Analysis of Green Supply Chain Management Application in Indonesian Automotive Company Using Integrated Green SCOR and AHP Method

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Abstract

The development and competition in the automotive industry have become one of the biggest contributors to various pollution and waste caused by the movement of the industrial supply chain in Indonesia. Companies in the automotive industry are required to implement green supply chain management. Therefore, it is necessary to analyze the application of green supply chain management in companies in the automotive industry. The study was conducted at a manufacturing company located in Cikarang, Jawa Barat, which is engaged in the field of car assembly, which is a company with fairly large car production in the Indonesian automotive industry. The population in this study are green procurement, green manufacturing and green logistics (inbound). The flow of the research was carried out with the initial steps of primary and secondary data collection, then the KPI design which would later be validated by an expert. After that, the AHP is weighted and then the performance is calculated using the Green SCOR method. The results showed there were 22 KPIs which became the basis for calculating Green SCOR. The results of the Green SCOR for GSCM obtained amounted to 65,819 where according to the monitoring system table the work indicators are included in the "Average" category. Therefore, there are still lot of room for improvement. Improving the performance of green supply chain management by implementing proposed improvements will have a good impact on green supply chain management as a whole.

Keywords
GSCM, Automotive Industry, Green SCOR, AHP.

1. Introduction
Awareness will be the importance of the role of Supply Chain Management in improving the company's performance continues to increase from year to year. Over time, each company increasingly focused on the performance of the components in the supply chain and also the collaboration between the actors contained in the supply chain. Movement of the supply chain has some adverse impacts on the surrounding environment. Pollution, garbage, waste, and other hazards to the environment often occur when the flow and supply chain processes take place. Srivastava (2007) defines green supply chain management as the integration of environmental thinking into supply chain management, including product design, material purchasing and supplier selection, manufacturing processes, delivery of end products to consumers, and also product management after their useful life. Green supply chain management slowly began to enter the realm of the automotive industry in Indonesia, several companies have implemented green supply chain management in the supply chain they live. The study was conducted on one company in the automotive industry which is engaged in assembling cars from Japan. The application of the green concept into the automotive industry is very important to reduce environmental impact, compete in market competition, and ensure compliance with regulations. Based on data from the ASEAN Automotive Federation, Indonesia is the second largest car manufacturer in Southeast Asia after Thailand with a total production of 1,286,848 units in 2019 before the Covid-19 outbreak in 2020 that attacked all countries in the world (ASEAN AUTOMOTIVE FEDERATION 2021). Based on the description above, it can be concluded that the problem that occurs is the presence of various pollution and waste caused by the movement of industrial supply chains in Indonesia, where the automotive industry is one of the biggest contributors to the adverse impact on the environment. The concept of green supply chain management must be continuously evaluated in order to continue to develop, so it is necessary to measure the output generated from supply chain activities. These measurements are related to performance at each stage of the supply chain. The phrase "you can't manage what you can't measure" is associated with various sources and has become an important business maxim today (Grant & Shaw

2021). To determine the performance of the supply chain, it can be measured by integrating the AHP method with the Green Supply Chain Operations Reference (Green SCOR) which is an integrated SCOR with environmental elements. AHP is a general theory in setting priorities for qualitative and quantitative decision making and has been widely used in various sectors in solving decision problems. In addition, environmental performance indices are widely applied to AHP principles to describe environmental performance in various countries (Nazim Abdullah et al. 2019). While the SCOR model is a business process that focuses on reengineering, benchmarking, process measurement, and analysis of best practices to be carried out in the supply chain as an integrated model (Nazim Abdullah et al. 2019). The SCOR principle enables companies to align their supply chain management practices and fill gaps in supply chain performance. An effective performance measurement system can provide a basic understanding of the system, influence the behavior in it and provide information related to the work of the system. Performance measurement of the green supply chain management concept as a whole starting from the dimensions of green procurement, green manufacturing and green logistics needs to be done so that PT. XYZ can evaluate the current implementation of the concept.

1.1 Objectives

The purpose of this study is to design and evaluate and recommend improvement strategies for the application of green supply chain in car assembly companies in Indonesia in the dimensions of green procurement, green production and green logistics. using the integrated AHP and Green SCOR methods.

2. Literature Review

Green Supply Chain Management brings traditional supply chain management practices that incorporate environmental criteria, or decision issues to purchase goods or services and long-term relationships with suppliers (Gilbert 2000). Green Supply Chain Management as a process of using environmentally friendly inputs and converting inputs into outputs that can be reused at the end of the cycle so as to create a sustainable supply chain (Penfield 2007).According to Srivastava (2007), Green Supply Chain Management as the integration of environmental issues into the Supply Chain Management, including product design, material purchase raw and supplier selection, manufacturing process, to delivery of the products end to the consumer (Figure 1).

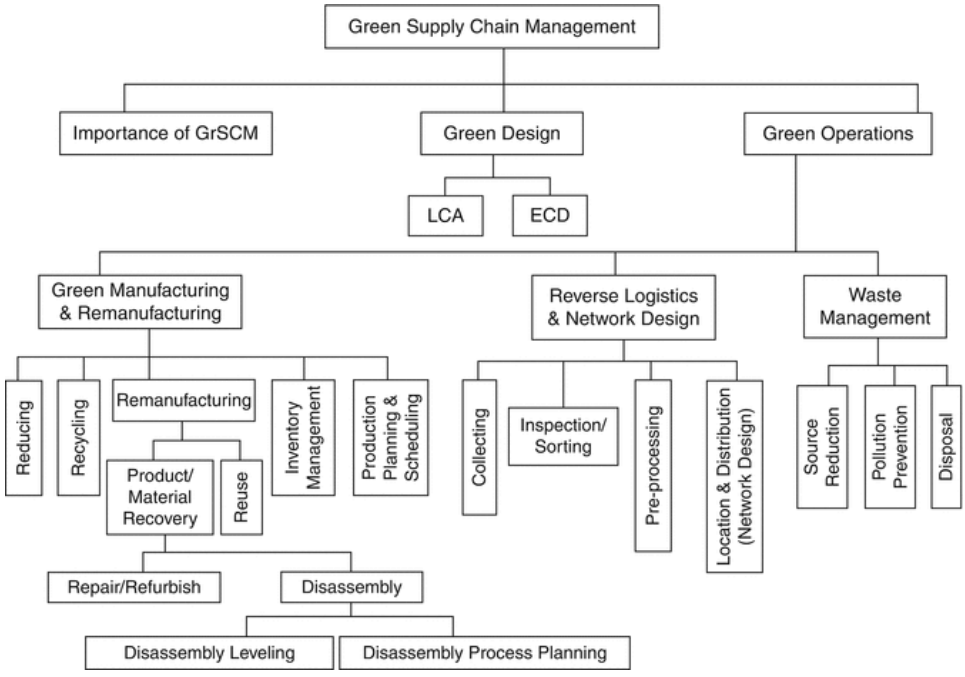

Figure 1. Green Supply Chain Automobile Industry Classification *Source: Srivastava, 2007*

Green Supply Chain Management integrates environmental and supply chain management and promotes the role of supply in an effort to protect the environment. Green Supply Chain Management recognizes and measures the environmental impact of various supply chain processes within an organization. According to Paul (2014) in Jabbour, et al. (2016) it is said that supply chain improvements are positive for the environment which includes policies and practices by adjusting the objectives of Green Supply Chain Management with the company's business goals and strategies. Adjusting the improvement of Green Supply Chain Management with the company's goals and strategies can create strategic value. The adjustment involves the following activities:

1. Determination of environmental functions in the business: product differentiation, competitor management, cost reduction, risk management, and market redefinition.
2. Alignment of Green Supply Chain Management objectives with company objectives: successful environmental performance is one of the main indicators.
    a. Evaluation of environmental influences resulting from each supply chain process and logistics activity.
    b. Using Green Supply Chain Management analysis as a motivation to accelerate innovation.
    c. Pay special attention to waste reduction.
    d. Supply chain integration and collaboration with suppliers and customers to work together to reduce carbon dioxide emissions and the negative impact on the environment from materials, production processes, products, packaging, transportation, warehousing and distribution activities.

Some of the operational functions and activities in Green Supply Chain Management (Ninlawan and Toke 2010) are as follows:

1. Green Procurement
   Green procurement relates to environmental conditions of purchase which consist of involvement in purchasing savings, reuse and strategic recycling activities of materials in the purchasing process. Green procurement is a solution for environmentally and economically conservative businesses and concepts for obtaining product and service options that minimize environmental impact.
2. Green Manufacturing
   Green manufacturing is a production process that uses environmentally friendly raw materials, is highly efficient and produces little or no waste and pollution. The impact of implementing green manufacturing is that it can reduce raw material costs, gain production efficiency and improve the company's image.
3. Green Distribution/Logistics
   Activities in green distribution are green packaging and green logistics. Green packaging, including saving packaging, using environmentally friendly materials, collaborating with suppliers to standardize packaging, saving material use and time for unloading and introducing recycling programs. Green logistics, including direct delivery to users using the site, using alternative fueled vehicles and shipping products in bulk.
4. Reverse Logistics
   Reverse logistics is the process of retrieving products from final consumers for increased value and proper disposal. Activities in reverse logistics include collection, combined sorting, recovery, redistribution and disposal.

The Green SCOR model is the result of the development of the existing SCOR model. This Green SCOR Model adds several considerations related to the environment in which it aims to create an analysis that will give an overview of the relationship of supply chain functions with environmental aspects to create Improved management performance between the two (Taylor c 2003). There are 5 main components in the Green SCOR model used in this study, including:

1. Plan, planning to minimize energy consumption, handling and storing hazardous materials, disposal of ordinary and hazardous waste.
2. Source, selection of suppliers that are environmentally friendly, environmentally friendly packaging, materials pass quality control.
3. Make, the process of making a product by considering its effect on the environment.
4. Deliver, focus on delivery above the target, large scale distribution and flexible packaging design.
5. Return, focus on renewing products and minimal returns.

The process and information flow of the five components can be seen in the following figure 2:

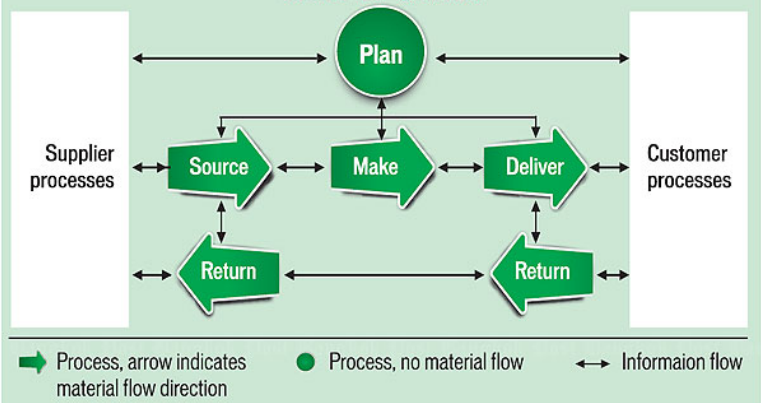

Figure 2. Green Supply Chain Operation Reference Model, *Source: Supply Chain Council, 2008*

The calculation of green SCOR requires an indicator to be measuring material (Figure 2). Each indicator has varying weights with different parameters, so a parameter is needed by the normalization of the parameters. The normalization process was carried out with the normalization formula of Snorm de Boer. Another method used is the AHP method, AHP is used to prioritize the priorities of the various alternatives or options available and those options are complex or multi-criteria.

3. Methods

The research subjects are managers in purchasing, manufacturing and material handling department and general managers who heads the production control and procurement subdivision who is an expert in the supply chain and also acts as a decision-maker for the process of the supply chain. The object under study is a company engaged in car assembly manufacturing with a focus of study on measuring the performance of green supply chain management. The population in this study is the activities related to procurement, manufacturing, and logistics in the company for the passenger car assembly process.

4. Data Collection

Data collection methods consist of collecting primary data by conducting interviews with purchasing, manufacturing and material handling manager and also production control and procurement general manager on the topics of supplier selection mechanisms, manufacturing process and logistics activities to get a clear picture of the problem that occurred so that it is possible to get an answer to this problem.

The research flowchart starts with collecting data taken from field studies, then designing an influential KPI for calculating the value of green supply chain performance. The KPI will be validated in advance by the expert, if it is said to be feasible as a matter that affects the performance of green supply chain management, then the KPI must be replaced or eliminated until all KPIs are said to be appropriate as material for calculating the performance of GSCM. After that, the Snorm calculation is done for each KPI that has been set. Then AHP is weighted for each KPI, this weighting will be validated by the expert, if the results of AHP weighting on the KPI are declared inconsistent, then AHP is re-weighted on the KPI. If it has been declared consistent, then AHP is weighted in the component. This weighting will be validated by the expert. If the result of AHP weighting on the attribute is declared to be inconsistent, then AHP is re-weighted on the attribute. If it has been declared consistent, then AHP is weighted in the component. The weighting on this component will be validated by the expert, if the result of AHP weighting on the attribute is declared to be inconsistent, then the AHP is re-weighted on the component. If it has been stated consistent, then the calculation of the green SCOR performance is then performed. After obtaining the performance value from the green SCOR, a discussion of the results of the study will then be concluded with conclusions and suggestions. Here is a picture of the research flowchart(Figure 3):

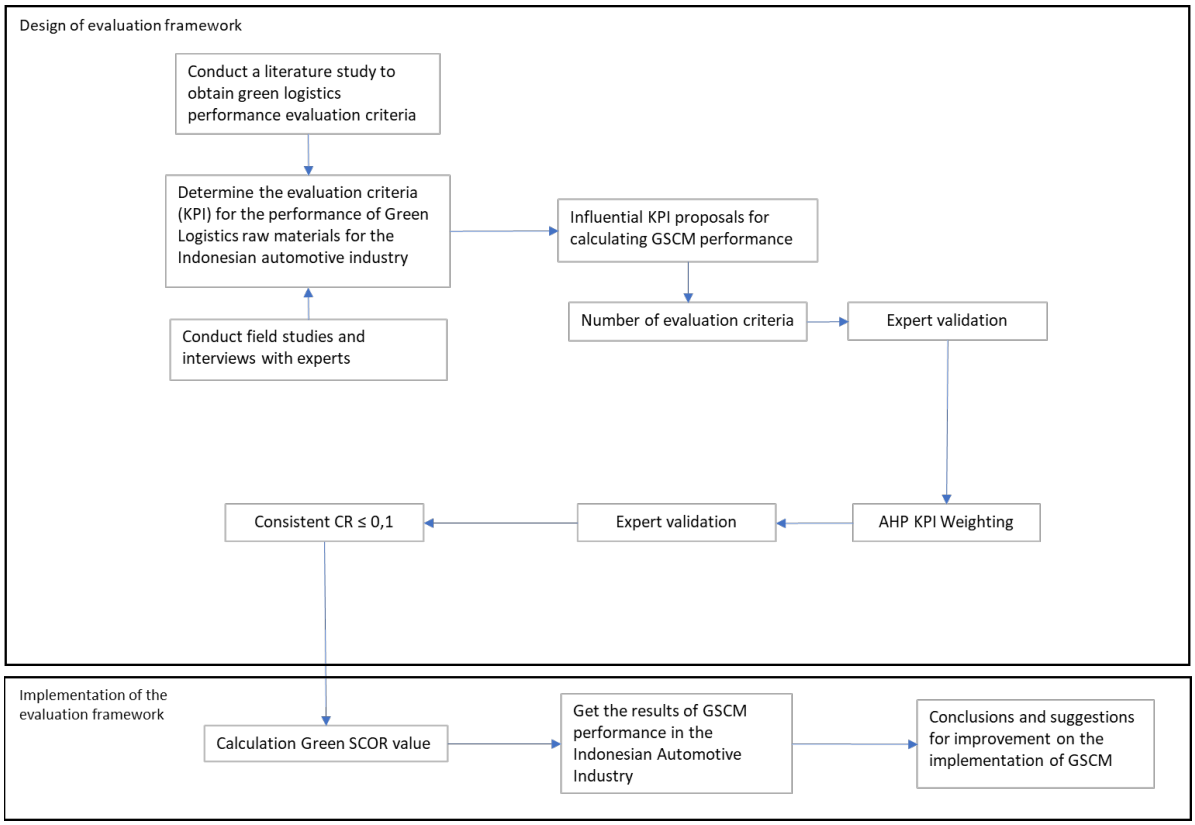

Figure 3. Research Flow Chart

5. Results and Discussion

5.1 Numerical Results

After conducting interviews through discussions and questions and answers with purchasing, manufacturing and material handling manager and also production control and procurement general manager subdivision which is an expert and decision-maker for the process of the supply chain and direct observation through observation or direct observation in the procurement, manufacturing and logistics department, a Key Performance Indicator is obtained (KPI), which forms the basis of calculations to determine the value of Green SCOR. This KPI has been verified directly by the expert and has an influence on the logistics performance itself. This verification is carried out to find out whether the performance indicators designed are correct and in accordance with company needs, namely by checking which indicators have not been included or do not need to be included because of the possibility of similarities with other indicators. There are 22 KPIs related to procurement, manufacturing and logistics (inbound) that will be normalized by a snorm de boer with the aim of equalizing parameters because each KPI has a different weight and scale. The following table 1 shows the results of the normalization:

Table 1. Snorm De Boer Normalization

Goal	SCOR Components	SCOR Attributes	KPI	Criteria	Snorm	Category
Green Supply Chain Management	PLAN	Responsiveness	Supplier standard management shall implement green procurement guidelines	Green Procurement and Supplier Management	100,00	Excelent
			Organize green supply chain training for suppliers	Green Procurement and Supplier Management	0,00	Poor
		Cost	Usage of recycled water	Green Production	70,45	Good
			Forecast accuracy with actual production	Green Production	99,17	Excelent
		Reliability	Usage of renewable energy sources	Green Production	0,00	Poor
	SOURCE	Reliability	% suppliers certified ISO 14001	Green Procurement and Supplier Management	67,60	Average
			% suppliers using energy saving and environmental protection	Green Procurement and Supplier Management	35,20	Poor
			Regular supplier audits related to GSCM implementation	Green Procurement and Supplier Management	0,00	Poor
		Flexibility	Supplier performance evaluation considering environment, quality, cost & service	Green Procurement and Supplier Management	100,00	Excelent
			Requirement for use of toxic and hazardous substance	Green Production	90,50	Excelent
	MAKE	Cost	Energy saving implementation	Green Production	45,64	Marginal
		Reliability	Percentage of waste product (solid, liquid, gas)	Green Production	89,84	Good
			Percentage of dangerous waste	Green Production	77,25	Good
		Asset	Air emission	Green Production	65,31	Average
			Water emission	Green Production	70,45	Good
		Responsiveness	Percentage of trained workers related green operation	Green Production	7,37	Poor
	DELIVER	Flexibility	Percentage of environmental friendly material packaging	Green Logistics	0,00	Poor
			Percentage of reusable/returnable material packaging	Green Logistics	75,57	Good
		Reliability	Green tranportation	Green Logistics	73,74	Good
			Green warehousing	Green Logistics	66,57	Average
			Percentage of non-feasible material packaging	Green Logistics	95,26	Excelent
	RETURN	Cost	Scrap and rework rate	Green Production	99,86	Excelent

KPIs that have values in the category of "poor" and "marginal" based on a working indicator monitoring system table 2 (Trienekens, J. H & Hvolby, HH, 2000) are marked in red to indicate that the KPI is a priority to do the improvement. The next step after normalization is weighting using the AHP (Analytical Hierarchy Process) method. At this stage, the pairwise comparison is discussed with the purchasing, manufacturing and material handling manager and also production control and procurement general manager subdivision, who are experts and decision-makers for the process of the supply chain. This is done to determine the level of importance of each level and KPI with the aim of calculating the total value of the performance of Green SCOR. This weighting is carried out for each KPI as well as components and attributes. Here are the results of AHP weighting:

Table 2. AHP Weighting Method

Goal	SCOR Component	Component Weight	SCOR Attribute	Attribute Weight	KPI	KPI Weight
Green Supply Chain Management	PLAN	0,4196	Responsiveness	0,1028	Supplier standard management shall implement green procurement guidelines	0,7509
					Organize green supply chain training for suppliers	0,2491
			Cost	0,6403	Usage of recycled water	0,2491
					Forecast accuracy with actual production	0,7509
			Reliability	0,2569	Usage of renewable energy sources	1,0000
	SOURCE	0,1646	Reliability	0,8333	% suppliers certified ISO 14001	0,6403
					% suppliers using energy saving and environmental protection	0,2569
					Regular supplier audits related to GSCM implementation	0,1028
			Flexibility	0,1667	Supplier performance evaluation considering environment, quality, cost & service	0,7509
					Requirement for use of toxic and hazardous substance	0,2491
	MAKE	0,2878	Cost	0,2462	Energy saving implementation	1,0000
			Reliability	0,5707	Percentage of waste product (solid, liquid, gas)	0,1667
					Percentage of dangerous waste	0,8333
			Asset	0,1212	Air emission	0,7509
					Water emission	0,2491
			Responsiveness	0,0620	Percentage of trained workers related green operation	1,0000
	DELIVER	0,0885	Flexibility	0,1667	Percentage of environmental friendly material packaging	0,2491
					Percentage of reusable/returnable material packaging	0,7509
			Reliability	0,8333	*Green tranportation*	0,6403
					Green warehousing	0,2569
					Percentage of non-feasible material packaging	0,1028
	RETURN	0,0396	Cost	1,0000	Scrap and rework rate	1,0000

Comparisons are made based on the policy of decision-makers which in this case are purchasing, manufacturing, material handling managers and production control, procurement general managers by assessing the importance of one element to another element. This weighting with AHP also needs to be tested for consistency with the formula of consistency ratio, where the comparison is declared consistent if the results of consistency ratio are less than equal to 0,1.

The next calculation is to calculate the final value of the performance of the Green SCOR (table 3, table 4 and table5). This calculation is done by way of multiplying each score normalization has been obtained from the normalization formula Snorm De Boer with the weight of each KPI, attributes, and components. The following is the result of the calculation:

Table 3. Calculation of KPI Value

Goal	SCOR Components	SCOR Attributes	KPI	Snorm	KPI Weight	(Snorm x KPI Weight)	Total Attribute
Green Supply Chain Management	PLAN	Responsiveness	Supplier standard management shall implement green procurement guidelines	100,00	0,7509	75,094	75,094
			Organize green supply chain training for suppliers	0,00	0,2491	0,000	
		Cost	Usage of recycled water	70,45	0,2491	17,547	92,016
			Forecast accuracy with actual production	99,17	0,7509	74,468	
		Reliability	Usage of renewable energy sources	0,00	1,0000	0,000	0,000
	SOURCE	Reliability	% suppliers certified ISO 14001	67,60	0,6403	43,285	52,325
			% suppliers using energy saving and environmental protection	35,20	0,2569	9,041	
			Regular supplier audits related to GSCM implementation	0,00	0,1028	0,000	
		Flexibility	Supplier performance evaluation considering environment, quality, cost & service	100,00	0,7509	75,094	97,635
			Requirement for use of toxic and hazardous substance	90,50	0,2491	22,541	
	MAKE	Cost	Energy saving implementation	45,64	1,0000	45,641	45,641
		Reliability	Percentage of waste product (solid, liquid, gas)	89,84	0,1250	11,230	78,821
			Percentage of dangerous waste	77,25	0,8750	67,591	
		Asset	Air emission	65,31	0,7509	49,047	66,594
			Water emission	70,45	0,2491	17,547	
		Responsiveness	Percentage of trained workers related green operation	7,37	1,0000	7,372	7,372
	DELIVER	Flexibility	Percentage of environmental friendly material packaging	0,00	0,2491	0,000	56,747
			Percentage of reusable/returnable material packaging	75,57	0,7509	56,747	
		Reliability	*Green tranportation*	73,74	0,6403	47,220	74,113
			Green warehousing	66,57	0,2569	17,100	
			Percentage of non-feasible material packaging	95,26	0,1028	9,793	
	RETURN	Cost	Scrap and rework rate	99,86	1,0000	99,859	99,859

Table 4. Calculation of Attribute Value

Goal	SCOR Component	SCOR Attributes	Total Attribute	Attribute Weight	(Total Attribute x Attribute Weight)	Total Nilai Komponen
Green Supply Chain Management	PLAN	Cost	92,016	0,633	58,257	65,014
		Reliability	0,000	0,277	0,000	
		Responsiveness	75,094	0,090	6,758	
	SOURCE	Reliability	52,325	0,833	43,604	59,877
		Flexibility	97,635	0,167	16,272	
	MAKE	Cost	45,641	0,246	11,237	64,742
		Reliability	78,821	0,571	44,980	
		Asset	66,594	0,121	8,068	
		Responsiveness	7,372	0,062	0,457	
	DELIVER	Flexibility	56,747	0,167	9,458	71,218
		Reliability	74,113	0,833	61,761	
	RETURN	Cost	99,859	1,000	99,859	99,859

Table 5. Calculation of GSCM Green SCOR Value

Goal	SCOR Component	Total Component Value (A)	Component Weight (B)	Total SCOR Value (A x B)
Green Supply Chain Management	PLAN	65,014	0,418	27,174
	SOURCE	59,877	0,170	10,155
	MAKE	64,742	0,280	18,158
	DELIVER	71,218	0,099	7,078
	RETURN	99,859	0,033	3,254
Total				**65,819**

Green SCOR performance value for GSCM obtained amounted to 65,819 which according to the monitoring system work indicators table included in the category of "Average". Therefore, there are still lot of room for improvement. Improving the performance of green supply chain management by implementing proposed improvements will have a good impact on green supply chain management as a whole.

5.3 Proposed Improvements

The results of the green supply chain performance value in this case study is considered unsatisfactory because it only reached the "Average" category, so that the increase in the performance value must continue to be carried out in order to achieve the optimal value. The increase in the performance value can be done by first making improvements to the KPIs that are included in the poor and marginal categories. The following is a proposed strategy for improving KPIs that fall into the poor and marginal category:

1. Conduct training related to Green Supply Chain Management or Green Training for suppliers considering customer/customer needs.
   The results of the study (Teixeira et al. 2016) show that green training is positively correlated with the application of green supply chain management practices in the green purchasing dimension. The results show the relevance of green training which emphasizes that organizational learning (Gosling et al. 2016) and alignment of human resource practices (Jackson et al. 2014) are very important for greening companies because they can reduce barriers to GSCM implementation.
2. Implementation of the use of new and renewable energy, such as the installation of solar cells as an energy source, gradually replacing conventional energy.
   Renewable Energy Sources (RE) such as solar, wind, geothermal, biomass, and hydropower are considered to be the most widely used sources in the NRE industry and therefore are very useful in combating the use of non-environmentally friendly energy sources. The production and consumption of this energy resource is very clean, which makes it very important. The increasing awareness of a clean environment has made dependence on fossil fuels unpopular, due to the associated environmental problems such as the emission of CO2 as well as other greenhouse gases. The excessive demand for energy coupled with the desire to keep the environment clean has resulted in a global campaign to replace conventional fuels with New Renewable Energy in both industrial and domestic applications through Green Supply Chain Management (GSCM) (Gawusu et al. 2022)
3. Conduct periodic audits to suppliers regarding the implementation of GSCM in general using third party auditors.
   The integration of audits into supplier management in GSCM can ensure that suppliers practice green manufacturing. It has been shown by Handfield et al. (2005) that GSCM involves the recognition and integration of environmental issues and concerns into the supply chain management process by auditing suppliers using environmental performance metrics. In addition, Young et al. (2001) also show that supplier performance can be improved through third-party audits. Some suppliers may not wish to perform an audit. As a result, several companies have collaborated to conduct this audit and present it as an opportunity for shared learning that will strengthen the relationship between producers and suppliers.
4. Forming a collaborative project with a company that can recycle plastic/cartonbox packaging materials.

A recent study from Ajinkya (2021) proposed a Closed Loop Supply Chain (CLSC) with an example of plastic bucket packaging that integrates the process of collecting and recovering plastic bucket packages with a finished product supply chain. Plastic bucket reverse logistics consists of phases such as recovering used buckets from the point of demand, sorting them for reusable parts, and disposing of non-reusable parts. Lastly, the processing of recovered parts to recover raw materials (plastic granules) which can be reused to make materials for the manufacture of buckets.

5. Provide regular training to employees regarding the implementation of Green Supply Chain in the company.
   A study conducted by Nejati et al. (2017), investigated the relationship between green human resource management and green supply chain management, considering the moderating effect of employee resistance to change. Based on a sample of 161 companies in the manufacturing industry in Iran, the data were analyzed using the partial least squares structural equation (PLSSEM) model. The results show a significant and positive impact of GHRM (Green Human Resources Management) on GSCM, confirming the integration between HRM and green management; "Green Development and Training", "Green Employee Empowerment", and "Green Pay and Rewards" have the most positive influence on GSCM.
6. Provide conditions for suppliers to implement energy saving and environmental protection.
   Improving Energy Efficiency is an operational challenge and a strategic opportunity for suppliers. The study of Wu et al. (2014) is an initial step in examining the role of buyers in influencing supplier decisions to implement Energy Efficiency initiatives as they seek to balance cost pressures with energy conservation demands that arise from governments and buyers. Currently, brand image related to the environment is one of the customer's considerations in choosing a product, so that the requirements for suppliers in implementing energy and environmental protection is one of the important things to do because it can have a broad effect on the environmental impact of the supply chain.
7. Implementing energy saving in the factory internally by minimizing energy consumption.
   The increase in energy costs due to increasing demand and its limited availability has resulted in increased production and transportation costs which in turn can increase the costs of the entire supply chain. In response to this, Shrouf et al. (2014) suggested a production model to minimize the cost of energy consumption by optimizing the length of the production cycle.

6. Conclusion

The conclusions generated based on this research there are 22 KPIs related to the implementation of Green Supply Chain Management in the Indonesian automotive industry based on the results of literature studies and case studies of PT. XYZ, which is one of the largest car manufacturers in Indonesia, has also been validated by experts. The results of the Green SCOR for the Green Supply Chain obtained are 65.819 where according to the work indicator monitoring system table included in the "Average" category, there are 7 KPIs that are included in the poor category. Therefore, it is necessary to propose improvements to KPIs that are included in the poor and marginal categories. Proposed improvements or proposed strategies related to improving the implementation of green supply chain management which includes green procurement, green production and green logistics, namely holding training related to Green Supply Chain Management or Green Training for suppliers tailored to customer/customer needs, implementing new energy use renewable energy sources such as installing solar cells as an energy source to replace conventional energy in stages, conducting periodic audits of suppliers regarding the implementation of GSCM in general using third party auditors, forming collaborative projects with companies that can recycle plastic packaging materials, providing regular training to workers related to the implementation of Green Supply Chain in the company, providing conditions for suppliers to implement energy savings and environmental protection and finally implement energy savings in internal factory by minimizing energy consumption.

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