even after the adjustment grooves products used by consumers. All these activities must be managed with due regard to environmental friendliness factor [5].

Green Supply Chain practices have not been widely implemented by companies in Indonesia. Many supply chains in Indonesia do not yet understand the importance of green supply chain practices and their impact on corporate sustainability. This might be because many companies do not understand the measurement of their company's green supply chain level. This research aims to provide a framework for measuring green performance that can be applied by every company in Indonesia.

II. LITERATURE REVIEW

A. Supply Chain Management

Supply Chain is a network of companies that jointly work to create and deliver a product into the hands of end users. These companies are usually including suppliers,

manufacturers, distributors, or retail store, as well as companies support such as logistics services company [6]. Supply chain management is widely scope of work and responsibilities. In general, all activities related to the flow of material, information, and money along the supply chain are the activities within the scope of SCM. When we refer to a manufacturing company, main activities included in the classification SCM is [6]:

- The activities of designing new products (Product Development)
- Activity obtain raw materials (Procurement, Purchasing or Supply)
- Production planning and inventory activity (Planning Control)
- Perform activities of production (Production)
- The activities do delivery / distribution (Distribution)
- Product returns management activities / goods (Return)

B. Green Supply Chain

Green Supply Chain integrating environmental management with supply chain activities which can encourage supply chain's role in protecting the environment. Green Supply Chain identify and quantify the environmental impact of supply chain processes within an organization [9]. Supply chain improvements that have positive environmental impacts to policies and best practices, are as follows [9]:

- Aligning the goals of Green Supply Chain with business corporate's strategic and objectives. Alignment of Green Supply Chain improvement with objectives and business strategy will create strategic value.
- Evaluation the result of environmental impacts from each process of supply chain and logistics activity.
- Using analysis of Green Supply Chain as a catalyst to accelerate innovation.

- Giving attention to waste reduction. Integration and supply chain collaboration with suppliers and customers to jointly reduce carbon dioxide emission and negative impacts on the environment of materials, production processes, product packaging, transportation, warehousing activity, and distribution

C. Hazardous and Toxic Substances and Hazardous and Toxic Substances Waste

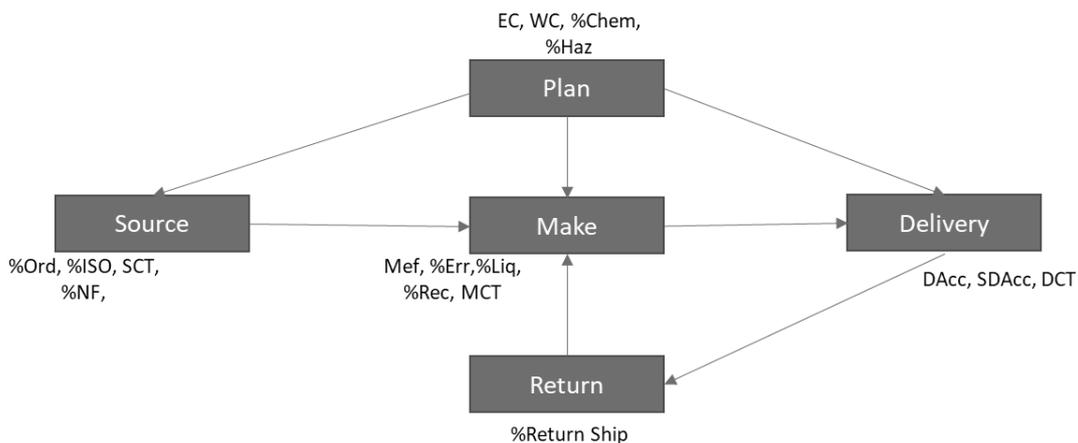
Hazardous and toxic substances are substances, energy, and / or other components which, due to their nature, concentration and / or amount, both directly and indirectly, can pollute and / or damage the environment, and / or endanger the environment life, health, and the survival of humans and other living things [7].

III. METHODOLOGY

The methodology of this research is mixed methods by using qualitative and quantitative approach as well. Study literature was Literature study was conducted to look at other studies in the field of green supply chain, specifically its application in Indonesia. Survey and intensive interview was conduct to gain an existing data about green activity performance in PT.X

IV. RESULT AND DISCUSSION

The performance measurements framework are made by Green SCOR models, where the model is composed of 3 (three) levels are at level 1 consists of a core supply chain process that Plan, source, make, Deliver, and Return. At the second level consists of the dimensions for performance measurement, while the dimensions used for this study is the Reliability, Responsiveness and Agility. While at Level 3 contains indicators of measurement that has the writer identified based on the literature and adapted to the company's business processes. The proposed framework can be seen in figure 1



EC=Energy consumption, WC = Water Consumption, %Chem = % Chemical Material Usage, %Haz = %Storage of Hazardous Material; %Ord = %Orders Received Damage Free, %ISO = % Supplier with ISO 14001 Certification, %NF = % Not Feasible Package; Mef = Material Use Efficiency, %Err = % Release Errors, %Liq = %Liquid And Solid Emission, %Rec = Recycleable Material, MCT = Make Cycle Time; DAcc = Delivery Quantity Accuracy, SDAcc = Shipping Document Accuracy, DCT = Delivery Cycle Time; %Return Ship = % of Error-Free Return Ship

Fig. 1. Framework for green Supply Chain Performance Measurement

Case study of application of the framework was carried out to PT.X, PT.X is defense company that produce special vehicle.

The framework will be used to analyze green supply chain performance by combining with AHP and Snorm de Boer technique.

A. Weightening using AHP

AHP weighting is done by comparing the level of importance between the processes, dimensions, and KPIs. After weighting processes, dimensions, and KPIs, the results can be described as in Table I.

TABEL I. RESULTS OF WEIGHTING AHP

Process	Weight	Dimension	Weight	KPI	Weight	End Weights
Plan	0324	Reliability	1	Energy Consumption	0279	0090
				Water Consumption	0:21	0068
				% Chemical Material Usage	0221	0072
				% Storage Of Hazardous Materials	0289	0094
Source	0217	Reliability	0326	% Orders Received Damage Free	0:48	0034
				% Supplier With ISO 14001 Certification	0:52	0037
		Responsiveness	0:31	Source Cycle Time	0593	0040
				% Not Feasible Package	0407	0027
				Upside Source Flexibility	1	0079
Make	0197	Reliability	0398	Material Use Efficiency	0398	0031
				% Release Errors	0:22	0017
				% Liquid And Solid Emission	0164	0013
		Responsiveness	0314	% Recycleable / Reusable Material	0218	0017
				Make Cycle Time	1	0062
Deliver	0175	Reliability	0:45	Deliver Quantity Accuracy	0532	0043
				Shipping Document Accuracy	0468	0038
		Responsiveness	0542	Deliver Cycle Time	1	0095
Return	0087	Responsiveness	1	% Of Error - Free Return Ship	1	0087

B. Normalization with Snorm de Boer

Data normalization is calculated using the Snorm de Boer method, data normalization is used to equalize the matrix value used as an indicator of measurement. The Smin and

Smax values obtained through interviews with informants to determine the value of the minimum performance achievement that is tolerated and the value of the expected maximum performance. The calculation results are as in Table II.

TABLE II. NORMALIZATION SNORM DE BOER

Process	Dimension	KPI	Actual Value (Si)	Smin	Smax	Snorm (1-100)
Plan	Reliability	Energy Consumption	28 455	27000	32000	70.90
		Water Consumption	12 822	12000	140000	99.36
		% Chemical Material Usage	23%	10%	100%	85.56
		% Storage Of Hazardous Materials	58%	50%	100%	84.00
Source	Reliability	% Orders Received Damage Free	100%	90%	100%	100.00
		% Supplier With ISO 14001 Certification	33.3%	30%	70%	8:25
	Responsiveness	Source Cycle Time	31.25	30	35	75.00
		% Not Feasible Package	0%	0%	10%	100.00
Make	Reliability	Material Use Efficiency	98.20%	90%	100%	82.00
		% Release Errors	0.0027%	0%	5%	99.95
		% Liquid And Solid Emission	100%	90%	100%	100.00
		% Recycleable / Reusable Material	70.08%	50%	80%	66.93
	Responsiveness	Make Cycle Time	30	28	35	71.43
	Flexibility	Upside Make Flexibility	100%	50%	100%	100.00
Deliver	Reliability	Deliver Quantity Accuracy	100%	90%	100%	100.00
		Shipping Document Accuracy	100%	90%	100%	100.00
	Responsiveness	Deliver Cycle Time	5.2	5	7	90.00
Return	Responsiveness	% Of Error - Free Return Ship	0%	0%	10%	100.00

C. Calculation and Final Performance Evaluation

Meanwhile, to calculate the overall performance can be done with the sum up the total value of the final performance. Traffic Light System helps to show the assessment criteria that need to be repaired. There are 3 (three) color indicators used, namely red for the performance value ≤ 60 which indicates that

the performance is poor, then yellow for the performance value between 60-80 which indicates that the achievement of moderate performance and green for the performance value ≥ 80 which indicates that the achievement good performance. The results of calculations are as shown in Table III

TABLE III. CALCULATION RESULTS FINAL PERFORMANCE

Process	Dimension	KPI	Snorm (1-100)	End Weights	Final Performance	Overall Performance (1-100)
Plan	Reliability	Energy Consumption	70.90	0090	6:41	86.54
		Water Consumption	99.36	0068	6:76	
		% Chemical Material Usage	85.56	0072	6:13	
		% Storage Of Hazardous Materials	84.00	0094	7:87	
Source	Reliability	% Orders Received Damage Free	100.00	0034	3:40	
		% Supplier With ISO 14001 Certification	8:25	0037	0:30	
	Responsiveness	Source Cycle Time	75.00	0040	2:99	
		% Not Feasible Package	100.00	0027	2:74	
	Flexibility	Upside Source Flexibility	100.00	0079	7:90	
	Make	Reliability	Material Use Efficiency	82.00	0031	
% Release Errors			99.95	0017	1:72	
% Liquid And Solid Emission			100.00	0013	1:29	
% Recycleable / Reusable Material			66.93	0017	1:14	
Responsiveness		Make Cycle Time	71.43	0062	4:42	
Flexibility		Upside Make Flexibility	100.00	0057	5:67	
Deliver	Reliability	Deliver Quantity Accuracy	100.00	0043	4:26	
		Shipping Document Accuracy	100.00	0038	3:75	
	Responsiveness	Deliver Cycle Time	90.00	0095	8:54	
Return	Responsiveness	% Of Error - Free Return Ship	100.00	0087	8:70	

Based on the table above, it can be seen that the performance of Green Supply Chain in PT. X obtain a score of 86.54 which indicates that the performance is included in the Good category, where it is known there are 4 KPIs included in the category of yellow and one KPI with red color category. The solution can be provided to improve the performance of KPI. Energy consumption can be improved by reducing electricity usage, using energy saving machine, or forming individual behavior that saves electricity. Company can provide guidance to supplier to get ISO 14001 certification. To improve the performance of Source Cycle Time and Make Cycle Time can be done by implementing a lean system, both in the related company and the supplier to reduce the lead time of the source process through the

elimination of processes that are considered not to add value (waste). To increase recycleable / reusable material, it is necessary to increase the quantity of material recycling both to support production and daily needs.

V. CONCLUSION

Framework that this research proposed was combining SCOR model and Key performance index in measuring level of green Supply Chain practices. This framework analyzing the performance indicator in every activity along the supply chain. Case study has already done to a defense company by combining with other technique such as AHP and Snorm de Boer technique.

Performance measurements are carried out using the Green SCOR model, then weighted using the Analytical Hierarchy Process (AHP) method, then normalized using the Snorm de Boer method which requires to equalize judgments about the frame used as an indicator of measurement and then carried out using the method Light Traffic System to provide responses to each KPI through the color category. Based on the Green Supply Chain Management Performance evaluation that has been carried out, the results obtained indicate that the implementation of Green Supply Chain Management obtained a score of 86.54 which indicates that the performance is included in the Good category. Of the 19 KPIs used, there were 1 KPIs in the red category, 4 KPIs in the yellow category, and 14 KPIs in the green category.

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