12. Green Supply Chain Operation Reference (Green SCOR) Performance Evaluation (Case Study: Steel Company)

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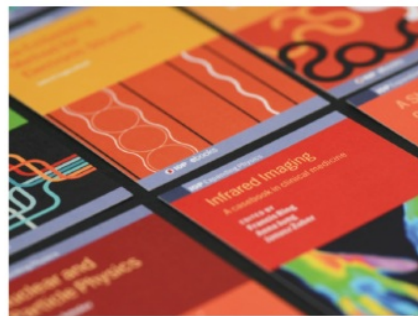
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Green Supply Chain Operation Reference (Green SCOR) Performance Evaluation (Case Study: Steel Company)

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Abstract. At the last decade, some environmental problems become increased. For that reason many companies are currently attention to environmental issues. The concern not only in the production process but in the overall activities. This research use the Green Supply Chain Operation Reference (Green SCOR) method to evaluating the green supply chain performance in steel company. Key Performance Indicator divided into five categories i.e. plan, source, make, deliver and return. The result of *Monitoring System Performance Indicators* is 67.73 (average category). From SNORM value in Traffic Light System, the water used is the lowest. And the value is 38. This shows a lack of performance value and needs improvement.

Key words — Green SCOR, *Supply Chain*, KPI, AHP.

1. Introduction

Management of business processes has undergone many significant changes in the past few decades. The pressure and movement are influenced by globalization encourages companies to improve environmental performance. The importance of relationships between organizations encourages companies to integrate networks with suppliers and consumers so that the concept of supply chain management emerges [1]. Performance measurement is very important for successfully implemented of supply chain management. Ineffective performance measurement will never reveal what adjustments are needed in the supply chain. Improved performance, effective collaboration with suppliers and customers to launch a supply chain is an interactive process. This means that performance measurements are very important especially in the supply chain [2]. Also [3] consider SC management offers a systemic approach to 'greening' the industry. Finnaly, between Supplier, customer and internal integration need to colaboration to enhance both green product and process innovations [4].

Green supply chain is needed to balancing between environmental aspect and company stategies. Yang et al., [5] also have same opinion, green supply chain is getting more and more attention. To increasing SC eco-efficiency, green practices are the main actions [6]. Different statements from Singh and Trived [7], they say to achieve environmental sustainability, obtained from collaboration between reverse logistics, closed-loop supply chain management and waste management In other hand, Al-Sheyadi et al., [8] proposed GSCM can be sets of some practises i.e. environmental management systems, eco design, and a source of reduction and external environmental practices.

Steel Company was chosen as preliminary investigation because it has a complete supply chain problem from upstream to downstream. In addition, among the existing manufacturing companies, steel company has complex activities. The company target is to make all variants steel products into green products and minimize the environmental problems.

Based on preliminary investigation, the steel company has some problems in using of energy, gas, water and delivery lead time. Some raw material are over due date from schedule That condition makes company experienced a setback in the production process. Finally, some buyers complained about the delay. The other hand, the company felt that production process had been wasted in many areas. The purpose of this research is performance evaluating of Green SCOR. After understanding the result especially area in the key performance indicators, company must make appropriate strategies to overcome the problems. Besides that, company can minimize the number of complain, fulfil environmental regulation and maximize the company profit.

2. Literature Review
2.1 Green SCOR Concept
The concept of Green SCOR (GSCM) in the era of industrial change that demands the role of industry in safeguarding the environment by reducing waste and pollution, has led to the emergence of Green Supply Chain Management in the implementation of supply chain strategies. Green Supply Chain Management requires industrial activities to improve the balance between marketing performance and environmental issues that give birth to new issues such as saving energy use, and reducing pollution in an effort to increase competitive strategies. The SCOR Green Model is a development of the existing SCOR model. This model is a development related to the environment in it. Thus, this model is used as a tool to manage environmental impacts from a supply chain application. Green SCOR model has the same 5 main assessments categories namely Plan, Source, Make, Delivery, and Return. While Green SCOR has work attributes i.e. Reliability, Responsiveness, Flexibility, Cost, and Assets. But on the Green SCOR model all of these things have different meanings because in this model everything is related to the environment

2.2 Consistency Test
A consistency test is a step to multiplying a consistency index with the priority of the criteria concerned and summing the results of the times. The order in consistency calculation is:
- Determination of consideration synthesis results.
- Multiplying each entry in each column of the matrix with the result of synthesis of the considerations.
- Divide each entry in the column number of rows with the corresponding entry from the priority vector to get λ *max*.
- Calculation of consistency index (CI0)
  Consistency ratio is accepted if CR = CI/RI ≤ 0,10. The formula for the consistency index (CI) is:

$$C_I = \frac{(\lambda_{maks} - n)}{(n-1)} \tag{1}$$

The following random index for matrices measuring 3 to 10 (matrices measuring 1 and 2 have inconsistencies of 0).
In the SCOR standardization process, the following calculations are applied:

$$S_{norm} = \frac{(S_{max} - S_i)}{S_{max} - S_{min}} \; x \; 100 \tag{2}$$

To calculate the final value of Green Supply Chain performance, a formula is applied:

$$P_i = \sum_{j=1}^{n} = S_{ij} W_j \tag{3}$$

Where:
P_i = total Green Supply Chain variance performance

N = objective number of performance

$S_{ij} = i$ Supply Chain Score in the j-performance objective

W_j= objective performance value

From these calculations will produce performance indicators values from Steel Company. If the work value is <40 then the achievement of performance can be categorized in very low conditions (poor), while the performance value is> 90 then it can be categorized as very good. It can be show in the Table 1.

Table 1. Performance Indicator Monitoring Systems

Table of **Monitoring System Performance** Indicators	
Monitoring System	**Performance Indicator**
<40	Poor
40–50	Marginal
51–70	Average
71–90	Good
>90	Excellent

Source: Trienekens dan Hvolby, 2000

The value of aggregate performance is the total number of multiplications of weight and normalized values of KPI and can be described as follows:

$$N\ aggregate = \sum I\ KPI = \sum W_i * N_i \qquad (4)$$

Where:

N aggregate = Value of the company's Supply Chain performance

3.Methodology

In this case study, researcher use independent variable and divided into 5 variables i.e. Plan, Source, Make, Deliver and Return. Every variables also divided into sub variable. Table 2 show the variable and sub variable.

Table 2. Variable and Sub Variable

No	Variable	Sub Variable
1	Plan	1.1 Energy used 1.2 Water used 1.3 Gas used 1.4 Energy used 1.5 Water used 1.6 Gas used
2	Source	2.1 % orders received damage free 2.2 % hazardous material in inventory 2.3 % of supplier with an EMS or ISO 14000 certification 2.4 Supplier delivery lead time
3	Make	3.1 Yield 3.2 Make Liquid Emission 3.3 % of Recyclable / Reusable Materials
4	Deliver	4.1 Deliver Quantity Accuracy 4.2 Shipping Document Accuracy 4.3 Delivery lead time 4.4 Minimum delivery quantity
No	Variable	Sub Variable

5	Return	5.1 % of Complain Regarding Missing Environmental Requirement from Product 5.2 % of Error – Free Return Shipped.

4. Result and Discussion

4.1 Weighting the Key Performance Indicator Process with the Green Supply Chain Operation Reference (GSCOR)

Weighting Key performance Indicator aims to determine the importance of existing Key Performance Indicator (KPI). According to Thomas L. Saaty, a weighting questionnaire will be considered consistent, if the value of the Consistency Ratio is less than 0.1 (10%). In the comparison matrix of the Supply Chain perspective the intensity of each of the interests of each KPI has been determined by Steel Company uses a paired comparison scale ranging from numbers 1 to 9. After filling out the comparison matrix questionnaire, the comparison matrix calculation is as follows (Table 2):

Table 3. Comparison Matric

KPI	Plan	Source	Make	Deliver	Return
Plan	**1**	3	5	7	7
Source	0.33	**1**	3	3	5
Make	0.20	0.33	**1**	3	5
Deliver	0.14	0.33	0.33	**1**	3
Return	0.14	0.20	0.20	0.33	**1**
Total	1.81	4.86	9.53	14.33	21

4.2 Testing criteria using consistency tests

In the calculation of the consistency test, a multiplication of the KPI comparison matrix is carried out with the following weights. From the results of the KPI matrix multiplication, the value is entered in the KPI testing table.

Table 4. Consistency Test Result

KPI	P	S	M	D	R	Total
P	**2.516**	3.450	3.650	2.751	1.477	13.844
S	0.830	**1.150**	2.190	1.179	1.055	6.404
M	0.503	0.380	**0.730**	1.179	1.055	3.847
D	0.352	0.380	0.240	**0.393**	0.633	1.998
R	0.352	0.230	0.146	0.130	**0.211**	1.069

After Processing Data Conducted Using Green SCOR Then Obtained the Value of Final Green Supply Chain Performance It Is 67.73 Where the Numbers Enter in the Average Category. Then to facilitate the KPI that needs improvement, in this discussion we will use a Traffic Light System. Traffic light system uses three colour indicators namely red, yellow, and green. The red indicator is given if the SNORM value shows a performance score of ≤ 50 which means the performance is not satisfactory, the yellow indicator is given if the SNORM value shows a performance score of $50 <$ performance score <70 which means it is in the marginal category. And the last colour indicator is green given if the SNORM value shows a performance score of ≥ 70 which means satisfying. The following is the result of grouping KPIs with a Traffic Light System.

Table 5. Traffic Light Systems

KPI	Actual (Si)	Min	Max	SNORM
EU	1.036.680	800.000	1.300.000	52.6
WU	11.924.250	10.000.000	12.000.000	38
GU	973.242	500.000	2.000.000	68.4
% ORDF	100	90	100	100
% HMI	0	0	10	100
% SWEIC	100	90	100	100
SDLT	70	60	90	67
Y	99,32	90	100	99.32
MLE	100	90	100	100
% OR	100	90	100	100
DQA	100	90	100	100
SDA	100	90	100	100
DLT	42	30	60	60
MDQ	469.265	350.000	600.000	52.3
%OCRMERFP	0	0	5	100
%OEFRS	0	0	5	100

Factors in the green supply chain performance consider the green SCOR concept and the conditions that exist in the company. There are five basic management aspects that exist in the GSCOR concept used in this study. These five basic management aspects include *plan, source, make, deliver, return*. Furthermore, the five basic management aspects are translated into three basic capabilities, namely reliability, responsiveness, and flexibility. After verification of the 16 indicators submitted, through the interview session, 16 indicators were verified and could be used as KPIs. Of the 16 verified indicators, weighting will be carried out. Weighting on each KPI is done using the AHP method. At this stage the data entered is obtained from the results of the questionnaire distributed to each of the heads of departments concerned. Furthermore, performance measurement or scoring is carried out using the Green Supply Chain Operation Reference (GSCOR) method and evaluating it using the traffic light system (TLS) method. Based on the table, it can be seen that of the 16 KPIs, 1 KPI is in the red colour category, 5 KPIs are in the yellow category and 10 KPI are in the green colour category. The total value of green supply chain performance measurement at Steel Company was obtained at 67.73 (*Average*). From these figures it can be seen that the green supply chain performance at Steel Company Steel is in yellow, which means that supply chain performance is good, but corrective actions are needed to improve the performance of the green supply chain of Steel Company. For KPIs that have not yet reached the target, the KPI with the red and yellow categories must be given corrective actions to improve the performance of the green supply chain of Steel Company. Five KPIs that are in yellow and need to be increased, namely EU (Energy Used) with a normalization score of 52.6; GU (Gas Used) with a normalization score of 68.4; SDLT (Supplier Delivery Lead Time); with a normalization score of 67; DLT (Delivery Lead Time) with a Normalization score of 60; and MDQ (Minimum Delivery Quantity) with a normalization score of 52.3. From the table it can be seen indicators that have a low score. The indicator is WU or Water Used with a normalization score 38,0; this shows a lack of performance value and needs improvement.

Table 6. Matric Multiplication Calculation

KPI	Normalization score	Proposed Improvement
EU (Energy Used)	52.6	Be more careful in planning for the production process so that the engine is not often off right and the required energy is large enough when the engine starts to start the production process again.
GU (Gas Used)	68.4	Gas will consume very large energy when machines often dies. So, company must have good planning and scheduling in production processes.

KPI	Normalization score	Proposed Improvement
EU (Energy Used)	52.6	Be more careful in planning for the production process so that the engine is not often off right and the required energy is large enough when the engine starts to start the production process again.
SDLT (Supplier Delivery Lead Time)	67	Supplier selection is very important to determine suppliers who have high capability. Pricing, timing, payment systems and good quality products will help the company to complete its production on time.
DLT (Delivery Lead Time)	60	Delivery management system must be properly controlled by the company. The company focus on delivering products to customers does not exceed the due date.
MDQ (Minimum Delivery Quantity)	52.3	The delivery system must be fit in quantity, product specifications and quality. Every delivery, the company must be in accordance with the purchase order.
WU (Water Used)	**38**	**The use of water as a means of support in the production process must accordance with the needs of the machine. The use of efficient water will have an impact on the waste produced.**

5. Conclusion

After processing data using Green SCOR, the value of the final green supply chain is 67.73 where the number is in the Average category. From the performance measurement of Green Supply Chain at Steel Company can find out 5 KPIs in yellow and need to be increased namely EU (Energy Used) with a normalization score of 52.6; GU (Gas Used) with a normalization score of 68.4; SDLT (Supplier Delivery Lead Time); with a normalization score of 67; DLT (Delivery Lead Time) with a Normalization score of 60; and MDQ (Minimum Delivery Quantity) with a normalization score of 52.3. And indicators that have a low score, namely the indicator is WU or Water Used with a normalization score 38,0; this shows the value of performance is lacking and there needs to be improvements that have been described.

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