Performance Analysis Of Green Supply Chain Management Using AHP And OMAX Methods

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Abstract—The manufacturing industry in Indonesia has experienced significant growth, leading to a high level of urgency concerning environmental pollution. Currently, within the manufacturing sector, there is an increased emphasis on environmental protection and sustainable production, which has become a key priority for companies. One approach to preventing environmental pollution is the implementation of Green Supply Chain Management (GSCM). Based on these circumstances, this study was conducted with the objective of evaluating the performance level of Green Supply Chain Management at the company. The research adopts the Green SCOR model, using Analytical Hierarchy Process (AHP) for weighting and Objective Matrix (OMAX) for scoring. Data processing is carried out using five Green SCOR models: plan, source, make, deliver, and return, resulting in a total of 26 Key Performance Indicators (KPIs). Out of the 26 KPIs, 5 fall under the red category, 6 are categorized as yellow, and the remaining 15 are in the green category. The final performance score for Green SCM activities at the company is 7.890, which falls within the yellow category. This indicates an average performance level, where the achievement of the performance indicators has not yet reached the target, although it is nearing the desired goal.

Keywords—Green Supply Chain Management, Green SCOR, AHP, OMAX, Shipyard Industry.

I. INTRODUCTION

Awareness of environmental sustainability is increasingly rising worldwide. To protect the environment, governments in various countries have developed multiple approaches, including the implementation of strict ecological regulations, support for cleaner production practices, and the adoption of ISO 14001 standards. Today, in the manufacturing sector, the emphasis on environmental protection and sustainable production has become a key priority for companies. It has been observed that internal operations within manufacturing companies often lead to various environmental issues, which are also connected to upstream and downstream supply chain activities. To build a sustainable and environmentally friendly image, companies must reduce atmospheric pollution by actively collaborating with their vendors and customers to effectively implement the concept of Green Supply Chain Management (GSCM) [1].

PT. XYZ is a state-owned enterprise specializing in shipyard production. In its business model, PT. XYZ accepts projects from customers or owners and establishes contract agreements before commencing production or building a ship. The production process at PT. XYZ is highly complex, involving numerous variables such as machinery and materials. Although the company has adopted the Green Supply Chain Management (GSCM) concept, its implementation remains suboptimal. This is evidenced by waste management performance data, which indicates a performance rate below 70%. Based on PT XYZ's waste management data from March 2023 to March 2024, the company managed to process 61% of solid domestic waste, 66% of liquid domestic waste, and 80% of hazardous and toxic waste (B3). The average waste management rate across all types is 69%, which is considered average and inadequate. Although 100% of the waste could not be processed during this period, the remaining 31% was carried over for processing in the following period. Solid domestic waste includes production residues such as scrap materials, food waste, and used packaging. Liquid domestic waste originates from

wastewater from cleaning and kitchen activities, while B3 waste includes sandblasting residues, fluorescent lamps, used lubricants, and sludge. Beyond the production process, supply chain activities also contribute to waste generation. The company needs to evaluate its supply chain with environmental considerations in mind, including improvements in implementing Green Supply Chain Management (GSCM). However, PT XYZ has not yet conducted a performance assessment of its GSCM concept. Evaluating and improving GSCM performance would help the company enhance its environmental responsibility within its supply chain operations.

The performance measurement of Green Supply Chain Management (GSCM) employs the Green SCOR (GSCOR) model as a reference to determine the Key Performance Indicators (KPIs) to be assessed. The Analytical Hierarchy Process (AHP) method is utilized to assign weights to these performance indicators, while the Objective Matrix (OMAX) is applied to evaluate the achievement of each KPI through a scoring system. Additionally, recommendations for improvement will be proposed for underperforming indicators. Compared to other methods such as Analytic Network Process (ANP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), AHP is preferred due to its capability to address both measurable (quantitative) problems and subjective judgments effectively [2]. The OMAX method is chosen for its advantages in providing a more structured and quantitative measurement system, unlike other methods such as the Balanced Scorecard and the European Foundation for Quality Management (EFQM), which primarily focus on qualitative indicators. The integration of AHP and OMAX creates a performance evaluation system that not only quantitatively measures performance through OMAX but also considers the significance of each criterion using AHP [3]. This approach enables organizations to optimize resources, improve performance based on strategic priorities, and make more effective decisions using deeper insights derived from data. Additionally, the study aims to determine the steps that should be taken to enhance and improve the implementation of Green Supply Chain Management (GSCM) within the company.

A supply chain is a system through which an organization delivers its goods and services to its customers. This chain also functions as a network of interconnected organizations that share a common goal: to optimize the procurement or distribution of goods [4]. Supply Chain Management (SCM) is a management concept that governs the relationships between an organization and business units within a company concerning material suppliers, purchasing, production facilities, logistics, marketing, and other related systems [5]. The main goal of SCM is to enhance value, maximize profitability in an efficient manner, and achieve customer satisfaction. SCM involves overseeing and coordinating all activities at each stage of the supply chain, starting from customer demand, order processing, procurement of raw materials, production, packaging, delivery, to after-sales service. By effectively managing the supply chain, companies can improve customer satisfaction, enhance operational efficiency, reduce costs, and achieve sustainability in their business [6].

Green Supply Chain Management (GSCM) is a strategy focused on reducing the environmental impact of an organization and its supply chain, particularly in relation to climate change, pollution, and the use of non-renewable resources. It combines supply chain management with efforts to minimize the environmental effects throughout the product life cycle. Key activities include collaboration with suppliers and customers, analysis of internal operations, incorporating environmental considerations in product design, and ongoing monitoring throughout the product’s life cycle. The goal of the green supply chain is to consider the environmental impact of all products and processes, including the environmental effects arising from goods/products and processes, starting from raw materials to finished products, and final disposal [7]. The main aspect of the green supply chain is to improve performance in two areas: economic and environmental. The implementation of GSCM can reduce environmental pollution and increase the

efficiency of the company's supply chain. GSCM aims to eliminate waste in the supply chain, including energy, emissions, harmful chemical gases, and waste [8].

The concept of Green SCOR in the era of industrial transformation, which demands the role of industries in protecting 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, giving rise to new concerns such as energy conservation and pollution reduction in efforts to enhance competitive strategies. The Green SCOR model is an advanced version of the existing Green SCOR model, focusing on environmental factors. This model serves as a tool to manage the environmental impact of supply chain applications. Green SCOR includes five key assessment categories: Plan, Source, Make, Deliver, and Return. Additionally, Green SCOR has work attributes such as Reliability, Responsiveness, Flexibility, Cost, and Assets. However, in the Green SCOR model, all of these attributes carry different meanings because they are specifically linked to environmental considerations [9].

Performance refers to how a company provides services and ensures its sustainability in the future. Performance is used to measure the organization's progress in achieving targets from the previous period. This is done to identify which targets have been achieved and which still require effort to reach. Performance measurement is an important factor in a company [10]. It leads to performance improvement through necessary enhancements. Performance measurement is a reflection of the level of achievement in implementing a program to realize the company's goals, objectives, vision, and mission through strategic planning. Various performance measures and performance measurement tools have been developed. Environmental performance has become an increasing focus with the rising issue of sustainability. Environmental performance is defined as the company’s achievement in managing the interactions between its activities, products, or services and the environment. Environmental performance measures must be objective, accurate, and reliable to meet and represent the interests of stakeholders [11].

Key Performance Indicator (KPI) is a measure or indicator that provides information on how successful an organization is in achieving its strategic objectives [12]. KPIs are essential in determining the level of success a company has in reaching its goals. KPIs consist of a list of measurable company activities that serve as benchmarks for comparing one performance against another. The results from validated KPI measurements within a company are used for performance evaluation and improvement, as well as to indicate how well the company has met its set targets [13]. Key Performance Indicators (KPIs) can be classified into three main types based on the assessment method of their quality: Nominal the Better, Smaller the Better, and Larger the Better.

1.) Nominal the Better

Refers to a quality characteristic with values that can be either positive or negative. The value is measured against a target value, and achieving a value closer to the target indicates better quality.

2.) Smaller the Better

Refers to a measurable characteristic with non-negative values and an ideal value of zero. Achieving a value closer to zero indicates better quality.

3.) Larger the Better

Refers to a measurable characteristic with non-negative values and an ideal value of infinity. Achieving a value closer to infinity indicates better quality [14].

The Analytic Hierarchy Process (AHP) is a qualitative methodology used as a basis for research to analyze data. This method is considered simple and flexible, allowing creativity in designing solutions to problems. Weighting criteria and determining the priority of each criterion based on a pairwise comparison matrix are tasks frequently

performed using AHP [2]. Super Decisions Software is a software tool that supports collaborative decision-making and hardware systems that facilitate group decision-making more efficiently, analytically, and justifiably. It allows real-time interaction between management teams to achieve a consensus decision. The method used in the Super Decisions program is the Analytical Hierarchy Process (AHP), which serves as the structure for the entire decision-making process. It is a tool that facilitates collaboration among various stakeholders. The steps of the Super Decisions tool in making comparisons are as follows: a. Input Comparison Table. b. Calculate Relative Weights. c. Evaluate Consistency. d. Interpret Results [15].

Objective Matrix (OMAX) is a productivity calculation system conducted on a partial basis, developed to monitor the productivity of each part of an organization by considering productivity criteria relevant to each department's function [16]. The OMAX method measures productivity by assessing the performance of each part of the company objectively, while also identifying factors that may contribute to any decline in productivity. The advantages of the OMAX method in measuring company productivity include its relative simplicity and ease of understanding, the ability to perform periodic productivity calculations, and its potential to enhance company's efficiency in conducting production activities [17]. The Traffic Light System (TLS) is closely related to the scoring system. The Traffic Light System functions as a signal to indicate whether the KPI score requires improvement or not. The indicators of this traffic light system are represented by several colors: green (score 8-10), yellow (score 4-7), and red (score 0-3) [18].

There are previous studies aimed at measuring the performance level of green activities using the AHP and OMAX methods. One such study conducted in 2023 [19], titled "Designing a Green Supply Chain Management Performance Measurement Model at PT. Japfa Comfeed Lampung," found that the GSCM performance value was 5.87, which falls under the marginal category, indicating that the GSCM performance at PT Japfa Comfeed Lampung still requires closer monitoring and attention in order to improve. Another study conducted in 2022 [20], titled "Measurement of Supply Chain Management Performance Using the Supply Chain Operation Reference Method Based on Analytical Hierarchy Process (AHP) and Objective Matrix (OMAX)," also resulted in a GSCM performance value of 5.87, placing it in the marginal category, which suggests that the supply chain performance in SMEs studied still falls short of the target. A further study, conducted in 2022 [21] and titled "Evaluation of Green Warehouse Performance Indicators Using Analytical Hierarchy Process and Objective Matrix (Case Study: PLN Cilegon)," found that eight performance indicators for green warehouse concepts were identified: 2 were good, 3 were moderate, and 3 were poor. All three studies used the AHP and OMAX methods for measuring supply chain performance. Based on previous research, AHP and OMAX performance measurements have been conducted for companies with a make-to-stock manufacturing type. In this study, GSCM performance measurement is conducted for a company with a make-to-order manufacturing type, specifically in the shipbuilding industry.

II. RESEARCH METHOD

Dependent variable is a variable whose value depends on or is influenced by the independent variable. The dependent variable used is the performance level of Green Supply Chain Management. Independent variable is a variable that can influence the dependent variable and is the cause of the formation of the dependent variable. In this study, the independent variable is the data based on the Green SCOR model (Plan, Source, Make, Deliver, Return).

The problem-solving steps that can be used in this research to obtain the best results are described in the following flowchart:

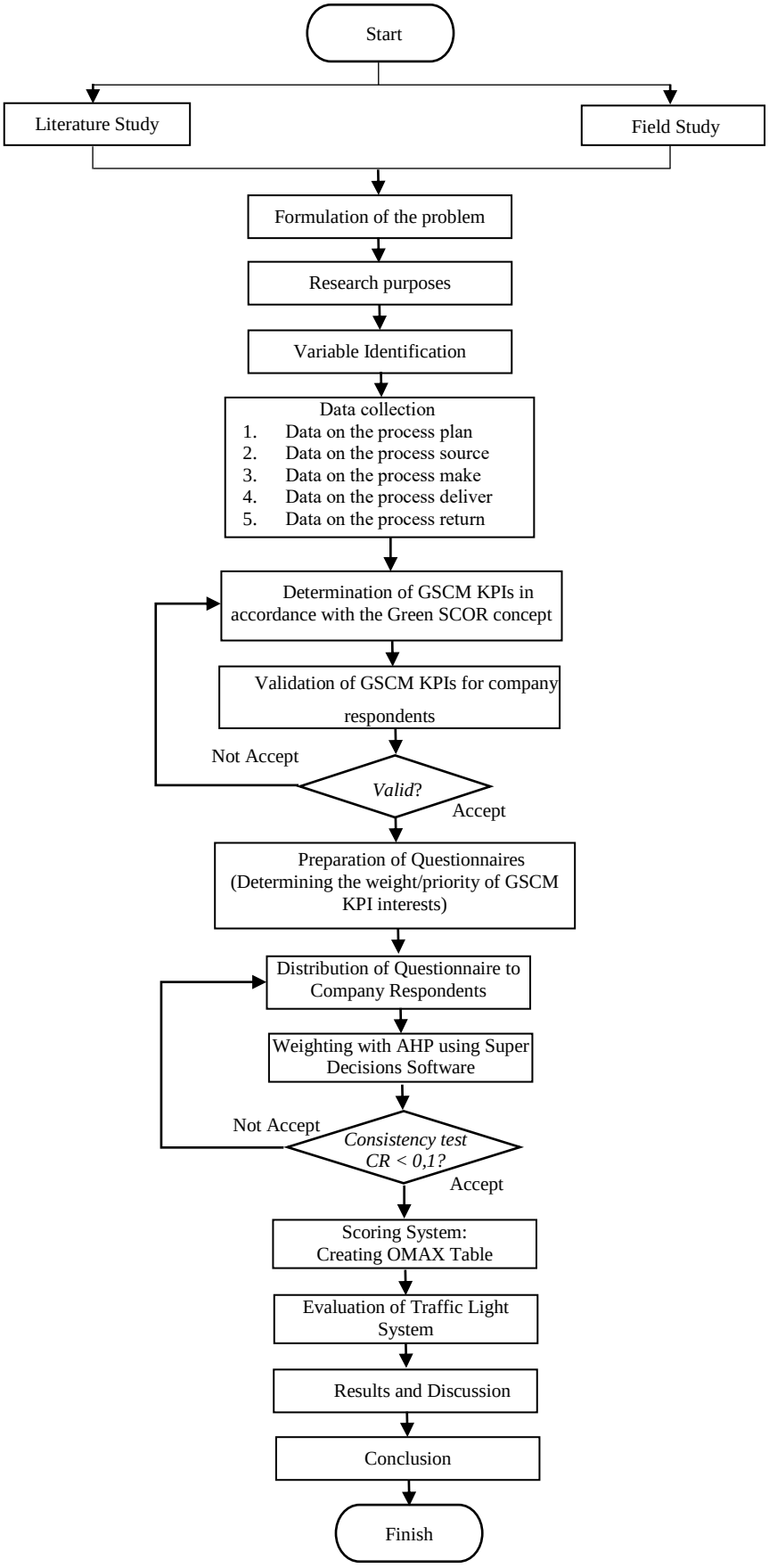

Figure 1. Research Flow

III. RESULT AND ANALYSIS

A. Validation of GSCM KPIs

The KPIs to be validated are based on the KPIs previously established (based on prior research). These KPIs will undergo a validation process by submitting the pre-determined indicators to the company, and the company will carry out the verification of these KPIs. The submission will be made in the form of a questionnaire and directed to the Chief Operating Officer (COO) of PT XYZ. Out of the 37 KPIs submitted, 26 KPIs were validated.

Table 1. Key Performance Indicators

Process	Dimension	Code	KPI Types	KPI
Plan	Reliability	P.1.1	Larger the better	Availability of mission statements on sustainability aspects
		P.1.2	Larger the better	Availability of process optimization for waste reduction
		P.1.3	Larger the better	Existence of internal regulations for the use of renewable energy
		P.1.4	Larger the better	Availability of waste management schemes
	Responsiveness	P.2.1	Larger the better	Availability of environmental audit systems
		P.2.2	Larger the better	Availability of environmental evaluation schemes
	Flexibility	P.3.1	Larger the better	Availability of internal environmental award systems
	Assets	P.4.1	Larger the better	Existence of Standard Operating Procedures (SOPs) related to environmental aspects in the production process
Source	Reliability	S.1.1	Smaller the better	Amount of hazardous materials in inventory
	Responsiveness	S.2.1	Larger the better	Percentage of suppliers certified with ISO 14001
		S.2.2	Larger the better	Percentage of suppliers meeting the agreed-upon environmental criteria
Make	Reliability	M.1.1	Smaller the better	Percentage of product defect rates
		M.1.2	Smaller the better	Level of gas emissions produced
		M.1.3	Smaller the better	Amount of scrap material generated during production
		M.1.4	Smaller the better	Level of hazardous waste produced
		M.1.5	Smaller the better	Percentage of environmental regulation violations
	Responsiveness	M.2.1	Larger the better	Percentage of divisions participating in environmental management training
	Assets	M.4.1	Smaller the better	Total electricity consumption within a year
		M.4.2	Smaller the better	Total water usage within a year
Deliver	Reliability	D.1.1	Larger the better	Percentage of completeness in product delivery documentation
	Responsiveness	D.2.1	Larger the better	Percentage of on-time product delivery performance by the company
		D.2.2	Larger the better	Percentage of product deliveries without defects
Return	Reliability	R.1.1	Larger the better	Amount of non-product output reused
		R.1.2	Larger the better	Amount of scrap material that can be recycled
	Responsiveness	R.2.1	Smaller	Percentage of defective material returns to suppliers

Process	Dimension	Code	KPI Types	KPI
			the better	
		R.2.2	Larger the better	Percentage of hazardous waste stored

B. Weighting with AHP using Super Decisions Software

The weighting of the level of importance is carried out with the help of Super Decisions software, which uses a measurement model similar to the Analytic Hierarchy Process (AHP) method. The weighting is divided into 3 categories according to the levels of the AHP matrix. Level 1 refers to the weighting of processes, including the processes of plan, source, make, deliver, and return. Level 2 refers to the weighting of dimensions, including reliability, responsiveness, flexibility, and assets. Level 3 refers to the GSCM performance indicators in the form of Key Performance Indicators (KPIs), with weighting applied to the KPIs validated by the company. In the final weight calculation, the three weights that have been determined using the Super Decisions software are multiplied. These three weights are the Level 1 (process) weight, Level 2 (dimension) weight, and Level 3 (KPI) weight. The final weight calculation can be seen in Table 2 below:

Table 2. Final Weight Calculation Based on the Green SCOR Matrix

Process (Level 1)	Weight	Dimension (Level 2)	Weight	KPI (Level 3)	Weight	Final Weight
Plan	0,45197	Reliability	0,30904	P.1.1	0,35031	0,048930
				P.1.2	0,26198	0,036592
				P.1.3	0,12528	0,017498
				P.1.4	0,26244	0,036656
		Responsiveness	0,33141	P.2.1	0,66667	0,099856
				P.2.2	0,33333	0,049928
		Flexibility	0,06458	P.3.1	1,00000	0,029187
		Assets	0,29498	P.4.1	1,00000	0,133321
Source	0,14783	Reliability	0,39583	S.1.1	1,00000	0,058516
		Responsiveness	0,60417	S.2.1	0,34167	0,030516
				S.2.2	0,65833	0,058798
Make	0,23735	Reliability	0,59791	M.1.1	0,35442	0,050297
				M.1.2	0,11471	0,016279
				M.1.3	0,12067	0,017124
				M.1.4	0,22672	0,032173
				M.1.5	0,18349	0,026039
		Responsiveness	0,18086	M.2.1	1,00000	0,042925
		Assets	0,22123	M.4.1	0,52083	0,027348
				M.4.2	0,47917	0,025160
Deliver	0,08122	Reliability	0,62500	D.1.1	1,00000	0,050761
		Responsiveness	0,37500	D.2.1	0,56250	0,017132
				D.2.2	0,43750	0,013325
Return	0,08165	Reliability	0,37500	R.1.1	0,69792	0,021369
				R.1.2	0,30209	0,009249
		Responsiveness	0,62500	R.2.1	0,21667	0,011057
				R.2.2	0,78333	0,039974
Total	1,0000		5,00000			1,0000

Based on Table 2, each process, dimension, and performance indicator has its respective weight. The final weight is obtained by multiplying these three weights. Then, the final weights are summed up, resulting in a total of 1.

C. Scoring System using OMAX

The scoring system is used to normalize the scale of each KPI, allowing the company to assess and determine the achievement level of each performance indicator using a value range from 0 to 10. In this system, the highest achievement for each KPI is assigned a value of 10, reflecting the optimal performance target expected. A value of 3 represents

average performance, while a value of 0 indicates the lowest performance or a condition that does not meet the standards. In the objective matrix (OMAX) model, it is necessary to determine performance, realistic targets, averages, and the worst achievement within the objective matrix (OMAX). Performance refers to the most recent data from the entire period. The realistic target is the value or achievement target the company aims to reach, or the best data based on each KPI type from the 12 periods. The average is the data representing the average value from those 12 periods, and the worst achievement is the lowest value based on each KPI type from those 12 periods. To clarify, here is a table using OMAX to determine performance, realistic target, and the average of 12 historical data points (or total subjects), the worst achievement, and the scale from highest to lowest.

The performance value is determined from the most recent data derived from historical data. Meanwhile, the realistic target is determined based on the best data value from the historical data average. To determine the worst achievement, it is based on the lowest achievement recorded in the company's historical data. After determining the performance, realistic target, average, and worst achievement, the next step is to determine the scale from highest to lowest by scoring using OMAX (Objective Matrix). The purpose is to assess the achievement of each KPI target for a specific period using a range of 0-10 for each KPI. The results of the Objective Matrix (OMAX) and Traffic Light System (TLS) for all KPIs can be seen in the following table:

Table 3. Objective Matrix on Plan Perspective

KPI Type		Plan							
KPI Code		P.1.1	P.1.2	P.1.3	P.1.4	P.2.1	P.2.2	P.3.1	P.4.1
Performance		1	1	1	1	1	1	1	1
Realistic Target	10	1	1	1	1	1	1	1	1
	9	1	1	1	1	1	1	1	1
	8	1	1	1	1	1	1	1	1
	7	1	1	1	1	1	1	1	1
	6	1	1	1	1	1	1	1	1
	5	1	1	1	1	1	1	1	1
	4	1	1	1	1	1	1	1	1
Average Value	3	1	1	1	1	1	1	1	1
	2	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1
Worst Performance	0	1	1	1	1	1	1	1	1
Score		10	10	10	10	10	10	10	10
Weight		0,0489	0,0366	0,0175	0,0367	0,0999	0,0499	0,0292	0,1333
Value		0,489	0,366	0,175	0,367	0,999	0,499	0,292	1,333
Total									4,52

Based on Table 3, it is known that for KPI P.1.1 (Availability of mission statement on sustainability aspects), a score of 10 with an achievement value of 1 was obtained, placing it in the green category. For KPI P.1.2 (Availability of process optimization for waste reduction), a score of 10 with an achievement value of 1 was obtained, placing it in the green category. For KPI P.1.3 (Existence of internal regulations for the use of renewable energy), a score of 10 with an achievement value of 1 was obtained, placing it in the green category. For KPI P.1.4 (Availability of waste management schemes), a score of 10 with an achievement value of 1 was obtained, placing it in the green category. For KPI P.2.1 (Availability of environmental audit systems), a score of 10 with an achievement value of 1 was obtained, placing it in the green category. For KPI P.2.2 (Availability of environmental evaluation schemes), a score of 10 with an achievement value of 1 was obtained, placing it in the green category. For KPI P.3.1 (Availability of internal environmental award systems), a score of 10 with an achievement value of 1 was obtained, placing it in the green category. For KPI P.4.1 (Existence of SOPs related to

environmental aspects in the production process), a score of 10 with an achievement value of 1 was obtained, placing it in the green category.

Table 4. Objective Matrix on Source Perspective

KPI Type		Source		
KPI Code		S.1.1	S.2.1	S.2.2
Performance		1432	31%	26%
Realistic Target	10	781,2	45%	32%
	9	892,0	44%	31%
	8	1002,8	42%	30%
	7	1113,6	41%	29%
	6	1224,3	40%	27%
	5	1335,1	39%	26%
	4	1445,9	37%	25%
Average Value	3	1556,7	36%	24%
	2	1818,6	33%	22%
	1	2080,5	29%	19%
Worst Performance	0	2342,4	26%	17%
Score		4	1	5
Weight		0,0585	0,0305	0,0588
Value		0,234	0,031	0,294
Total				0,559

Based on Table 4, it is known that for KPI S.1.1 (Amount of hazardous materials in inventory), a score of 4 with an achievement value of 1423 was obtained, placing it in the yellow category. For KPI S.2.1 (Percentage of suppliers certified with ISO 14001), a score of 1 with an achievement value of 31% was obtained, placing it in the red category. For KPI S.2.2 (Percentage of suppliers meeting the agreed-upon environmental criteria), a score of 5 with an achievement value of 26% was obtained, placing it in the yellow category.

Table 5. Objective Matrix on Make Perspective

KPI Type		Make							
KPI Code		M.1.1	M.1.2	M.1.3	M.1.4	M.1.5	M.2.1	M.4.1	M.4.2
Performance		0,03%	30,87	15	41,4	0%	100%	107120	10100
Realistic Target	10	0,01%	9,2	8,0	10,0	0%	100%	96630	8819
		0,02%	12,8	9,1	14,8	0%	100%	99116,1	9039,8
		0,026%	16,4	10,1	19,5	0%	100%	101602,3	9260,6
		0,034%	20,0	11,2	24,3	0%	100%	104088,4	9481,4
		0,04%	23,7	12,3	29,1	0%	100%	106574,5	9702,1
		0,05%	27,3	13,4	33,8	0%	100%	109060,6	9922,9
		0,06%	30,9	14,4	38,6	0%	100%	111546,8	10143,7
Average Value	3	0,07%	34,5	15,5	43,4	0%	100%	114032,9	10364,5
		0,09%	56,5	17,3	62,9	0%	100%	120783,6	10837,3
		0,11%	78,5	19,2	82,5	0%	100%	127534,3	11310,2
Worst Performance	0	0,13%	100,5	21,0	102,0	0%	100%	134285	11783
Score		8	4	3	3	10	10	5	4
Weight		0,0503	0,0163	0,0171	0,0322	0,0260	0,0429	0,0273	0,0252
Value		0,4024	0,0651	0,0514	0,0965	0,2604	0,4293	0,1367	0,1006
Total									1,542

Based on Table 5, it is known that for KPI M.1.1 (Percentage of product defect rate), a score of 8 with an achievement value of 0.03% was obtained, placing it in the green category. For KPI M.1.2 (Level of gas emissions produced), a score of 4 with an achievement value of 30.87 was obtained, placing it in the yellow category. For KPI M.1.3 (Amount of scrap material produced during production), a score of 3 with an achievement value of 15 was obtained, placing it in the red category. For KPI M.1.4 (Level of hazardous waste produced), a score of 3 with an achievement value of 41.4 was obtained, placing it in the red category. For KPI M.1.5 (Percentage of environmental regulation violations), a score of 10 with an achievement value of 0% was obtained,

placing it in the green category. For KPI M.2.1 (Percentage of divisions attending environmental management training), a score of 10 with an achievement value of 100% was obtained, placing it in the green category. For KPI M.4.1 (Total electricity consumption in one year), a score of 5 with an achievement value of 107120 was obtained, placing it in the yellow category. For KPI M.4.2 (Total water consumption in one year), a score of 4 with an achievement value of 10100 was obtained, placing it in the yellow category.

Table 6. Objective Matrix on Deliver Perspective

KPI Type		*Deliver*		
KPI Code		D.1.1	D. 2.1	D. 2.2
Performance		100%	10 0%	10 0%
Realistic Target	10	100%	10 0%	10 0%
	9	100%	99 ,8%	10 0%
	8	100%	99 ,6%	10 0%
	7	100%	99 ,4%	10 0%
	6	100%	99 ,1%	10 0%
	5	100%	98 ,9%	10 0%
	4	100%	98 ,7%	10 0%
Average Value	3	100%	98 ,5%	10 0%
	2	100%	97 ,0%	10 0%
	1	100%	95 ,5%	10 0%
Worst Performance	0	100%	94 ,0%	10 0%
Score		10	10	10
Weight		0,0507	0, 0171	0, 0133
Value		0,5076	0, 1713	0, 1332
Total				0, 812

Based on Table 4.28 above, it is known that for KPI D.1.1 (Percentage of completeness of product delivery documents), a score of 10 with an achievement value of 100% was obtained, placing it in the green category. For KPI D.2.1 (Percentage of on-time product delivery performance by the company), a score of 10 with an achievement value of 100% was obtained, placing it in the green category. For KPI D.2.2 (Percentage of product deliveries without defects), a score of 10 with an achievement value of 100% was obtained, placing it in the green category.

Table 7. Objective Matrix on Return Perspective

KPI Type		Return			
KPI Code		R.1.1	R.1.2	R.2.1	R.2.2
Performance		532	45%	7%	92%
Realistic Target	10	936	75,0%	3,0%	95,0%
	9	860,4	71,3%	3,6%	93,3%
	8	784,9	67,5%	4,3%	91,6%
	7	709,3	63,8%	4,9%	89,9%
	6	633,8	60,1%	5,5%	88,2%

KPI Type		Return			
KPI Code		R.1.1	R.1.2	R.2.1	R.2.2
	5	558,2	56,4%	6,2%	86,5%
	4	482,6	52,6%	6,8%	84,9%
Average Value	3	407,1	48,9%	7,4%	83,2%
	2	314,1	40,3%	9,3%	77,8%
	1	221,0	31,6%	11,1%	72,4%
Worst Performance	0	128	23,0%	13,0%	67,0%
Score		4	2	3	8
Weight		0,0214	0,0092	0,0111	0,0400
Value		0,0855	0,0185	0,0332	0,3198
Total					0,457

Based on Table 4.29 above, it is known that for KPI R.1.1 (Amount of non-product output returned to the process through reuse), a score of 4 with an achievement value of 532 was obtained, placing it in the yellow category. For KPI R.1.2 (Percentage of scrap material that can be recycled), a score of 2 with an achievement value of 45% was obtained, placing it in the red category. For KPI R.2.1 (Percentage of defective material returned to the supplier), a score of 3 with an achievement value of 7% was obtained, placing it in the red category. For KPI R.2.2 (Percentage of hazardous waste stored out of the total produced), a score of 8 with an achievement value of 92% was obtained, placing it in the green category.

D. Calculation of the Final Value of Green Supply Chain Management Performance

From the results of the performance measurement system design, key performance indicators (KPIs) and their respective weights were obtained through the Analytic Hierarchy Process (AHP) method using Super Decision software. The next step is to conduct measurement or assessment (scoring) using the Objective Matrix (OMAX) method. In calculating the final performance of Green Supply Chain Management (GSCM), the Traffic Light System is used to compare the targets with the company's actual performance. This system classifies performance into three color categories: green, yellow, and red, each of which has a different meaning. Based on the references in the literature review chapter, the green category reflects a score of 8–10, indicating satisfactory performance; the yellow category shows a score of 4–7, indicating average or marginal performance; and the red category represents a score of 0–3, indicating unsatisfactory performance.

Table 7. Performance Results GSCM Performance with Traffic Light System

No	**Key Performance Indicators**	**Code**	**Scoring Result**		
			Weight	**Score**	**Value**
1	Availability of mission statements on sustainability aspects	P.1.1	0,0489	10	0,489
2	Availability of process optimization for waste reduction	P.1.2	0,0366	10	0,366
3	Existence of internal regulations for the use of renewable energy	P.1.3	0,0175	10	0,175
4	Availability of waste management schemes	P.1.4	0,0367	10	0,367
5	Availability of environmental audit systems	P.2.1	0,0999	10	0,999
6	Availability of environmental evaluation schemes	P.2.2	0,0499	10	0,499
7	Availability of internal environmental award systems	P.3.1	0,0292	10	0,292
8	Existence of Standard Operating Procedures (SOPs) related to environmental aspects in the production process	P.4.1	0,1333	10	1,333
9	Amount of hazardous materials in inventory	S.1.1	0,0585	4	0,234
10	Percentage of suppliers certified with ISO 14001	S.2.1	0,0305	1	0,031
11	Percentage of suppliers meeting the agreed-upon environmental criteria	S.2.2	0,0588	5	0,294
12	Percentage of product defect rates	M.1.1	0,0503	8	0,402
13	Level of gas emissions produced	M.1.2	0,0163	4	0,065

14	Amount of scrap material generated during production	M.1.3	0,0171	3	0,051
15	Level of hazardous waste produced	M.1.4	0,0322	3	0,097
16	Percentage of environmental regulation violations	M.1.5	0,0260	10	0,260
17	Percentage of divisions participating in environmental management training	M.2.1	0,0429	10	0,429
18	Total electricity consumption within a year	M.4.1	0,0273	5	0,137
19	Total water usage within a year	M.4.2	0,0252	4	0,101
20	Percentage of completeness in product delivery documentation	D.1.1	0,0508	10	0,508
21	Percentage of on-time product delivery performance by the company	D.2.1	0,0171	10	0,171
22	Percentage of product deliveries without defects	D.2.2	0,0133	10	0,133
23	Amount of non-product output reused	R.1.1	0,0214	4	0,085
24	Amount of scrap material that can be recycled	R.1.2	0,0092	2	0,018
25	Percentage of defective material returns to suppliers	R.2.1	0,0111	3	0,033
26	Percentage of hazardous waste stored	R.2.2	0,0400	8	0,320
Total Value of GSCM Performance Analysis					7,890

From the results obtained in Table 7, it can be seen that out of 26 KPIs, 5 of them fall into the red category, 6 are in the yellow category, and 15 are in the green category. The total value resulting from the green supply chain performance analysis at the company is 7.890, which falls into the yellow category (marginal). Based on the value, it can be concluded that the company's GSCM performance falls into the yellow category, indicating that the performance indicators have not been fully achieved, although the values are close to the target. The performance indicators in the red and yellow categories need improvement to enhance the company's GSCM performance. However, the primary focus for improvement should be on the performance indicators in the red category, as their achievement is far below the target. If these indicators are not promptly addressed, it could lead to a decline in GSCM performance and negatively affect production activities. Meanwhile, the performance indicators in the green category, which show good results, should be maintained or even improved to ensure the sustainability of the company's performance.

IV. CONCLUSION

Based on the research results, the performance level of Green Supply Chain Management (GSCM) at PT. XYZ achieved a final score of 7.890 out of 10, which falls into the yellow or marginal (average) category. Out of the total 26 KPIs, 5 indicators are in the red category, 6 indicators are in the yellow category, and 15 indicators are in the green category. The red indicators include the percentage of ISO 14001 certified suppliers (S.2.1), the amount of scrap material produced during production (M.1.3), the amount of hazardous waste generated (M.1.4), the amount of non-product output reused (R.1.1), and the percentage of recyclable scrap material (R.1.2). The yellow indicators include the amount of hazardous materials in inventory (S.1.1), the percentage of suppliers meeting environmental criteria (S.2.2), gas emissions (M.1.2), annual electricity consumption (M.4.1), annual water usage (M.4.2), and the percentage of defective material returned to suppliers (R.2.1).

Improvement recommendations need to be made for these indicators to enhance the performance of the company's GSCM, considering that the performance of these indicators has not fully met the targets, although the values are close to the objectives. Improvement recommendations are focused on the red and yellow category indicators, especially those related to the source, make, and return processes. Improvements can be

made by establishing rules or standard operating procedures (SOPs) that apply to all supply chain activities, from suppliers to employees at PT. XYZ. Additionally, a comprehensive evaluation of the supply planning and production processes is crucial, as most of the issues stem from the lack of evaluation and oversight. By implementing these recommendations, it is expected that the company can improve its GSCM performance to reach a better target and achieve a satisfactory category.

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