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Green Supply Chain Management Performance Measurement Using the Balanced Scorecard - Analytic Network Process in the Fresh Dairy Industry

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ABSTRACT

The objective of this study was to obtain an overview of the process and measure the performance of Green Supply Chain Management in the dairy industry in Bandung area, West Java, Indonesia. The method used in this research is the Balanced Scorecard - Analytic Network Process to measure the performance of Green Supply Chain Management. Data was collected through the observation, in-depth interviews, questionnaires, and literature studies. The research findings show that some Key Performance Indicators has not been achieved the target, and must be improved to optimize the overall Green Supply Chain Management. The novelty of this research concerning to the importance of business organizations paying attention on Green Supply Chain Management for the long term. The open market for the domestic fresh milk industry is very vulnerable to threats due to environmental issues. Therefore, the results of this study are expected to be a reference for other business organizations.

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INTRODUCTION

The market share of the domestic fresh milk industry is still large due to the low production of fresh milk in the country. However, there is another threat that can change the market, namely environmental issues. It is a scientific consensus that livestock which is the main source of fresh milk production is responsible for at least 14.5-16.5% of greenhouse gas emissions and is estimated to cause significant environmental degradation from loss of biodiversity to deforestation [1]. Another factor in line with this is shown by the results of a survey from the Indonesian Political Indicator and the Bright Indonesia Foundation, namely that 53% of Indonesia's young generation are worried about environmental damage. These things, among others, encourage the livestock industry, especially fresh milk industry, to carry out green supply chain management optimally [2], [3].

Several studies related to the importance of green supply chain management show that green supply chain management can help improve the company's brand image and can increase consumer buying interest [4]. Other studies look at the measurement and evaluation of supply chain performance. The process of reforestation or the application of green supply chain management has a significant influence on the company's competitiveness [5]. The implementation of green supply chain management is effective because it touches all lines of the company from budgeting to distribution and sales. The dimensions of green supply chain management studied refer to internal management, green design, green purchasing, green production, green logistics, and reverse logistics. The implementation of an environmentally friendly approach will open up the prospect of influencing the green

product portfolio not only across the product spectrum but also to all members of the supply chain [6]. This illustrates the advantages of implementing green supply chain management. Some of these studies use the Balanced Scorecard and Analytic Network Process methods to measure supply chain performance [7], [8].

The Balanced Scorecard (BSc) is a measuring tool that can be used for the purpose of improving supply chain performance, it is also a popular tool to help develop a company's vision, mission, and strategy, right down to the selection of decisions and actions [9]. This concept was born from the process of finding and perfecting a performance measurement system which initially only focused on the financial perspective, even though there are other perspectives that are also important to be used as a performance measure [10], [11].

Meanwhile Analytic Network Process related to the decision-making method in the form of a comprehensive analytical framework that is used to analyze decision-making in government, society, and or companies [12]. If in AHP the form of the model is a standard hierarchy then in ANP it is the other way around. The model used is in the form of a network which does not require independence between elements which if in an ANP case can be used as an effective tool. Compared to various previous studies, the research conducted focuses more on the implementation of green supply chain management in the fresh milk industry [13]. The purpose of this research is to provide an overview of the performance process of green supply chain management that can be applied in a business organization so that it is expected to improve the image of the organization [14], [15].

RESEARCH METHOD

The business organization or company where this research is conducted is the Bandung Cattle Breeders Cooperative, West Java, Indonesia. Data collection techniques were carried out through observation, questionnaires, interviews, and literature studies. The research process begins with identifying the problem. Analytic Network Process (ANP) modeling is carried out to find the relationship between KPIs, whether in the same perspective (inner dependency) or in different perspective (outer dependency). Next is the weighting of KPIs with ANP using Super Decision software. ANP is a decision-

making method in the form of a comprehensive analytical framework, in the form of a network that does not require independence between elements. After the stages of identification, collection and processing of data, the research entered the analysis stage. The process of analyzing the performance of green supply chain management uses Objective Matrix (OMAX) tools as a tool to measure performance achievement. According to Giggs, the Objective Matrix (OMAX) is a system used to measure partial productivity in a company. The final stage is then drawing conclusions and interpreting the results of the OMAX calculation. The stages or flowcharts of this research can be seen in Figure 1.

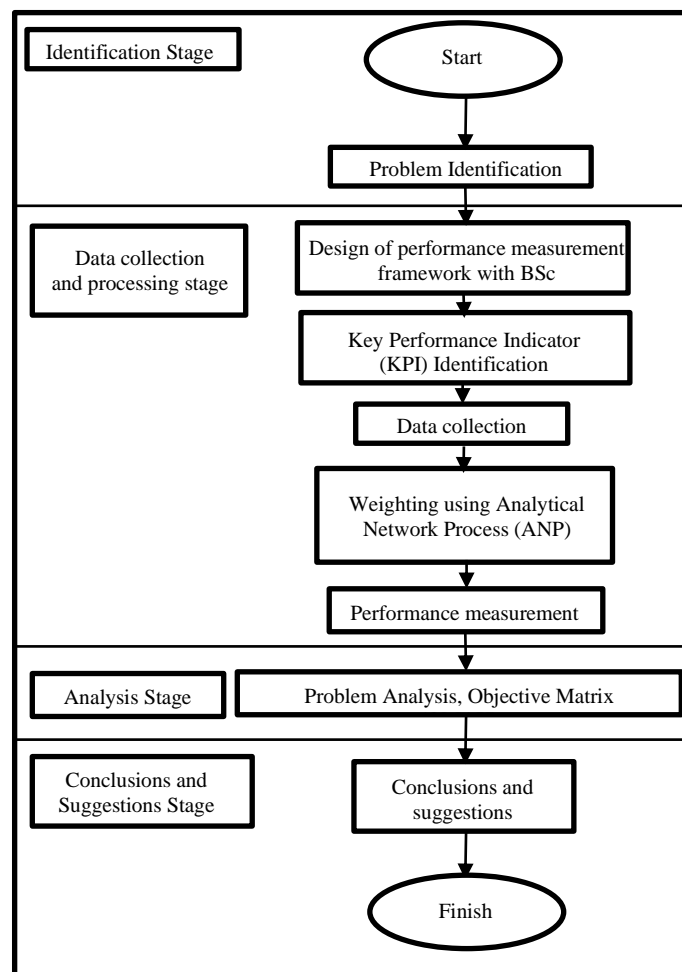


Figure 1. Research Flowchart

RESULT AND DISCUSSION

After going through various stages of this research, from the beginning to the end, the results can be presented as follows. The results of the validity test of the Key Performance Indicator (KPI) questionnaire reduced from 38 KPI to 21 KPI. The valid KPIs consist of 4 KPIs from a financial perspective, 3 KPIs from a customer perspective, 10 KPIs from an internal business process perspective, and 4 KPIs from an innovation and learning perspective. The results of the validated KPI recapitulation are used for weighting the KPI which will be used as a reference in the next stages.

Company Green Supply Chain Performance Measurement Results

Calculation of performance achievement is done by calculating each KPI. Performance values are obtained through Objective Matrix (OMAX) calculations by calculating data from a 2 year period, namely 2020 and 2021 and the achievement targets for each KPI. The benchmarking process is the process of comparing the actual condition of the company with a value, ideally using data from the company's competitors or with data from the previous period. The results of the recapitulation can be seen on the following [Table 1](#).

Table 1. Validated Key Performance Indicators (KPI)

No.	Code	Key performance indicator (KPI)
	F	Financial
1.	F1	Income and productivity ratio
2.	F2	The suitability of the rate of return on investment with the specified target
3.	F3	Suitability of costs for operational activities with the budget that has been set
4.	F4	Compatibility of costs for waste disposal/treatment with the set budget
	C	Customer
5.	C1	Distribution planning schedule effectiveness
6.	C2	Time or duration required for delivery
7.	C3	Number of free shipments defect/damage/complaint
	IB	Internal Business Process
8.	IB1	Integration with suppliers regarding waste management
9.	IB2	Ratio of use of organic animal feed
10.	IB3	Have suppliers and members with green knowledge or start moving towards "greening"
11.	IB4	The level of raw materials/environmentally friendly materials in the product
12.	IB5	The time required for production
13.	IB6	The suitability of the amount of output produced from production with the target
14.	IB7	Percentage reduction in inventory level from the previous period
15.	IB8	Waste reduction rate
16.	IB9	The suitability of inventory costs with the set budget.

No.	Code	Key performance indicator (KPI)
17.	IB10	Compatibility of the cost of environmental education to members/employees with the set budget
	IL	Inovation and Learning
18.	IL1	Number of environmental compliance auditing programs for employees
19.	IL2	Internal performance evaluation system includes environmental factors
20.	IL3	Frequency of training, counseling or education to employees/members regarding the environment
21.	IL4	Frequency of assistance on technical problem solving to suppliers (members)

After obtaining the results of the validated Key Performance Indicators (KPI), then weighting is carried out to obtain even more specific results. The results of this weighting are needed for the next stage

related to the Objective Matrix (OMAX). The results of the validated Key Performance Indicators (KPI) weighting can be seen in the next [table 2](#).

Table 2. Final Weighting Results Key performance Indicators (KPI)

Perspective	KPI	Weight	Total Weight
Financial	F1	0,37	0,11
	F2	0,17	0,05
	F3	0,31	0,09
	F4	0,15	0,04
Customer	C1	0,39	0,11
	C2	0,31	0,09
	C3	0,29	0,08
Internal Business Process	IB1	0,08	0,02
	IB2	0,04	0,01
	IB3	0,07	0,02
	IB4	0,10	0,03
	IB5	0,22	0,06
	IB6	0,17	0,05
	IB7	0,14	0,04
	IB8	0,04	0,01
	IB9	0,12	0,03
	IB10	0,03	0,01
Innovation and learning process	IL1	0,28	0,04
	IL2	0,25	0,04
	IL3	0,25	0,04
	IL4	0,23	0,04
Total			1,00

After going through the stages of the Validated Key Performance Indicators, and the Final Weighting Results Key Performance Indicator. Then the next step is to measure the performance of the green supply chain. The scoring system is carried out to see the performance achievements of the green supply chain. Calculation of performance achievement is done by calculating each KPI. Performance values are obtained through the calculation of the objective matrix by calculating data from the 2-year period, namely 2020 and 2021 as well as the achievement targets for each KPI.

The benchmarking process is the process of comparing the company's actual condition with a value, ideally using data from the company's competitors. Due to the difficult conditions for doing so, this research uses the company's internal targets and data for the previous period (2020) as a benchmark. From the results that shows in [table 1](#) and [table 2](#) about Key Performance Indicator validation and its weighting, we can then measuring the performance of the green supply chain and analyze the data using the objective matrix (OMAX). This objective matrix is a system that is used to measure partial productivity to monitor productivity in a company or only in certain parts.

Thus, in this study, measurement was carried out by evaluating several criteria accompanied by weighting with the aim of obtaining a total index used as a benchmark. OMAX has 4 schemes consisting of :

Part (A), the section that defines the indicators and achievements. This section consists of:

- a) indicators or criteria represented by Key performance indicators (KPI) as performance measures to be measured, and

- b) Performance, which is representative of the achievement of the company's performance at each KPI.

The quantification section consisting of levels or scores (B). The numbers that will show the level of performance from the measurement of each performance criterion. This level or score consists of 11 levels ranging from 0 to 10. The greater the translation, the better.

Part (B) is divided into 3 more parts, namely: a) the level that shows the lowest performance value, namely level 0, b) the level that shows the achievement value, and c) the level that shows the expected performance value, namely level 10.

Part (C), which consists of: a) level, filled in according to the KPI achievement level position, b) weight, filled in according to the weight of each KPI, c) value, which is the result of an assessment or multiplication between the level and the weight of each -each KPI.

Part (D), Index, namely the sum of all the values of each criterion that describes the performance achievement indicators of the company.

In addition to OMAX, Traffic Light System is used to analyze supply chain performance. This assessment method aims to facilitate the understanding of performance achievement, and is related to the scoring system. The Traffic Light System provides a mark on the scoring results which has a function to distinguish whether the KPI score requires improvement or not. The indicator is interpreted through the color according to the color of the traffic lights, namely green, yellow, and red.

- Red color, illustrates that the achievement of an indicator (KPI) has

not been achieved and is below the target that has been set. This red color also indicates the need for an improvement.

- The yellow color illustrates the achievement of an indicator (KPI) that has not reached the target but is close to the target set. So the company must increase vigilance for the possibility that will occur.
- While the green color illustrates that the achievement of indicators (KPI) has met the set targets.

The total achievement of the green supply chain performance in the Company shows how far the green supply chain achievement can be made by the company. Based on the results of calculations using the OMAX method and the Traffic Light System, it can be seen that the company's green supply chain performance gets a value of 8.70 which is in the green color category. The results of calculations can be seen in [Table 3](#).

Table 3. Company's Green Supply Chain Performance Value

No (A)	Perspective (B)	Perspective Weight (C)	KPI (D)	Level (E)	Total Weight (F)	Value (G=(Cx F))	Total Value (H)				
1	<i>Financial</i>	8,69	F1	7,33	0,11	0,92	2,51				
			F2	10,00	0,05	0,43					
			F3	6,32	0,09	0,78					
			F4	7,70	0,04	0,38					
2	<i>Customer</i>	10	C1	10,00	0,11	1,17	2,96				
			C2	10,00	0,09	0,93					
			C3	10,00	0,08	0,87					
			IB1	3,55	0,02	0,21					
			IB2	2,14	0,01	0,09					
			IB3	3,55	0,02	0,18					
3	<i>Internal Business Process</i>	8,76	IB4	10,00	0,03	0,24	2,45				
			IB5	10,00	0,06	0,53					
			IB6	10,00	0,05	0,41					
			IB7	10,00	0,04	0,34					
			IB8	10,00	0,01	0,10					
			IB9	4,17	0,03	0,28					
			IB10	0,17	0,01	0,07					
			4	<i>Innovation and learning</i>	4,85	IL1		10,00	0,04	0,22	0,78
						IL2		10,00	0,04	0,19	
						IL3		3,33	0,04	0,19	
IL4	5,00	0,04				0,17					
Total Index of Green Supply Chain Performance			8,70								

Based on data on [table 3](#), it can be seen that the achievement of a financial perspective is in the green category with a score of 8.69. Then the customer perspective is also in the green category with a score of 10. Likewise, the internal business process perspective is in the green category with a score of 8.76. This green category shows if the performance from the perspective of financial, customer, and internal business processes in the company's green supply chain has reached the target. Meanwhile, the perspective of the innovation and learning process is in the yellow category with a value of 4.85. These results indicate that its performance has not reached the performance targets set by the company [16].

From the results of the data analysis, what must be considered is the one in red, therefore it must be a priority to improve the company's supply chain key performance indicators. There are 4 KPIs in red, namely KPI Integration with suppliers regarding waste management (IB1), KPI Ratio for use of organic animal feed (IB2), KPI Having suppliers and members with environmentally friendly knowledge or starting to move towards "greening" (IB3), KPI Compatibility of environmental education costs to members/employees with the stipulated budget (IB10). It is necessary to study further the causes of not achieving the targets of each of the KPIs from the targets that have been set, so that recommendations for improvements can be given in accordance with the existing problems.

From these measurement results, we can refer back to the understanding that Green Supply Chain is a supply chain network designed by considering the environmental impacts that occur from

supply chain activities themselves. While green supply chain management is supply chain management that makes environmental issues an element to be integrated into the supply chain system in a company [17].

The presence of one element that has not reached the target indicates that green supply chain management is not optimal. The implication of still not achieving some of the targets can reduce supply chain performance in the long term. For this reason, contextual recommendations for improvement include, among others;

- a) The need for companies to provide special training on an ongoing basis to farmers and employees to work with environmental principles that are better than now,
- b) Need to find suppliers and increase the capacity of providing organic feed so that the need for organic feed for farmers is more adequate,
- c) Maximize budget absorption for conduct training and education as well as assistance for farmers to maintain consistency in the implementation of programs that are environmentally friendly.

Expanding the network for better relationship and mutual understanding among supply chain members (from up streams to down streams), and others such as government, academia, industry, media, and various other related communities.

CONCLUSION

In general, the company's green supply chain management performance is quite good because it is in the green category. However, there are still some performance indicators that have not reached the target, such as integration with suppliers regarding waste management, the use of

organic animal feed, having suppliers and members with environmentally friendly knowledge, and so forth. Based on that condition, improvements need to be made so that supply chain performance will be even better in the long term.

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