Performance Measurement Analysis of Sustainable Supply Chain Management Using the AHP-Based SCOR Method and OMAX at PT XYZ

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Abstract
The manufacturing industry faces many challenges in continuing to compete with its competitors. These challenges come from various aspects, namely economic, social, and environmental. One approach to fixing this problem is to use effective SCOR, AHP, and OMAX methods. PT XYZ is a sugar company that has never measured sustainable supply chain performance. In connection with this, many studies have measured the performance of the sustainable supply chain. This research aims to improve the performance of Sustainable Supply Chain Management (SSCM) in production activities carried out by PT. XYZ so that the production process runs well and still pays attention to the sustainability aspects that must be implemented. A total of nineteen key performance indicators (KPIs) were generated by the five SCOR models used in data processing (plan, source, make, deliver, and return). There are seventeen key performance indicators with green indicators and two yellow indicators. With a final score of 8,022 on the sustainable supply chain performance level, this value is included in the green category which shows the company has successfully implemented the concept of sustainability in its business line.

***Keywords*:** *AHP, OMAX, SCOR, Sustainable Supply Chain.*

Abstrak
Industri manufaktur memiliki banyak tantangan untuk terus bersaing dengan kompetitornya. Tantangan tersebut terdapat dari berbagai aspek yaitu ekonomi, sosial, dan lingkungan. salah satu pendekatan untuk memperbaiki masalah ini dengan menggunakan metode SCOR, AHP, dan OMAX yang efektif. PT XYZ merupakan perusahaan gula yang belum pernah melakukan pengukuran kinerja sustainable supply chain. Sehubungan dengan hal ini, banyak penelitian yang melakukan pengukuran kinerja sustainable supply chain. Sebanyak sembilan belas indikator kinerja utama (KPI) dihasilkan oleh lima model SCOR yang digunakan dalam pemrosesan data (plan, source, make, deliver, dan return). Terdapat tujuh belas indikator kinerja utama dengan indikator

warna hijau dan dua indikator warna kuning. Dengan skor akhir 8,022 pada tingkat kinerja sustainable supply chain, nilai ini masuk pada kategori hijau yang menunjukkan perusahaan berhasil menerapkan konsep keberlanjutan pada lini bisnisnya.

Keywords*: *AHP, OMAX, SCOR, Sustainable Supply Chain.

1. Introduction

The manufacturing industry faces many challenges in continuing to compete with its competitors. These challenges come from various aspects, namely economic, social, and environmental. With these challenges, companies must have a strategy to maintain their competitiveness over time (Warella et al., 2021). Supply chain management involves upstream and downstream business activities (Immawan & Nugraha, 2020). Sustainable supply chain management will process the flow of stock, knowledge, capital, and collaboration from stakeholders in following sustainable practices to improve desired outcomes (Singh & Maheswaran, 2024). In creating sustainable cooperation, innovation is needed to develop network integration in the supply chain that pays attention to company profits and environmental, economic, and social responsibility. This activity is called Sustainable Supply Chain Management (SSCM) (Adriant et al., 2021). SSCM steps involve all the links, such as selecting environmentally friendly raw materials, planning products that can be recycled, and applying technology that supports energy efficiency (Suwanda, 2023).

PT XYZ is a sugar factory in East Java with the main products of crystal sugar and molasses. In the 2023 milling season, crystal sugar production decreased by 13% from the 2023 Company Budget Work Plan (RKAP). The decline occurred due to a shortage of the primary raw material, namely sugar cane, so it could not meet high consumer demand because sugar is one of the basic needs. From an economic perspective, this problem results in much unmet demand due to production shortages and affects PT XYZ's profits. In addition, from an environmental aspect, the production activities carried out by PT XYZ produce liquid waste in the form of process wastewater, air waste (emissions) that occur due to boiler exhaust gas, and B3 waste (toxic and hazardous materials). When viewed from a social perspective, PT XYZ has a production room that can potentially cause work accidents. It has a high production area and fairly hot room temperature, especially in the sugar crystallization line, and lacks safety on unsafe floors.

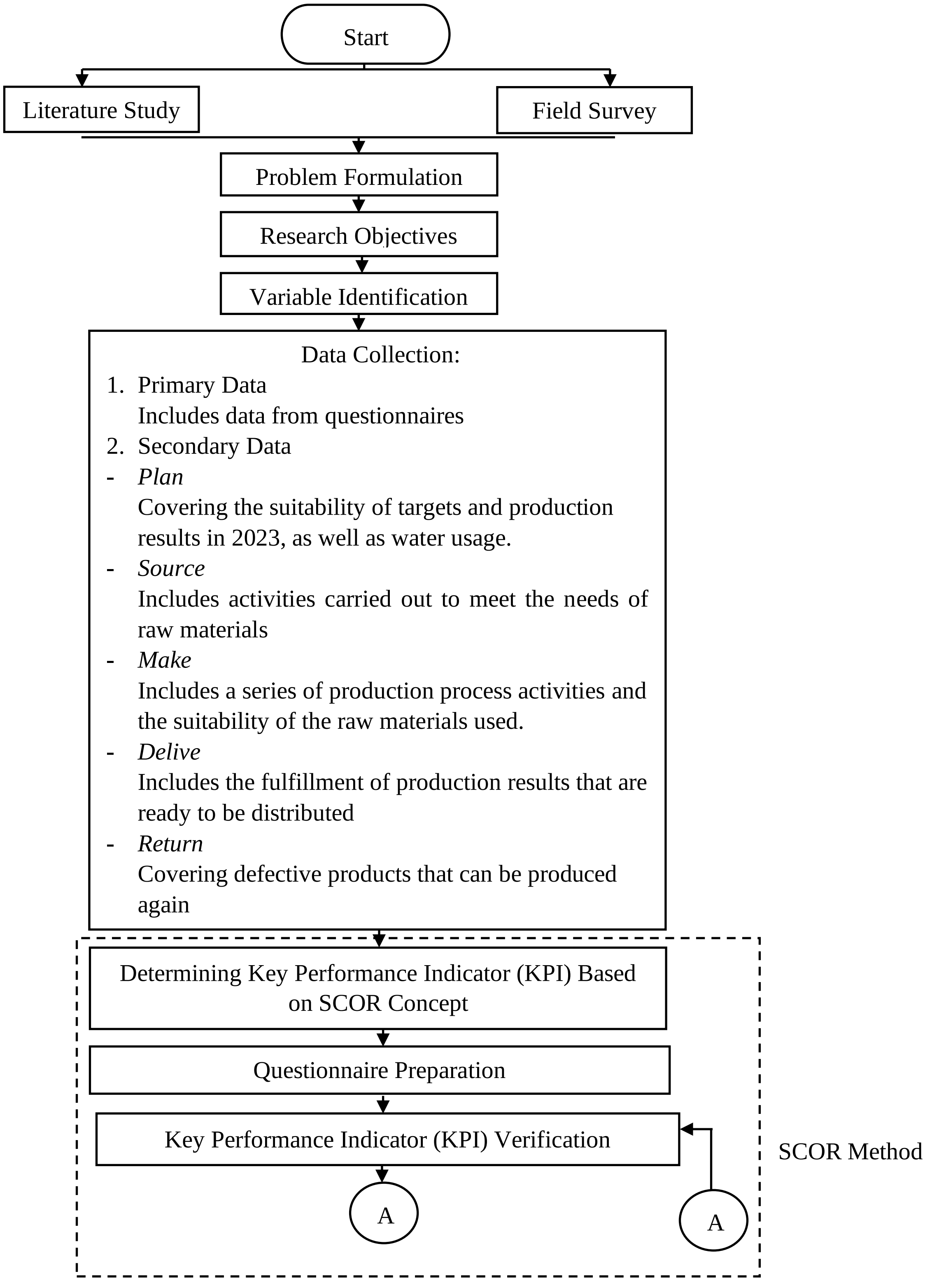
This needs to be an important concern for PT XYZ to pay attention to the sustainability system. Therefore, a sustainable holistic approach is required, which is known as the Sustainable Supply Chain Management (SSCM) concept. A sustainable supply chain aims to integrate economic, environmental, and social objectives into an organization through orderly coordination of business processes to improve business and profitability (Nugraha et al., 2019). This will involve strategic thinking to integrate sustainability practices in every process chain, from planning and procurement of raw materials to production, distribution, and waste treatment (Solehudin et al., 2023). The SCOR Method can be used to overcome the challenges of implementing the SSCM system in the company (Yusliana & Abdulrahim, 2023). Supply Chain Operations Reference (SCOR) divides the supply chain process into five core processes: plan, source, make, deliver, and return (Zulfikar & Ernawati, 2020). This method was chosen to evaluate and improve the company's overall supply chain performance. In addition, the Analytical Hierarchy Process (AHP) method is also used to solve decision-making problems (Felice & Petrillo, 2023). The advantage of this method is that it provides a single model that is easy to understand and is flexible for a diversity of structured problems. This method aims to give weight to each matrix so that it is known which performance attributes are most important in supporting the effectiveness of SSCM (Putri & Rukmayadi, 2022). In SSCM, productivity measurement is also done using the Objective Matrix. It is a partial measurement method to monitor productivity in each part of the company (Revaldiwansyah & Ernawati, 2021). OMAX has the advantages of being relatively simple, easy to obtain data, and more flexible (Cahyawati, 2021), and able to evaluate performance based on indicators determined to improve the performance process (Ramayanti et al., 2020).

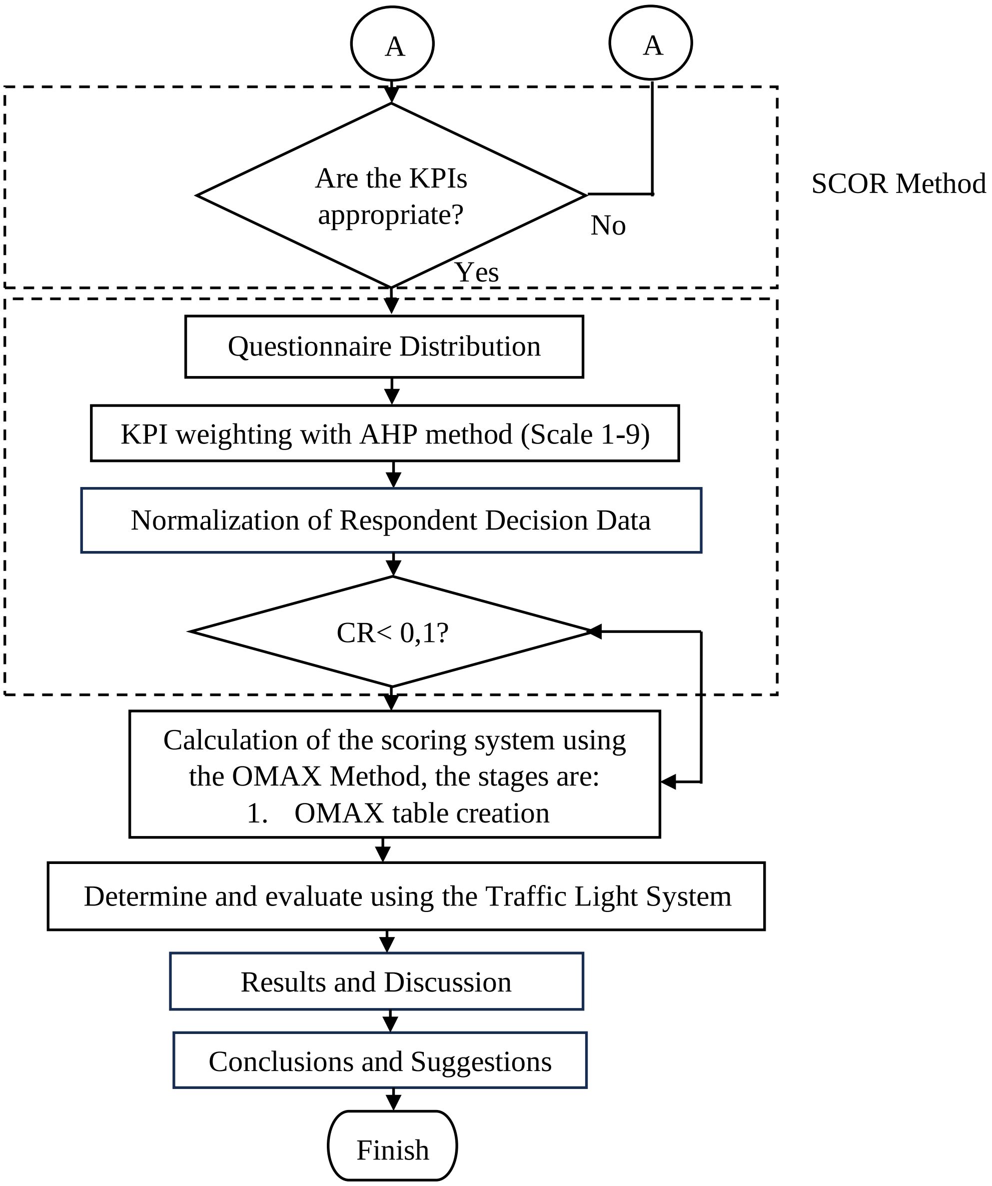
Using the AHP-based SCOR method and OMAX is hoped to help companies improve the performance of Sustainable Supply Chain Management (SSCM). In addition, the use of the SCOR and OMAX methods is expected to provide an overview of the proposed improvements that the company needs to make to improve the performance of Sustainable Supply Chain Management (SSCM). That way, this research aims to improve the performance of Sustainable Supply Chain Management (SSCM) in the production activities carried out by PT. XYZ so that the production process runs well and still pays attention to the aspects of sustainability that need to be applied.

2. Method

2.1 Research Flow

The methodology in this study consists of explaining the research flow. Figure 1 explains the steps of this research.


Start
Literature Study
Field Survey
Problem Formulation
Research Objectives
Variable Identification
Data Collection:
1. Primary Data
Includes data from questionnaires
2. Secondary Data
- Plan
Covering the suitability of targets and production results in 2023, as well as water usage.
- Source
Includes activities carried out to meet the needs of raw materials
- Make
Includes a series of production process activities and the suitability of the raw materials used.
- Delive
Includes the fulfillment of production results that are ready to be distributed
- Return
Covering defective products that can be produced again
Determining Key Performance Indicator (KPI) Based on SCOR Concept
Questionnaire Preparation
Key Performance Indicator (KPI) Verification
A
A
SCOR Method



Source: Research Flow, 2024
Figure 1. Flowchart

2.2 AHP Method

This research will use company data from 2023, which will be processed using the AHP-based SCOR method and OMAX. Data collection involves observation, interviews, and questionnaire distribution. After identifying and validating KPIs, weighting and consistency checks are carried out on them. Weighting is done using the AHP method using a scale with an importance level of 1-9.

Level 1 = Two elements have the same importance
Level 3 = One element is slightly more important than the other
Level 5 = One element is more important than the other
Level 7 = One element is more important than the other
Level 9 = One element is more important than the other

Level 2,4,8 = Centre value

To determine the Maximum eigenvalue (max), the normalized eigen Vector is calculated by summing each row and dividing by the number of criteria. Next, calculate the Consistency Index (CI), with the formula:

$$CI = \frac{(\lambda \text{max} - n)}{(n-1)} \tag{1}$$

$$\lambda \text{ max} = (\text{total weighting criteria}_1 \times \text{eigen value}_1) + (\text{total weighting criteria}_n \times \text{eigen value}_n) \tag{2}$$

$$CR = \frac{CI}{IR} \tag{3}$$

Description:
CR: Consistency Ratio
CI: Consistency Index
IR: Index Random Consistency
n: Number of elements being compared

On a scale of 1-9, for several orders of matrices, the following average IR values were obtained:

Table 1. Index Random Consistency (IR) Values

Ratio Value											
n	1	2	3	4	5	6	7	8	9	10	11
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.11

If the calculation can be said to be correct if the CR value ≤ 10% (0.1) then the pairwise comparison value is considered consistent. However, if CR > 0.1 then the value of pairwise comparisons is inconsistent and needs to be improved (Rezki et al., 2023).

2.3 OMAX

After weighting with AHP, continue with the OMAX method scoring system. To fill in the OMAX table correctly, some things need to be considered, namely:

The green supply chain performance score determines whether the performance results can meet the company's target for each KPI. KPI scores can be evaluated using the Traffic Light System (TLS). To see whether improvements need to be made, it can be seen from the level (0-3): 1 to 3 using red, 4-7 using yellow, and 10 using green.

3. Result and Discussion

3.1 Identify KPIs

Based on the 23 KPIs submitted, 19 KPIs have been verified and approved by the expert. The following are the 19 KPIs used:

Table 2. Verified and Validated KPIs

Level 1 Criteria	**Level 2 Attributes**	**Code**	**Level 3 Sub- Criteria**	**Aspects**	**Reference**
Plan	*Reliability*	PRL 1	Percentage conformity of results and targets	Economics	(Putri, 2022)

Level 1 Criteria	Level 2 Attributes	Code	Level 3 Sub- Criteria	Aspects	Reference
		PRL 2	Total water usage required in the production process	Economics	(Setiyono and Ernawati, 2023)
	Responsive	PRS 1	Average time in the repair process	Economics	(Tutuhatu Newa et al., 2023)
Source	*Reliability*	SRL 1	Percentage of accuracy of the amount of raw materials delivered by the amount ordered	Economics	(Putri,2022)
	Responsive	SRS 1	Time taken to fulfill raw material demand	Economics	(Putri,2022)
		SRS 2	Time required to issue a raw material request letter	Economics	(Putri,2022)
		SRS 3	Good supplier partnerships	Social	(Mardiana et al, 2022)
Make	*Reliability*	MRL 1	% Sugar pol	Economics	Observation result
		MRL 2	Suitability of ground raw materials	Economics	Observation result
		MRL 3	Effectiveness of ISO 14001: 2015 implementation	Environment	(Setiyono and Ernawati, 2023)
		MRL 4	Effectiveness of ISO 9001:2015 implementation	Economics	(Setiyono and Ernawati, 2023)
	Responsive	MRS 1	Percentage of production delays that hamper the company's supply chain process	Economics	(Yusri et al, 2024)
		MRS 2	Production waste is processed for process continuity	Environment	(Patradhiani, 2023)
	Agility	MAG 1	Percentage of health and labor insurance	Social	(Hapsari et al, 2021)
Deliver	*Reliability*	DRL 1	Inventory fulfillment rate of finished products that are ready to be shipped	Economics	(Setiyono and Ernawati, 2023)
	Responsive	DRS 1	Lead time for finished products	Economics	(Putri,2022)
Return	*Reliability*	RRL 1	Number of defective products that can be remanufactured	Economics	(Patradhiani, 2023)
		RRL 2	Percentage of complaints submitted by consumers	Economics	(Putri and Rukmayadi, 2022)
	Responsive	RRS 1	Average processing time of defective products	Economics	(Patradhiani, 2023)

Source: Observation data

After obtaining verified and validated KPIs, weighting is carried out at each SCOR level. Next, the weighting of each KPI will be carried out using the AHP method.

3.2 AHP Method

After filling out the comparison questionnaire, the weighting and normalization of data and the weighting of each KPI will be carried out. The following is a normalization table:

Table 3. Criteria Weighting Matrix (Level 1)

Criteria	*Plan*	*Source*	*Make*	*Delivery*	*Return*
Plan	1.000	2.590	2.141	2.817	1.528
Source	0.386	1.000	2.280	2.817	2.817

Criteria	*Plan*	*Source*	*Make*	*Delivery*	*Return*
Make	0.467	0.439	1.000	1.968	1.136
Deliver	0.355	0.355	0.508	1.000	2.432
Return	0.655	0.355	0.880	0.411	1.000
TOTAL	**2.863**	**4.739**	**6.808**	**9.014**	**8.913**

Source: Primary Data Processed

After obtaining the normalization matrix results, proceed with the criteria consistency test. The calculation is as follows:

Table 4. Weighting and Consistency between Criteria

Criteria	*Plan*	*Source*	*Make*	*Deliver*	*Return*	Jumlah	*Eigen Vector*	*λmax*	CR
Plan	**0.349**	0.547	0.314	0.313	0.171	1.694	0.339	0.970	0.1
Source	0.135	**0.211**	0.335	0.313	0.316	1.309	0.262	1.241	
Make	0.163	0.093	**0.147**	0.218	0.127	0.748	0.150	1.019	
Deliver	0.124	0.075	0.075	**0.111**	0.273	0.657	0.131	1.185	
Return	0.229	0.075	0.129	0.046	**0.112**	0.591	0.118	1.053	
TOTAL	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**5.000**	**1.000**	**5.468**	

Source: Primary Data Processed

From this calculation, the consistency test value, or CR, is 0.10. If CR ≤ 0.1, it can be said to be consistent, and the data can be taken into account properly in the calculation

Table 5. Calculation of Sustainable Supply Chain Performance Matrix with SCOR

No	Process	Weight Level 1	Attribute	Weight Level 2	*Key Performance Indicator*	Weight Level 3	Final Weight
1	*Plan*	0.349	*Reliability*	0.634	PRL 1	0.634	0.140
2					PRL 2	0.366	0.081
3			*Responsive*	0.366	PRS 1	1	0.128
4	*Source*	0.211	*Reliability*	0.721	SRL 1	1	0.152
5			*Responsive*	0.279	SRS 1	0.244	0.014
6					SRS 2	0.192	0.011
7					SRS 3	0.564	0.033
8	*Make*	0.147	*Reliability*	0.529	MRL 1	0.137	0.011
9					MRL 2	0.341	0.026
10					MRL 3	0.252	0.020
11					MRL 4	0.261	0.020
12			*Responsive*	0.313	MRS 1	0.381	0.017
13					MRS 2	0.619	0.057
14			*Agility*	0.158	MAG 1	1	0.023
15	Deliver	0.111	*Reliability*	0.695	DRL 1	1	0.077
16			*Responsive*	0.305	DRS 1	1	0.034
17	Return	0.112	*Reliability*	0.532	RRL 1	0.873	0.052
18					RRL2	0.127	0.008
19			*Responsive*	0.468	RRS 1	1	0.053

Source: Primary Data Processed

Table 5 displays the findings of the pairwise comparisons made at Level One for the five SCOR processes. The planning process has the highest weight (0.349), followed by source (0.211), make (0.147), deliver (0.111), and return (0.112). The final results of weighting comparisons at level two attributes on each attribute are Plan-Reliability is (0.634), Plan-

Responsive is (0.366), Source-Reliability is (0.721), Source-Responsive is (0.279), Make-Reliability is (0.529), Make-Responsive is (0.313), Make-Agility is (0.158), Deliver-Reliability is (0.695), Deliver-Responsive is (0.305), Return-Reliability is (0.532), Return-Responsive is (0.468) The results of weighting comparisons at level three sub-criteria on each sub-criteria are PRL 1 with a weight of 0.634 and a final weight of 0.140; PRL 2 with a weight of 0.366 and a final value of 0.081; PRS 1 with a weight of 1 and a final weight of 0.128; SRL 1 with weight 1 and final weight 0.152; SRS 1 with weight 0.244 and final weight 0.014; SRS 2 with weight 0.192 and final weight 0.011; SRS 3 with weight 0.564 and final weight 0.33; MRL 1 with weight 0.137 with final weight 0.011; MRL 2 with weight 0.341 and final weight 0.026; MRL 3 with weight 0.252 and final weight 0.020; MRL 4 with weight 0.261 and final weight 0.020; MRS 1 with weight 0.318 and final weight 0.017; MRS 2 with weight 0.619 and final weight 0.057;MAG 1 with weight 1 and final weight 0.023; DRL 1 with weight 1 and final weight 0.077; DRS 1 with weight 1 and final weight 0.034; RRL 1 with weight 0.873 and final weight 0.052; RRL 2 with weight 0.127 and final weight 0.008; RRS 1 with weight 1 and final weight 0.053.

In the final weight column is obtained from the result of multiplying the weight of level 1 with level 2 and also level 3.

3.3 OMAX Method

The following is a table of the company's historical data used to determine the performance of SSCM with the OMAX method.

Criteria			Sour ce	Period					Best performance	Target Realiza tion	Ave rage	Worst Achieve ment
				1	2	3	4	5				
Plan	*Reliabi lity*	PRL 1	%	53	104	110	109	43	110	100	83,8	43
		PRL 2	m^3	207.132	486.170	627.370	570.952	599.941	627370	432,462	498313	207.132
	Responsive	PRS1	Hours	0,76	0,47	0,46	0,43	0,36	0,76	1,000	0,50	0,36
Source	*Reliabi lity*	SRL1	%	76	96	96	93	36	96	100	79,4	36
	Responsive	SRS 1	Da ys	1	1	1	1	1	1	1	1	0
		SRS 2	Da ys	1	1	1	1	1	1	1	1	0
		SRS 3	Times	30	22	22	22	22	30	30	23,6	22
Ma ke	*Reliabi lity*	MRL 1	%	9,34	9,45	9,95	10,43	10,38	10,43	9,95	9,91	9,34
		MRL 2	To ns	52.619	187.170	198.663	194.966	79.416	198.663	899,488	142.566	52.619
		MRL 3	%	100	100	100	100	100	100	100	100	0
		MRL 4	%	100	100	100	100	100	100	100	100	0
	Responsive	MRS 1	%	2	2	2	2	2	2	2,79	2	0
		MRS 2	Tons	15.442	53.478	50.587	50.486	21.076	53.478	38.264	38.214	15.442
	Agility	MAG 1	%	4	4	4	4	4	4	4	4	0
Deliver	*Reliability*	DRL 1	Tons	2.905	14.672	16.355	16.320	6.870	16.355	65.583	11.424	2.905
	Responsive	DRS 1	Hours	12	12	12	12	12	12	12	12	0
Ret urn	*Reliability*	RRL 1	%	100	100	100	100	100	100	100	100	0
		RRL 2	%	0	0	0	0	0	0	0	0	0
	Responsive	RRS 1	Hours	11	12	12	11	12	12	12	11,6	11

Source: Primary Data Processed

Figure 2. OMAX and Traffic Light System on All Criteria

The following is an example of calculating the objective matrix for KPI (PRL 1)

1. Known levels
   a. Level 0 = 43
   b. Level 3 = 83.8
   c. Level 10 = 100
2. Level 1 to level 2 calculation
   Interpolation 0 and 3

$$\frac{\text{Level 3-level 0}}{3-0} = \frac{83.8-43}{3-0} = 13.6$$

   a. Level 1 = 43 +13.6 = 56.6
   b. Level 2 = 56.6 + 13.6 = 70.2
3. Level 4 to Level 9 calculation
   Interpolation 3 and 10

$$\frac{\text{Level 10-level 3}}{10-3} = \frac{100-83.3}{10-3} = 2.4$$

   a. Level 4=83.3+2.4= 85.7
   b. Level 5 = 85.7 + 2.4= 88.1
   c. Level 6= 88.1 + 2.4 = 90.5
   d. Level7=90.5+2.4 = 92.9
   e. Level 8= 92.9 + 2.4= 95.3
   f. Level 9= 95.3 + 2.4 = 97.7

The following is a measurement and assessment carried out using OMAX and the Traffic Light System.

Table 6. Sustainable Supply Chain Management Performance Results

KPI	Measurement Results			KPI	Measurement Results		
	Bobot	*Score*	Value		Bobot	*Score*	Value
PRL 1	0.140	10	1.4	MRL 4	0.020	10	0.20
PRL 2	0.081	7	0.567	MRS 1	0.017	10	0.17
PRS1	0.128	9	1.152	MRS 2	0.057	10	0.57
SRL1	0.152	9	1.368	MAG 1	0.023	10	0.23
SRS 1	0.014	10	0.14	DRL 1	0.077	4	0.077
SRS 2	0.011	10	0.11	DRS 1	0.034	10	0.034
SRS 3	0.033	10	0.33	RRL 1	0.052	10	0.52
MRL 1	0.011	10	0.11	RRL 2	0.008	10	0.08
MRL 2	0.026	9	0.234	RRS 1	0.053	10	0.53
MRL 3	0.020	10	0.20				
Total Value Performance Analysis							**8.022**

Source: Primary Data Processed

4. Conclusion

Based on the results and discussion in this study, it can be concluded as follows: The Sustainable Supply Chain performance level at PT XYZ has a final score of 8.022 out of 10, with a green category, which means satisfactory. Of the total 19 KPIs, 2 KPIs are yellow. The yellow indicators are PRL 2 and DRL 1. The proposed improvement to KPI PRL 2 is to recycle water; this can be done with filtration or reverse osmosis technology to reuse the remaining water from the production process. The limitations of this research are the more quantitative approach without involving qualitative aspects, and the results are specific to PT XYZ, so they are less relevant to the context of other companies. Suggestions for future researchers are expected to explore other indicators or criteria as additional references that are relevant to other industries.

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