GREEN SUPPLY CHAIN PERFORMANCE MEASUREMENT USING SUSTAINABLESCOR ON LAUNDRY MACHINERY MANUFACTURER (PT. HARI MUKTI TEKNIK)

UNDERGRADUATE THESIS

Submitted to International Program
Department of Industrial Engineering
The requirement for the degree of
Industrial Engineering
at
Universitas Islam Indonesia

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INTERNATIONAL PROGRAM
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UNIVERSITAS ISLAM INDONESIA
YOGYAKARTA
2023

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Yogyakarta, April 7th, 2023

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UNDERGRADUATE THESIS APPROVAL OF SUPERVISOR

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DEDICATION PAGE

This undergraduate thesis that spent a lot of time and resources is dedicated to my family that always supports me in any situation and condition.

To all my friends who always share happiness to each other.

This thesis also would not be possible to be completed without the guidance of my supervisor,
Dr. Ir. Elisa Kusrini, M.T., CPIM., CSCP

MOTTO

"...a slight change in your daily habits can guide your life to a very different destination." – James Clear

ACKNOWLEDGEMENT

Assalamu'alaikum Warahmatullahi Wabarakatuh.

Alhamdulillah, all praise to Allah SWT, because only with his permission the author can finish the undergraduate thesis. Shalawat and greetings to the Prophet Muhammad SAW who has saved mankind from the jahiliyyah era to the Islamiyah era and also give syafa'at into Yaumul Akhir.

This report was made to fulfill the requirements for completing a degree in Industrial Engineering at Universitas Islam Indonesia. The author realizes that he cannot finish the undergraduate thesis without the support, prays, and motivation from all parties. Thus, the author would like to thank:

1. Mr. Prof. Dr. Ir. Hari Purnomo, M.T. as Dean of Industrial Technology Faculty, Universitas Islam Indonesia.
2. Mr. Muhammad Ridwan Andi Purnomo, S.T., M.Sc., Ph.D. as the Head of the Undergraduate Program in Industrial Engineering, at Universitas Islam Indonesia.
3. Mrs. Ir. Ira Promasanti Rachmadewi, M. Eng. as the Secretary of the International Undergraduate Program Industrial Engineering, Universitas Islam Indonesia.
4. Mrs. Dr. Ir. Elisa Kusrini, M.T., CPIM., CSCP. as the supervisor who always provides guidance and knowledge to help the author finish this undergraduate thesis.
5. Mrs. Devy Nurrahma, S. Kom as the staff of the International Undergraduate Program in Industrial Engineering, Universitas Islam Indonesia who always help the author in providing administrative aspects during undergraduate thesis reports.
6. The author's beloved parents, Mr. Imam Budiawan S.E. and Mrs. Budi Susetyowati, and the author's siblings, Adhi Candra Darmawan who always gives support, motivation, and prayer.
7. All IP students' batch 2018, and all friends for the togetherness and encouragement that cannot be mentioned one by one.
8. Mr. Ashari as the owner of PT. Hari Mukti Teknik (Kanaba), Mr. M. Amin Syukron, S.T, M.T. as Business Development of PT. Hari Mukti Teknik (Kanaba) and all employees of PT. Hari Mukti Teknik (Kanaba) who has assisted in collecting data and information needed to complete this research.

9. As well as all parties whose cannot be written one by one, the authors want to thank you, and may Allah SWT repay for your kindness.

The author realizes this undergraduate thesis cannot be said as perfect, so the author appreciates if the reader gives critics and recommendations. The author hopes that this report can give many benefits to all parties.

Wassalamu'alaikum Warahmatullahi Wabarakatuh.

Yogyakarta, April 7th, 2023

(Argha Satria Nugraha)

ABSTRACT

Over the past few decades, the management of business processes has undergone a variety of significant changes brought by globalization such as regulations, laws, lifestyle, and customer tastes in society. Businesses need to implement more reliable approaches to encourage sustainable management at all stages of their supply chain including environmental conservation. From a sustainability standpoint, when a company supply chain has achieved the desired level of eco-friendliness in all aspects the performance will be considered adequate. Assessing the sustainability performance measurement in the company supply chain becomes vital because its activities are targeted toward sustainability goals related to the process of production, supply, recycling, and waste disposal. This research identifies and provides a suggestion related to sustainable performance on PT. Hari Mukti Teknik which is a manufacture industry located in Yogyakarta, this research helps the company improve its sustainable performance to meet the demands brought by globalization. For this, the supply chain operation reference (SCOR) version 12 model especially SustainableSCOR is considered the basic performance evaluation reference. Moreover, through a literature review, complementary research methods, especially in terms of priority weighting, were added to the performance evaluation process by using the analytical hierarchy process (AHP) method. This study identified using 6 (six) level-1 indicators and 9 (nine) level-2 indicators. Based on the findings, 7 (seven) level-2 indicators have not reached company specific-matric and it's found the value obtained from the green supply chain performance (GSCM) calculation is 49.5 which is classified as "marginal". To increase the GSCM score, suggestions are provided in this research such as managing, reusing, and selecting each raw material as well as wastewater management targeting for reuse. The result if the company implements the suggestion which is able to meet the demands that come from the government as well as consumers.

Keywords: Manufacture; Sustainable; Environment; Supply Chain Performance; GCSM; SustainableSCOR

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CHAPTER I
INTRODUCTION

1.1 Research Background

In spite of pressure from the COVID-19 pandemic, the manufacturing sector contributed the most to Indonesia's economic growth with 7,07% in the second quarter of 2021, growing by 6,91%. The manufacturing sector expanded by 3,68% and accounted for 0.75% of the national economy's growth in the third quarter of 2021. The sector is positioned to become the driver of the national economy, with a goal of a Gross Domestic Product (GDP) contribution of more than 20% by 2024, because of its demonstrated resilience, which shows that the trajectory of industrial growth is still on track. Manufacturing contributed the most amount of the country's GDP in the second quarter of 2021. (Ministry of Investment, n.d.)

The concept of supply chain management develops because companies integrate networks between suppliers and customers due to the significance of interactions between enterprises. The term "supply chain management" refers to the entire process, starting with the receipt of raw materials from the supplier and continuing through the distribution of finished goods to consumers (Miradji, 2014; Kusrini et al., 2019). To find out the performance of the company's supply chain, a measu rement is needed. From these measurements, a result will be obtained, so that whether or not the supply chain performance of the company can be evaluated. With a good supply chain performance, the performance of the company will be increasingly directed and provide benefits for the company, suppliers, and consumers. Furthermore, supply chain performance measurement and evaluation are essential components of a company's management, without which it would be difficult to describe the effects of supply chain management decisions, the direction of its operational outcomes, and the actions that must be made to enhance the efficacy (Miradji, 2014; Narkuniene & Ulbinaite, 2019; Pulansari & Putri, 2020).

Over the past few decades, the management of business processes has undergone a variety of significant changes. Companies are encouraged to enhance their environmental performance as a response to the pressure and movement brought on by globalization (Zhu & Sarkis, 2006). Due to the changes in regulations, laws, lifestyle, and customer tastes in society and their outcomes, organizations or manufacturers need to implement more reliable approaches to encourage sustainable management at all stages of their supply chain (Taghavi et al., 2021). The environmental burden is affected by every stage of the supply chain, including resource extraction, manufacturing, distribution, product consumption, waste disposal, and other activities. Environmental risks include excessive water and energy consumption without conservation, the use of dangerous substances, pollution, and more. Besides the supply chains that have devasting environmental effects, increasing population growth, urbanization, and, on the other hand, the rapid increase in greenhouse gases, environmental concerns around the world have been given more attention (Zhou et al., 2019). Governments and organizations seem to be aware that the traditional supply chains, which seek to maximize profits, are the cause of these adverse effects. Therefore, it is necessary for traditional supply chains to confirm the response to environmental concerns. Therefore, sustainable supply chain management is an advice to improve the consequences of sustainability in supply chains (Hoseini et al., 2021). Researchers and academics came up with a variety of concepts to incorporate environmental concerns into the management of business processes and develop the concept of green supply chain management (GSCM). The concept of GSCM is essential for companies to achieve a competitive advantage in implementing innovative strategies (Aalirezaei et al., 2018; Hoseini et al., 2021; Fitriana, 2022). However, employing GSCM helps reduce waste production and enhances the environment's performance (Taghavi et al., 2021).

GSCM is an approach for integrating environmental considerations into the supply chain management process, begin with product design and continuing thru product procurement and sourcing, production processes, finished product distribution, and product lifecycle management (Tronnebati & Jawab, 2020; Aalirezaei et al., 2018). In order to achieve a sustainable competitive strategy, GSCM is attempting to use green logistics and environmental improvement throughout the entire supply chain as a strategic tool. The objectives are based on three main subjects: green (product) design, green (process) production, and product recycling (Boks & Stevels, 2007). According to statistics, by implementing environmentally friendly methods, GSCM can regulate 80% of environmental impacts (Ren et al., 2019).

In analyzing the GSCM performance of an organization or company, a tool is needed that can measure this, the most popular and most widely employed for measuring the performance are SCOR, Economic Value Added (EVA), Balanced ScoreCard (BSC), Six Sigma, and many more. Meanwhile, for this research, a tool will be used in the form of a SCOR model or Supply Chain Operation Reference. SCOR is a product of APICS following the merger between the Supply Chain Council and APICS in 2014 and for this research using SCOR model version 12.0 which produce in 2017. SCOR itself is a tool to analyze every supply chain activity of an organization or company, from this analysis an organization or company can determine strategies or changes to their supply chain system with the aim of increasing effectiveness (APICS, 2017). The SCOR model has been developed to describe all corporate processes involved in responding to consumer demand. The model itself is divided into several tabbed sections and is organized on the six main management processes of Plan, Source, Make, Deliver, Return, and Enable. For both large-scale projects and site-specific projects, the model has been able to properly define and offer a foundation for supply chain optimization. When dealing with environmental sustainability concerns, SustainableSCOR employs GRI definitions and measurements (GRI 300 series Topic-Specific Standards). This approach is being employed to assist supply chain professionals to become more visible of the environmental issues present in their value and supply chains, allowing them to model and manage these impacts. An organization can employ the current SCOR-based methodologies for defining supply chain scope and configuration by integrating SustainableSCOR metrics into the SCOR Model. Following the completion of this process, SustainableSCOR metrics allow for the gathering of targeted, structured data as well as the calculation of metrics. In the end, give a comprehensive overview of supply chain environmental performance.

In this research, the performance of GSCM for each SustainableSCOR indicator will be calculated at a company called PT. Hari Mukti Teknik which this company is a manufacturing company that produces various types of laundry machinery such as washing machines, dryers, and others. The company is located in Jln. Wonosari KM 8.5, Dusun Padangan RT.02/RW.25, Sitimulyo Village, Piyungan, Bantul, Yogyakarta Special Region (DIY). PT. Hari Mukti Teknik has the desire to apply an approach based on environmental conservation to their products including their production process, this is stated in the company vision and mission. According to observations and interviews in the company, PT. Hari Mukti Teknik has never taken measurements on their supply chain regarding green supply chain management (GSCM). Due to these things, the authors chose this company to help measure the company's GSCM rate where the output can be used by the company to consider choosing a suitable approach that can be applied to their supply chain with the hope to increase the company's GSCM rate in the order to gain the company vision and mission. In calculating the GSCM, the indicator taken from the SCOR guidebook version 12 made by APICS specifically uses SuistainableSCOR and will be compared between the actual data obtained from this measurement with company-specific metrics to obtain the gap for each indicator.

1.2 Problem Formulation

Based on the research background, the problem formulation that can be made are:

1. What type of indicator on SuistainableSCOR need to be improved by the PT. Hari Mukti Teknik?
2. How to improve the green supply chain performance at PT. Hari Mukti Teknik based on SuistainableSCOR findings?

1.3 Research Objective

Based on the problem formulation, the objectives to be achieved through this research:

1. Identifying the performance attributes based on SuistainableSCOR that need to be improved by the PT. Hari Mukti Teknik.
2. Providing recommendations and suggestions for PT. Hari Mukti Teknik on how to improve their green supply chain performance based on SuistainableSCOR findings.

1.4 Scope of Research

There are several limitations of this research that must be known as guidelines in carrying out this undergraduate thesis research, the limitation of this undergraduate thesis research are:

1. This research was conducted at PT. Hari Mukti Teknik.
2. This research uses the object of the Kanaba Washer Barrier Softmount 50 kg where this product is only one of the products produced by PT. Hari Mukti Teknik.
3. The key performance indicator (KPI) or company specific-matrix used is the following the current situation at the company.
4. This research only focuses on environmental aspects.
5. The data were obtained through observation and interviews at PT. Hari Mukti Teknik.

6. The data were taken from October to November 2022.
7. The analysis result will be provided as the recommendation and suggestion for PT. Hari Mukti Teknik.

1.5 Benefits of Research

The benefits of the research that will be obtained can be used by many parties with the following details:

1. For college students, his research is expected to provide applied theory and its relevance as a preparation before entering the world of work and as to measure the abilities or skills to gain new experience or skills.
2. For the community, this research is expected to be able to become a reference for improving the performance of a business or industry so that more people develop businesses and have an impact on economic as well as environmental improvement in the community.
3. For the government, this research is expected to be able to become a reference for measuring the performance of a business or industry so that more people are interested to develop businesses and give an impact on economic as well as environmental development in the community.
4. For the company, this research is expected to be able to help in giving recommendations and suggestions to environmental problems in the company, according to the scientific capacity of the student concerned and familiarity with the scientific profession of Industrial Technology, especially in the field of Industrial Engineering.
5. For the next researchers, this research is expected to become a future reference and will be developed more by future researchers who have an interest in this undergraduate thesis research topic.

1.6 Systematic Research

This undergraduate thesis research report will be organized into several chapters which will be explained below:

CHAPTER I INTRODUCTION

This chapter contains the background for the undergraduate thesis research, problem formulation from the research background, objectives of the research, scope of the research, and also benefits of this research.

CHAPTER II LITERATURE REVIEW

This chapter will summarize the findings from prior research which are relevant to this research. After reviewing the prior research thoroughly, it will become the reference for this undergraduate thesis research to solve the existing problem.

CHAPTER III METHODOLOGY

This chapter describes the framework, flow chart, and data collection method of this undergraduate thesis research. This part will help to make the research more structured and organized. In this chapter, the flow of the research will be explained in detail so that the readers can understand the research methodology.

CHAPTER IV DATA COLLECTION AND PROCESSING

This chapter describes the types of data that will be used in this research including the approach to obtaining the data. Besides that, this chapter will explain the overview of the company along with the problems which makes the reason for this research conducted as well as sales data which is used as the basis for data processing using the SCOR version 12 method, especially using SuistainableSCOR to determine the performance of the green supply chain along with the results of each processing on the indicator used which will be used to make strategies or changes to their supply chain system with the aim of increasing environmental and economic effectiveness.

CHAPTER V RESULT AND DISCUSSION

This chapter will discuss the result of the data collection conducted in the previous chapter. The analysis in this chapter is carried out by comparing the results of data processing with a metric obtained from findings in previous research to determine the performance of the company supply chain. After knowing the performance that must be improved, this chapter will provide recommendations and suggestions on how the company can provide improvements to its green supply chain performance based on SustainableSCOR findings.

CHAPTER VI CONCLUSION AND SUGGESTION

This chapter is closing that contains conclusions, recommendations, and suggestions regarding the undergraduate thesis research. The conclusion is made based on the result and discussion and must answer the objective of the research.

CHAPTER II
LITERATURE REVIEW

2.1 Empirical Study

2.1.1 Supply Chain Management

The supply chain is a series of all activities of an organization or company that are related to one another or in other words a series that connects upstream, middle to downstream. The middle series can define as a supplier, manufacturer, distributor, shop, or company retail, as well as supporting companies such as logistic service providers.

According to Wang et al. (2016) and Christopher (2000), A supply chain, in general, is a collection of parties engaged in a series of processes including the acquisition of raw materials or components, their assembly and/or conversion into a product, and the delivery of the finished product to a customer. Furthermore, Lamming et al. (2000) referred to the term "SCM" which originated in the early 1980s, at that time, it only referred to the management of materials across various functional boundaries within an organization. Later, it was expanded to include "upstream" production chains and "downstream" distribution channels. From several definitions from previous research, it can be concluded that the term "supply chain" refers to all of the processes involved in transforming and distributing goods and services, along with the ensuing information flows, from raw material sources to final users. All these activities, both internal and external, are integrated with management. By coordinating numerous tasks in a supply chain, SCM traditionally seeks to decrease the total of these costs. Additionally, it works to increase availability, product quality, and delivery times in a way to meet customer satisfaction (Sadeghi et al., 2016; Christopher, 2000).

According to research conducted by Fawcett et al. (2008), from their research there is a figure that explains the benefits of supply chain management, the image can be seen below.

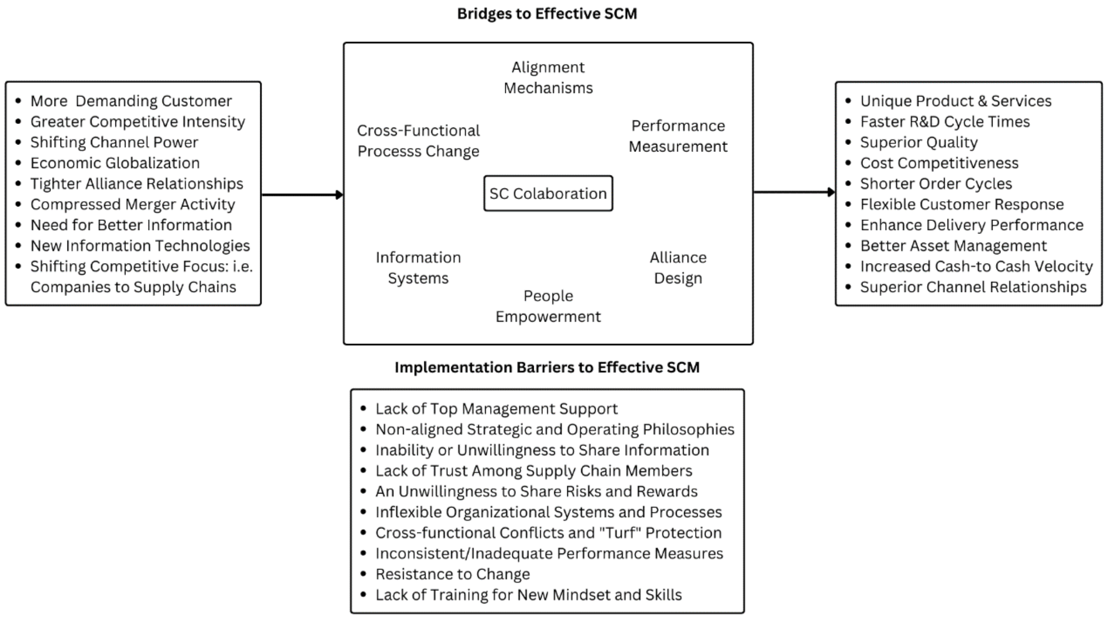


Figure 2.1 Benefits of Supply Chain Management.

Source: Fawcett et al. (2008)

The figure above offers a sample of the SC benefits literature. The main desired benefits are increased inventory turnover, increased income, and cost reductions across the supply chain. In addition to reducing expenses for both parties, collaboration enables inventory to reach customers more quickly. Increased revenue and reduced costs that can be shared across the chain are the two-fold results.

To achieve customer loyalty, companies must provide what customers want when and where they want it. Close relationships with suppliers allow for customized orders during peak periods of high demand, assisting in meeting client expectations. Other advantages are increased market responsiveness, increased economic value, capital utilization, reduced product time to market, and reduced logistics costs. Revenue growth driven by better responsiveness at lower costs and with fewer assets contributes to excellent performance. Overall, SCM has the opportunity to provide value for each member of the chain. However, the value and extent of these advantages vary among chain members.

2.1.2 Green Supply Chain Management

Green supply chain management (GSCM) is an approach as well as a modification of the concept of supply chain management (SCM) in general, where this approach has the same concept as supply chain management (SCM) which is used to increase availability, product quality, and delivery times in a way to meet customer satisfaction (Christopher, 2000). In the concept of green supply chain management (GSCM), environmental aspects are added as a concern.

According to Xing Qianhan et al. (2010), The term "green supply chain management" (GSCM) refers to a specific implementation of the sustainable development approach in manufacturing enterprises. It may be effective in reducing environmental pollution and useful in improving manufacturing companies' competitiveness. The GSCM concept seeks to reduce negative environmental impacts and increase resource efficiency throughout the whole product lifecycle, from raw materials, production processing, packing, storage, and distribution, through scrap recycling (Pulansari & Putri, 2020; Xing Qianhan et al., 2010). Furthermore, according to Taghavi et al. (2021), GCSM is a new concept for determining the right direction for developing products to be compatible with environmental regulations and predetermined standards, and businesses require it as a strategy to collaborate on solving environmental problems. The green supply chain concept aimed to enhance the ecological knowledge of businesses, their stakeholders, and related individuals. Because a green supply chain (GSM) increases credibility, efficacy, distinction, and revenue growth, it has caught the attention of managers and inspired them to implement this concept. According to statistics, by implementing environmentally friendly methods, GSCM can regulate 80% of environmental impacts (Ren et al., 2019).

2.1.3 Supply Chain Performance Measurement

A supply chain performance measurement system is an important role for an organization or company in identifying its supply chain performance, from this measurement the organization or company can determine its decisions or strategies to improve the supply chain system with the aim of increasing supply chain effectiveness (Pulansari & Putri, 2020).

According to Balfaqih et al. (2016), In supply chain performance measurement, it's crucial to measure the right thing at the appropriate time so that decisions could be made immediately. The lack of linkage between organizations' strategies and the measurements employed, the lack of relating measures to customer value, the biased focus on financial metrics, and the availability of numerous contradictory performance indicators are common problems in performance measurement systems (PMS) (Brewer & Speh, 2000).

In order to focus on appropriate data collecting and calculation techniques, performance measurement criteria should also be based on business objectives and have a clear definition of purpose and scope (Balfaqih et al., 2016).

There are various goals for establishing a PMS in the supply chain, including identifying success, determining whether customer needs are met, understanding business processes, providing factual decisions, enabling progress, tracking progress, and identifying bottlenecks, waste, problems, and improvement opportunities (Gunasekaran & Kobu, 2007). As a result, it is crucial to take the SC into consideration as a whole when creating a supply chain performance assessment system (SCPMS). In analyzing or improving the supply chain performance of an organization or company, a tool is needed that can measure this, the most popular and most widely employed for measuring the performance is SCOR, Economic Value Added (EVA), Balanced ScoreCard (BSC), Six Sigma, and many more.

2.1.4 Supply Chain Operation Reference (SCOR)

The Supply Chain Operations Reference model (SCOR) is the product of APICS following the merger between the Supply Chain Council and APICS in 2014. In order to keep up with changes in supply chain business practices, the SCOR model was created in 1996 and is continuously updated. For analyzing and comparing the performance of the supply chain, SCOR is still a valuable tool. SCOR captures a common understanding of supply chain management. It offers a special framework that integrates business operations, metrics, best practices, and technology into a single framework to enhance supply chain partners' communication and improve the effectiveness of supply chain management and related supply chain improvement activities.

Referring to SCOR guidebook version 12, the SCOR model was established to describe the business activities involved in all phases of meeting consumer demand. The model itself is divided into several tabbed sections and is organized on the six main management processes of Plan, Source, Make, Deliver, Return, and Enable.

2.1.5 SuistainableSCOR

According to the SCOR Guidebook version 12.0, SustainableSCOR is a development of the previous SCOR model made by APICS. The development of this model adds several considerations related to environmental conservation on the indicator that exists in the

SCOR model. Thus this model is used as a tool to evaluate and compare supply chain activities and performance in terms of environmental impacts as described by Ntabe (2015) which states that GreenSCOR (which has the same concept as SustainableSCOR) is a modified model that is integrated with environmental considerations in 5 (five) key management processes in SCOR, metrics, and best practices into supply chain processes by considering the impact of operations at each stage of the product cycle.

In this study, the indicator selection used refers to the SCOR guidebook version 12.0 made by APICS (2017) which was selected from SustainableSCOR. SustainableSCOR itself is defined as a model that works like SCOR in general which defines a scope of a supply chain, and processes operations and measures supply chain performance and provides a good foundation for the environmental context in a supply chain. SuistainableSCOR uses the GRI (Global Reporting Initiative) definitions and measurements when dealing with sustainable environmental topics (GRI 300 Series Special Topic Standards). This approach is used to help an expert in a supply chain context gain visibility into environmental topics that exist in their supply chain and value chain networks and enable them to model and manage their impacts. GRI (Global Reporting Initiative) is an independent international organization that helps businesses or other organizations to identify and analyze their impacts and be able to account for their impacts, by providing a common language to communicate these impacts. GRI standards help organizations to understand and report their impact on the economy, environment, and people in a comparable and credible manner, so it can increase transparency or their contribution to sustainable development (GRI - Standards, n.d.).

2.1.6 Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a theory used to decide a decision or in other words, AHP is a structured technique to organize and analyze complex decisions which are based on mathematics and psychology. According to Saaty (1994) AHP is a framework of thought that is used to unify a framework of thought or logic and problem-solving that has a spectrum ranging from an instant awareness to a fully integrated consciousness by organizing perceptions, feelings, judgments, and memories into a hierarchy of powers that have an influence on the outcome of the decision. In this data processing concept, a pairwise comparison weighting questionnaire is needed for each alternative used which will be filled out by someone who has expertise in that field (Saaty, 1994; Susanty et al., 2016).

In research conducted by Grzybowski & Starczewski (2020), it is said that the priority determination technique used in the AHP framework is based on what is called a pairwise comparison matrix (PCM). PCM contains the decision maker (DM) evaluation of the priority weight ratio. This evaluation is often called a DM assessment which is usually expressed in the value of a predetermined set of numbers called a scale (Dong et al., 2008; Franek & Kresta, 2014; Kou et al., 2016; Saaty, 1994). In expressing opinions, a scale of 1 to 9 is the best scale according to Saaty (1993) with a paired comparison rating scale as follows.

Table 2.1 Paired Comparison Rating Scale Definition.

Intensity of Importance	**Definition**	**Explanation**
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	-
3	Moderate importance	Experience and judgment slightly favor one activity over another
4	Moderate plus	-
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	-
7	Very strong or demonstrated importance	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	-
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

Source: Saaty (1993).

Table 2.2 Pairwise Comparison Questionnaire Example.

No	**Indicator**	**Scale**																	**Indicator**
1	SS.1.003 Total Supply Chain Non-Renewable	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.004 Total Supply Chain Renewable

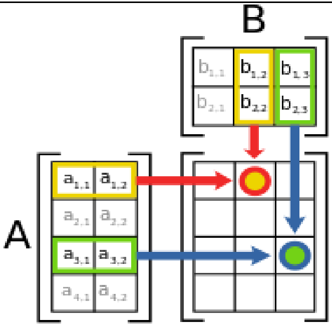
	Material Used																	Material Used
…	…	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	…
…	…	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	…
…	SS.1.025 Total Supply Chain Non-Hazardous Waste	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.026 Total Supply Chain Hazardous Waste.

Source: Saaty (2008).

In the pairwise comparison matrix (PCM), the weighting will be carried out using a questionnaire as described previously. After the weighting is done, the next step is to normalize the data and later the results of data normalization will be totaled for each indicator and these results will be used in calculating the eigen vector, multiplication matrix, eigen value (λ), λ_{max}, consistency index (CI), index ratio (IR), and consistency ratio (CR), below are the details of each calculation carried out in data processing this time (Susanty et al., 2016; Franek & Kresta, 2014; Garminia et al., 2011; Dong et al., 2008).

Table 2.3 Calculation Matrix on AHP Method.

Calculation Matrix	**Definition**	**Formula**
Total Weight Matrix	Total weight of all the alternatives used which have been normalized.	$= Total\ Weight\ of\ Criteria\ X$
Eigen Vector	A non-zero vector that only changes in length when multiplied by the matrix.	$= \frac{n}{Total\ Weight\ of\ Overall\ Criteria}$ *n is the total number of alternatives used.
Multiplication Matrix	A binary operation that produces a matrix from two matrices	$C = \begin{pmatrix} a_{11}b_{11} + \cdots + a_{1n}b_{n1} & \dots & a_{11}b_{1p} + \cdots + a_{1n}b_{np} \\ \dots & \dots & \dots \\ a_{m1}b_{11} + \cdots + a_{mn}b_{n1} & \dots & a_{m1}b_{1p} + \cdots + a_{mn}b_{np} \end{pmatrix}$ If A is an m × n matrix and B is an n × p matrix, the product of the matrix C = AB (denoted without a multiplication sign or a dot) is defined as an m × p matrix

Calculation Matrix	Definition	Formula
	whose number of columns in the first matrix must be equal to the number of rows in the second matrix.	 *or* $= MMULT(array1; array2)$ – for calculations using excel
Eigen Value (λ)	A factor used to scale eigenvectors. Geometrically, an eigenvector, which corresponds to a real nonzero eigenvalue, is pointed in the direction in which it is stretched by the transformation and the eigenvalue is the factor in which it is stretched (Burden & Faires, 1993).	$= \frac{Multiplication\ Matrix\ Result\ for\ Each\ Criteria}{Eigen\ Vector\ Result\ for\ Each\ Criteria}$
λ_{max}	The highest value of the eigenvalue (λ) of a matrix.	$= \frac{Total\ Weight\ of\ Eigen\ Value\ on\ Overall\ Criteria}{n}$ *n is the total number of criteria used.
Consistency Index (CI)	A value that shows the level of consistency of a decision from comparative	$= \frac{\lambda_{max} - n}{n - 1}$ *n is the total number of criteria used.

<table>
<tr><th>Calculation Matrix</th><th>Definition</th><th>Formula</th></tr>
<tr><td></td><td>data between a pair of criteria.</td><td></td></tr>
<tr><td>Index Random (IR)</td><td>The average value of the consistency index of several specific values of random number pairwise comparison metrics.</td><td><table><tr><td>n</td><td>1,2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td></tr><tr><td>IR</td><td>0</td><td>0,58</td><td>0,90</td><td>1,12</td><td>1,24</td><td>1,32</td><td>1,41</td><td>1,45</td><td>1,49</td><td>1,51</td></tr></table>*n is the total number of criteria used.</td></tr>
<tr><td>Consistency Ratio (CR)</td><td>The value used to measure the degree of deviation from pure inconsistency in each matrix size. The recommended CR value should not be more than 0.1 (Saaty, 1994).</td><td>$$= \frac{CI}{IR}$$</td></tr>
</table>

2.2 Inductive Study

An inductive study is a study or drawing conclusions from previous related studies or research and will be used as a reference for research to be carried out in terms of using methods that are in accordance with the case study to be studied. The table below describes several previous research journals related to green supply chain performance measurement using SustainableSCOR in a company along with the results in the form of conclusions from the research in this study.

Table 2.4 Inductive Study.

No	Author	Title	Research Method	Result
1	F. Pulansari and A. Putri (2020).	Green Supply Chain Operation	GreenSCOR, Consistency Test, Snorm de	Based on their research, they use Green Supply Chain Operation

No	Author	Title	Research Method	Result
		Reference (Green SCOR) Performance Evaluation (Case Study: Steel Company)	boer, Traffic Light System.	Reference (Green SCOR) as the main method to measure green supply chain performance on their research object (Steel Company). They use 19 (nineteen) variables for measuring green supply chain performance. After they complete measuring and processing all data related to a variable that they use, they do weigh between key performance indicator (KPI) processes with the GreenSCOR to determine the importance of the existing KPI. After that, they calculate every variable that they use to know the score of each variable with the aim to know the variables that need to improve using the traffic light system. The result of green performance measurement is 67,73 (average category). From the snorm value in the traffic light system, the water used is the lowest with a value of 38. Shows that is a lack of performance value and needs to be improved.
2	Rangga Primadasa and Akh Sokhibi (2020).	Green SCOR Model for Green Supply Chain Performance Measurement Management (GSCM) of	Green Supply Chain Management (GSCM), GreenSCOR, Analytical Hierarchy Process (AHP).	The objective of this research is to develop Key Performance Indicators (KPIs) to evaluate green supply chain management (GSCM) in the palm oil sector in Indonesia. The process for developing

No	Author	Title	Research Method	Result
		Palm Oil Industry in Indonesia		KPI uses The Green SCOR Model as a framework to generate all of the indicators and green objectives. For the palm oil industry in Indonesia, there are 23 KPIs from 9 green targets for GSCM. The analytical hierarchy process (AHP) was used to measure the importance grade of KPIs in order to ensure that they were more precise. According to experts in the palm oil industry, managing plantations and palm oil mills using the certification of the Roundtable on Sustainable Palm Oil (RSPO) and Indonesian Sustainable Palm Oil System (ISPO) is the leading green objective (29,7%), followed by reducing and tackling greenhouse gas emissions (15,9%), and managing waste (11,8%).
3	Erfan Taghavi, Alireza Fallahpour, Kuan Yew Wong and Seyed Amirali Hoseini (2021).	Identifying and Prioritizing the Effective Factors in the Implementation of Green Supply Chain Management in The Construction Industry.	Green Supply Chain Management (GSCM), Multi-Criteria Decision-Making (MCDM), Fuzzy Decision-Making Trial and Evaluation Laboratory (FDEMATEL).	This paper aims to identify and categorize the essential factors that influence the implementation of green supply chain management (GSCM) in the construction sector. Fuzzy decision-making trial and evaluation laboratory (FDEMATEL) and fuzzy analytic network process (FANP) have been developed to fulfill the

No	Author	Title	Research Method	Result
				objective. An extensive literature review was used to identify the parameters used in this approach, and the validation criteria were introduced through the opinions of the experts to discuss regarding data uncertainty. The FDEMATEL method first establishes the linkages between the criteria that are used to decide which are the most crucial factors in the GSCM approach. After that, the local weight of the criteria was determined by the FDEMATEL method and the FANP approach, which is based on cause-and-effect correlations. The study's findings demonstrate that external. The findings of this study can help managers make better use of the GSCM method in the Iranian construction industry since the results demonstrate that external factors are the most significant and influencing aspects of the GSCM approach.
4	Yuanyuan Zhou, Li Xu and Ghulam Muhammad Shaikh (2019).	Evaluating and Prioritizing the Green Supply Chain Management Practices in Pakistan: Based on Delphi and	Green Supply Chain Management (GSCM), Delphi, and Fuzzy Analytical Hierarchy Process (AHP).	This research's evaluation of green SCM techniques was done from Pakistan's standpoint. Using the tools of Delphi and Fuzzy AHP, the primary objective of this research was to generate important indicators for analyzing

No	Author	Title	Research Method	Result
		Fuzzy AHP Approach		green SCM practices. Three textile manufacturing companies have been chosen for this study's further research. The Fuzzy AHP results showed that the most important indicators for the adoption of green SCM practices in Pakistan are green production, green design, and green purchasing. The least important indicators for the development of green SCM are green warehousing, green logistics, and reverse logistics. Furthermore, selecting an eco-friendly supplier, pushing suppliers to take eco-friendly actions, and eco-design products were the topmost sub-indicators for green SCM practices. The results of the alternatives then show that the manufacturing firm (F1) is the optimal manufacturing company for Pakistan's sustainable implementation of green SCM practices. Managers would be helped by this decision-making process to evaluate and determine the optimal company in Pakistan for green practices.
5	Aries Susanty and Sri Radina Putri Nur	Using GreenSCOR to Measure	Green Supply Chain Management	In this research study, measurements and analyses related to the

No	Author	Title	Research Method	Result
	Hidayatika (2016).	Performance of The Supply Chain of Furniture Industry.	(GSCM), GreenSCOR, Analytical Hierarchy Process (AHP), Snorm de Boer Importance-Performance Analysis (IPA).	performance of green supply chain management (GSCM) were carried out by 20 furniture companies in Jepara, including 3 (three) large-scale enterprises on in-house manufacturing indoor, 4 (four) large-scale enterprises on in-house manufacturing outdoor, 6 (six) medium-scale enterprises on in-house manufacturing indoor and 7 (seven) medium-scale enterprises on in-house manufacturing outdoor. Data collection in this study used an interview and a questionnaire system. After that, data processing is carried out on each GreenSCOR attribute used and then weighted the importance level for each attribute. The last calculation process is to equalize the attribute scores using the snorm de boer method and then data processing is carried out again to determine the GSCM score for each research object. The last step is to create a dashboard using the importance-performance analysis (IPA) method for plotting individual indicators. The measurement results showed that, when compared between

No	Author	Title	Research Method	Result
				medium-scale in-house manufacturing indoors and large-scale in-house manufacturing outdoors, the enterprises in the category of large-scale in-house manufacturing outdoors have a better aggregate value of the sum total of performance index of each indicator for the implementation of GSCM practices.
6	Sumeet Gandhi, Sachin Kumar Mangla, Pradeep Kumar & Dinesh Kumar (2016).	A Combined Approach Using AHP and DEMATEL for Evaluating Success Factors in Implementation of Green Supply Chain Management in Indian Manufacturing Industries.	Green Supply Chain Management (GSCM), GreenSCOR, Analytical Hierarchy Process (AHP), Decision-Making Trial and Evaluation Laboratory (DEMATEL)	In this study, an evaluation related to success factors (SF), or can be called with attributes that are related to the implementation of green supply chain management (GSCM) from the Indian manufacturing industry perspective is carried out. This study uses 24 SF or attributes that are relevant to the application of GSCM which are obtained from previous research and input from experts. After processing the data for each SF or its attributes, the data is processed again using the Analytical Hierarchy Process (AHP) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) method. Using the AHP method, it is able to compare the implementation of the GSCM and SF in terms of importance and priority.

No	Author	Title	Research Method	Result
				The DEMATEL method also analyzes the interacting links between the SF using a causal effect mapping framework. The suggested model can assist business managers and practitioners in formulating both short- and long-term flexible decision-making strategies for effectively managing a green supply chain.
7	Vijay Sharma, Pankaj Chandna and Arvind Bhardwaj (2017).	Green Supply Chain Management Related Performance Indicators in Agro Industry: A Review	Green Supply Chain Management (GSCM), GreenSCOR, Reliability Analysis, Analytical Hierarchy Process (AHP), Sensitivity Analysis, and Statistical Analysis.	The purpose of this study is to analyze the performance indicators and sub-indicators that are responsible for implementing green supply chain management (GSCM). This study also conducted a literature review and consultation with industrial experts to gain performance indicators used, which are 13 indicators and 79 sub-indicators. The type of data taken is quantitative data which is taken using a standard questionnaire and followed by qualitative data collection. The next step is reliability analysis to see internal consistency associated with the scores corresponding to the performance indicators. The next step is doing an analytic hierarchy process (AHP) in which comparing the criteria and defining their significance

No	Author	Title	Research Method	Result
				over each other was done by discussing it with the experts from the industry and environmental management system or in other words this method is used to find the final priority weights of the indicators and sub-indicators used. Sensitivity analysis has been used to determine how sensitive weighting is while creating a comparison matrix. It has been employed in this study to ascertain how weights affect the final ranking of performance indicators responsible for GSCM implementation. To determine where the middle value of the data sits, statistical analyses like mean, mode, median, and variance have also been done on the data. As a result of this study, the most important performance indicator is internal environmental management, which is dependent on top management's commitment to adopting sustainable practices in order to attain GSCM.
8	S. Uddin, S. M. Ali, G. Kabir, S. A. Suhi, R. Enayet and T. Haque (2019).	An AHP-ELECTRE Framework to Evaluate Barriers to Green Supply Chain	Green Supply Chain Management (GSCM), Analytical Hierarchy Process (AHP),	This study discusses the implementation of green supply chain management (GSCM) in the leather-processing industry (LPI) in Bangladesh. The leather-processing

No	Author	Title	Research Method	Result
		Management in the Leather Industry	Elimination Et Choix Traduisant La Realite (ELECTRE-I), Sensitivity Analysis.	industry (LPI) in Bangladesh is struggling with many obstacles to implementing GSCM. This study uses the barrier indicators obtained from previous studies. However, the purpose of this research is to focus on these indicator gaps to be used as an evaluation in increasing the effectiveness of GSCM implementation. To identify and prioritize the potential barriers to implementing GSCM in the leather industry, this study integrates the Analytical Hierarchy Process (AHP) and Elimination Et Choix Traduisant La Realite (ELECTRE-I) methods. The proposed framework is put into practice at a leather-processing factory in Bangladesh to validate it. A sensitivity analysis is carried out to examine the reliability of this method's outcome. The result of this research indicates that while green technology and techniques are the most efficient pathways to GSCM, the high cost of advanced technology is the main barrier to its implementation. The results of this study will help researchers and practitioners by providing

No	Author	Title	Research Method	Result
				information on barriers and potential approaches for implementing GSCM.
9	K. Mathiyazhagan, Ali Diabat, Abbas Al-Refaie and Lei Xu (2015).	Application of Analytical Hierarchy Process to Evaluate Pressures to Implement Green Supply Chain Management.	Green Supply Chain Management (GSCM), Analytical Hierarchy Process (AHP).	The research purpose is to look at the pressures on GSCM adoption and categorize those pressures according to the opinions of experts. This study uses 15 indicators which are the main focus of analysis. After processing the data on each attribute used to find out the gap in each attribute. The next step is attribute weighting in which the weighting data collection is obtained with a questionnaire given to 35 experts in 10 mining and mineral industries in north India. After that, the attribute priority classification process is reprocessed using the analytical hierarchy process (AHP) method to determine the attribute priority scale that needs to be improvised to increase the effectiveness of GSCM. The conclusion of this research is that the highest score is on the attribute Pressure from Non-governmental organizations (NGO) for environmentally friendly products (E2). This work successfully provides recommendations for the mining and mineral industries, including the

No	Author	Title	Research Method	Result
				necessity for strong oversight through governmental rules. Second, for the government to provide additional financial incentives to firms that have begun implementing environmental standards. This study simplifies the work of identifying major pressures on GSCM adoption for all department managers.
10	Abhishek Mojumder and Amol Singh (2021).	An Exploratory Study of the Adaptation of Green Supply Chain Management in Construction Industry: The Case of Indian Construction Companies.	Green Supply Chain Management (GSCM), Analytical Hierarchy Process (AHP), ANOVA, Spearman Correlation Coefficient.	This study uses the object construction industry in India, various drivers, enablers, and barriers to the adoption of green supply chain practices have been reported. The primary purpose of the current research study is to first examine how well different types of Indian construction companies are able to adopt green supply chain practices and then to determine the relationship between these variables and the readiness of the construction sector to adopt these practices. Using the AHP methodology, these drivers, enablers, and barriers are then ranked in order of importance. Senior construction project managers from Indian construction firms of various sizes and geographic areas were

No	Author	Title	Research Method	Result
				given a questionnaire to fill out. Descriptive statistics are used for preliminary analysis. Using ANOVA and spearman's correlation coefficient, four hypotheses are examined. The AHP technique is also used to develop the priority structure for drivers, enablers, and barriers. The findings show that the theories of institutions, complexity, ecological modernization, resource-based view, and resource dependency are strongly supported. The research will assist construction project managers and clean production policymakers in making more informed, systematic, and effective decisions while implementing sustainable supply chain strategies within the context of the construction industry.

CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Object

The object of this research is to evaluate and improve the implementation of green supply chain management (GSCM) using Supply Chain Operation Reference (SCOR), especially using SuistainableSCOR approach with the newest model of SCOR which is SCOR version 12.0. The data used in this research was obtained from interviews and observations of the supply chain process in PT. Hari Mukti Teknik. This research objective is to improve the green supply chain management (GSCM) performance to meet the globalization needs in PT. Hari Mukti Teknik that located in Dusun Padangan RT.02/RW.25, Sitimulyo Village, Piyungan sub-district, Bantul district, Yogyakarta Special Region (DIY) province.

3.2 Research Instrument

This research uses the questionnaire as a medium to collect data regarding with green supply chain condition of PT. Hari Mukti Teknik addressed to the head of the production department. Another instrument is Excel that used for processing the data.

3.3 Data Collection Method

There are two types of data used to support this research which are primary and secondary data. Those two types of data have different data collection methods. The following explains the data used and the data collection method.

3.3.1 Primary Data

Primary data is information gathered for the first time by the researcher to solve the problem at hand. Surveys, observations, tests, questionnaires, and personal interviews are examples of key data sources. This research will conduct an observation, interview, and questionnaires with the head of the production department of PT. Hari Mukti Teknik to obtain some information and data that are needed for this research. The scope of the interview and questionnaire method is to gain related data that is needed in this research like business processes, sales data, and others. The data and information that are already obtained will be transferred from qualitative to quantitative data.

3.3.2 Secondary Data

Secondary data refers to information that has already been gathered, produced, and accessed by other researchers. Previous literature such as books, journals, articles, and other publications was used to support this research.

3.4 Data Processing Method

Data processing is an activity to change or manipulate the data taken into a form of information that is easy to understand and later can be used as a basis for making decisions. Data processing in this research can be seen below:

1. The first step in this research is to identify the situation of the object of research such as an overview of the company's business processes, the background of the problems that have occurred, efforts undertaken, and the organizational structure of the company with the aim of knowing the objectives of the improvement program.
2. Identifying business processes and company achievement expectations that aim to determine the SuistanableSCOR indicator in accordance with the expected outcomes of this research can help the company to gain its objective.
3. After determining the indicator used, the next step is data collection by using the method of observation and interviews, continued with data processing on each indicator to determine the gap for each indicator, processing at this phase is defined by comparing the actual data with special metrics owned by the company to achieve their goals on each indicator used.
4. The next step is to weigh the importance of each indicator (level-1 indicator dan level-2 indicator) used. To get the weighting data is done by filling out questionnaires by experts (in the context of this research is the head of the production department).
5. After the weighting data is obtained, the next step is data processing using the analytical hierarchy process (AHP) method, followed by calculating the eigen vector, multiplication matrix, eigen value (λ), λ_{max}, consistency index (CI), index ratio (IR), and consistency ratio (CR) where the calculation is to determine the weight of priority that has been normalized for every indicator (level-1 indicator dan level-2 indicator).
6. After completing data processing using the AHP method, from the data processing, it can be seen the priority scale of each indicator used, and at this stage, a data processing recapitulation will be carried out which contains actual data, company-

specific metrics, gaps, local weights (level-1 and level-2), and global weight of each indicator to determine the priority scale.

7. The next step is to provide recommendations and suggestions to the company regarding the gaps that exist in each indicator that are adjusted to the priority scale with the aim of improving the company's GSCM performance.

3.5 Data Analysis Method

The descriptive analysis technique is a statistic used to analyze data by describing or summarizing the data obtained as they are without the intention of drawing generalizable conclusions or making generalizations (Sugiyono, 2014). Some data in this study may be gathered qualitatively, but it is frequently examined quantitatively, with frequencies, percentages, averages, or other statistical analyses used to identify correlations. The qualitative input will subsequently be translated into numerical data for comparison and assessment.

3.6 Research Flowchart

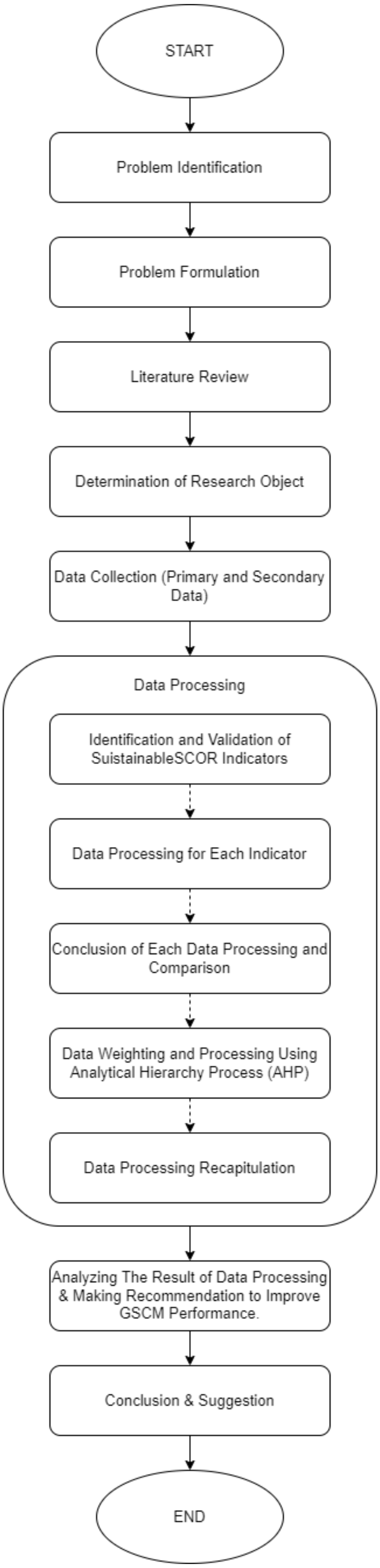


Figure 2.2 Research Flowchart.

Based on the figure above, the research flowchart will be explained further:

1. Problem Identification

   The identified problem can be found through preliminary observations and findings. The identified problem is the issue that will be researched and focused on in this research to solve.

2. Problem Formulation

   The next step is to formulate the problems identified in order to determine the objectives and benefits of the research conducted.

3. Literature Review

   At this step, an analysis of the previous findings is carried out which has a context or topic that is under the context or topic discussed in this research. The purpose of this step is as a reference to assist in the implementation of this research.

4. Determination of Research Object

   The next step in this research is the determination of the research object. In determining the object of research, the company introduction was carried out through direct observation and interviews.

5. Data Collection (Primary and Secondary Data)

   For data collection, this study uses two types of data, namely primary and secondary data. Primary data are obtained directly by observing the object, interviews, and questionnaires. While secondary data are obtained from reviewing or quoting literature or previous research relevant to this research. Data collection starts from company profiles to supply chain activities in the company. The supply chain activity data is the main key in this research.

6. Data Processing

   After completing data collection, the next step is data processing in which there are 5 (five) main data processing in this study, the main data processing will be explained further:

   1) Identification and Validation of SuistainableSCOR Indicators

      In the initial step of data processing, identification, and validation are carried out regarding the use of the SustainableSCOR indicator, which is adjusted to the company objectives, so that the purpose of this research can help improve the effectiveness of GSCM performance.

2) Data Processing for Each Indicator

The next step is to process data on each indicator used using historical company data and the results will be used for comparison with company-specific metrics to determine gaps in each indicator.

3) Conclusion of Each Data Processing and Comparison

After completing data processing on each indicator, the next step is to conclude each indicator data processing and compare it with company-specific metrics to find gaps in each indicator. The gap here aims to determine which indicator needs to be improvised to increase GSCM performance.

4) Data Weighting and Processing Using Analytical Hierarchy Process (AHP)

In this step, the weighting of each indicator used is carried out by giving a pairwise-comparison questionnaire to an expert (in this study is the head of the production department), followed by processing with the AHP method, and followed by calculating the eigen vector, multiplication matrix, eigen value (λ), λ_{max}, consistency index (CI), index ratio (IR), and consistency ratio (CR) where the calculation is to determine the weight of priority that has been normalized for every indicator (level-1 indicator dan level-2 indicator).

5) Data Processing Recapitulation

The next step after processing data on each indicator followed by weighting and processing using AHP, this phase will be doing a recapitulation of the entire data processing process and there are actual data, company-specific metric data and gaps for each indicator. In addition, there are a weight for each indicator at level-1 and level 2 and there is an overall weight, from the data it can be seen the priority scale of each indicator.

7. Analyzing Results of Data Processing & Making Recommendations to Improve GSCM Performance.

After performing the calculation of the green supply chain management (GSCM) performance value, it will be known the level of GSCM that exists in the company and also from the gaps that are known during the calculation process for each indicator, it can be seen which indicators need to be improved and from the AHP process it can be seen the priority scale for each indicator that is not in accordance with company-specific metrics. In this study, recommendations will be given regarding how to improve the level of GSCM performance on each indicator used in this study.

8. Conclusion & Suggestion

   The conclusion is made to answer the objective of the research that has already been determined at the start. At the same time, the suggestions are accommodated as considerations and recommendations for future research regarding the same topics.

CHAPTER IV
DATA COLLECTION AND DATA PROCESSING

4.1 Data Collection

Observations and data collection was conducted at PT. Hari Mukti Teknik is done directly, while the data needed in this research is a general description of the company, the production process, the company vision and mission, as well as supporting data for the research such as the bill of material (BOM), specific product description document, specific material description document, supply chain water used, water used on specific product manufacture, waste produce, and weighting for each SCOR indicator used.

4.1.1 Company General Description

Figure 4.1 PT. Hari Mukti Teknik Logo.

PT. Hari Mukti Teknik was originally a workshop located in Jln. Wonosari KM 8.5, Dusun Padangan RT.02/RW.25, Sitimulyo Village, Piyungan, Bantul, Yogyakarta Special Region (DIY) with the name Bengkel Hari Mukti Teknik which serves welding products and washing machine repairs. Hari Mukti Teknik workshop started operating in 2008 until now it has become PT. Hari Mukti Teknik with Mr. Ashari as a owner.

In the beginning, PT. Hari Mukti Teknik was a workshop that only served customers for welding products and washing machine repairs. However, with the point of view of very satisfactory work, consumer demand began to vary. To be able to meet consumer demand and continue to maintain business, Hari Mukti Teknik workshop is required to innovate and develop its business. With an engineering background, this is not a big problem for them, in fact, it is the latest challenge to be solved. Over time, Hari Mukti Teknik workshop continues to develop, not only serving welding products and washing machine repairs, but Hari Mukti Teknik workshop has also started to produce several machines. Even though, many products are being made, the focus of PT. Hari Mukti Teknik remains in the production of laundry equipment machines. At first, the laundry equipment produced was a laundry dryer for industrial use with the trademark "Kanaba". With continuous developments and innovations, PT. Hari Mukti Teknik started to produce other types of laundry equipment such as washer extractor soft mount, washer capsule, extractor, dryer, and roll ironer with the same trademark, “Kanaba”. This "Kanaba" product is increasingly being recognized by the Indonesian people with customers spread across various regions in Indonesia such as Yogyakarta, Jakarta, Bogor, Bandung, Cikarang, Surabaya, Semarang, Solo, Bali, Medan, Padang, Kalimantan, Sulawesi, and even up to Timor Leste with consumer segments ranging from the laundry industry, hotels to hospitals. With hard work and efforts made by all stakeholders, in 2016 PT. Hari Mukti Teknik successfully obtained the SNI-ISO 9001:2015 (Indonesian National Standard) certification, in 2018 PT. Hari Mukti Teknik also managed to get the certification of SNI-ISO 37001:2016 (Indonesian National Standard from BSN - National Standardization Agency) and was tested by B4T (Center for Materials and Technical Goods).

4.1.2 Company Vision and Mission

The following is the vision and mission of PT. Hari Mukti Teknik:

Vision:

To be a safe, quality, trustworthy, and environmentally friendly manufacturer of Machinery and Production Equipment.

Mission:

- Conduct research and development of production machines and tools.
- Interaction with customers and continuous improvement to meet customer expectations in terms of quality and delivery.
- Increase product creativity through innovation and technology.
- Improving the competence of local workers.
- Prioritizing commitment and quality of goods in running the business to avoid bribery behavior.
- Controlling environmental impacts and continuous improvement to produce environmentally friendly products.

4.1.3 Production Activity Process

Below are the main activities of PT. Hari Mukti Teknik production activities of Kanaba Washer Barrier Softmount from orders from customers who enter the company, followed by ordering raw materials to product delivery. Several additional activities are not shown in the main activity table such as machine maintenance and other activities. Below is the figure of the Kanaba Washer Barrier Softmount and the production activity process.

Figure 4.2 Kanaba Washer Barrier Softmount.

Below are the specifications of the object (Kanaba Washer Barrier Softmount) used in this study.

Table 4.1 Kanaba Washer Barrier Softmount Specifications.

Specification	**S 50 BR**
Capacity	50 kg
Tumbler Type	Single
Drum Compartment	1
Tumbler Diameter	900 mm
Tumbler Length	820 mm
Tumbler Volume	521 l
Body Wide	1650 mm
Body Depth	1440 mm
Body Height	1730 mm
Motor	15 hp
Power	11 kW
Heating Power	28,8 kW
Water Input (Cold, Hot, Chemical)	1”
Water Output	3” (2 DOD is Additonal)

Specification	S 50 BR
Washer RPM	30 – 50 RPM (Programmable)
RPM Spin	580 RPM
Tumbler Material	Stainless Steel
Body Material	Stainless Steel
Frame Material	Mild Steel

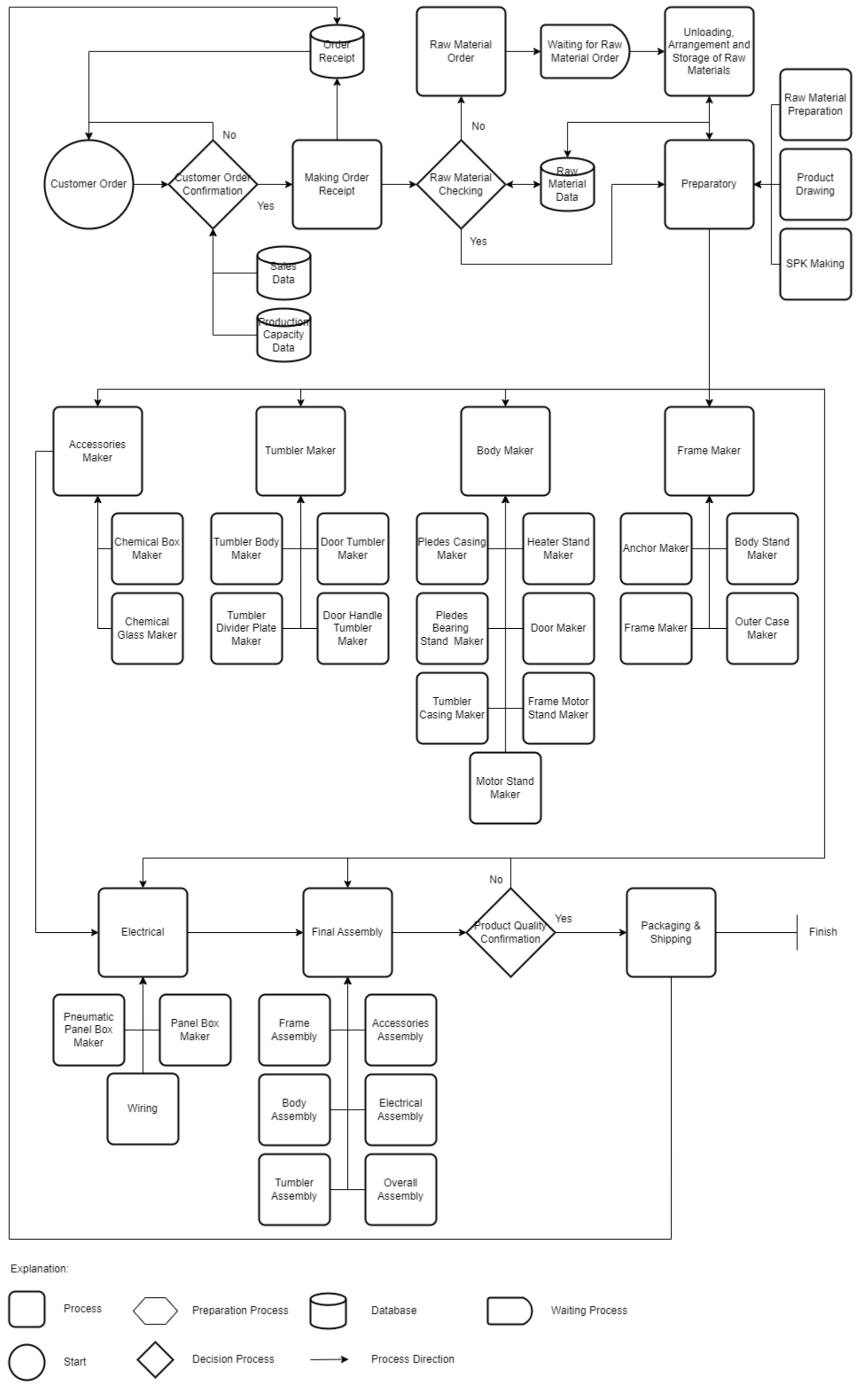


Figure 4.3 Kanaba Washer Barrier Softmount Production Process.

The following is an explanation and a series of processes carried out in the production process of product X.

1. Customer Order

   At this stage, the customer makes an order for the product they need by online in a way contacting social media or it can be offline directly at the workshop, at this stage the customer will provide the required product details.

2. Customer Order Confirmation

   At this stage, the company will consider orders from customers by correlating the data they have (such as sales data and production capacity data) with customer requests (such as time, order quantity, etc.).

3. Making Order Receipt

   Customer order that has been confirmed at this stage the company will make an order receipt which is proof of the order made by the customer, this document contains the details of the customer's order such as customer details, ordered products, product quantity, delivery date, and others.

4. Raw Material Checking

   At this stage, raw material checks are carried out to start the production of customer requests, this checking is done by looking at the raw material data owned. If the raw material needs are not met, then an order for raw materials is made to the supplier, otherwise, if the raw material needs are met, it can proceed to the next stage.

5. Unloading, Arrangement, and Storage of Raw Materials

   This stage is carried out when the arrival of raw materials occurs. The unloading of raw materials is carried out by unpacking the packaging of raw materials followed by the arrangement and storage of raw materials in the warehouse and accompanied by updating of raw material data.

6. Preparatory

   At this preparatory stage, the preparation of raw materials that will be used and product drawing is carried out followed by making SPK (Surat Perintah Kerja) which will be distributed to all production divisions.

7. Frame Maker

   At this stage, the product frame is made, which includes Anchor Maker, Frame Maker, Body Stand Maker, and Outer Case Maker.

8. Body Maker

At the stage of the body maker, there are 7 (seven) main parts made, namely Pledges casing maker, Pledges Bearing Stand Maker, Tumbler Casing Maker, Heater Stand Maker, Door Maker, Frame Motor Stand Maker, and Motor Stand Maker.

9. Tumbler Maker

   This stage involves making a product tumbler, which includes working on a Tumbler Body Maker, Tumbler Divider Plate Maker, Door Tumbler Maker, and Door Handle Tumbler Maker.

10. Accessories Maker

    In this stage, the manufacture of product accessories is carried out in which there are only 2 (two) processing stages which are Chemical Box Maker and Chemical Glass Maker.

11. Electrical

    At this stage, the electrical part of the product is made, where this part supports how the product can be run. In this stage, there are 3 (three) main processes that are carried out including Pneumatic Panel Box Maker, Panel Box Maker, and Wiring.

12. Final Assembly

    At the final assembly and electrical stages, various assembly related machine support modules and other supporting electrical components are carried out such as Frame Assembly, Accessories Assembly, Body Assembly, Electrical Assembly, Tumbler Assembly, and Overall Assembly. At this stage, electrical checks are also carried out on the product which is to be adjusted to the desired capacity and also testing on the product to find out whether the product can run well or not.

13. Product Quality Confirmation

    In this stage will carry out inspection and quality control to ensure product conformity with the established standard. This stage includes checking the function and condition of each part of the product and also product testing to ensure that each component functions properly.

14. Packaging & Shipping

    At this stage, the packaging is carried out where this packaging uses a sheet made of wood which aims to protect the product from damage during the shipping process. After the packaging stage is complete, the next stage of the product is loaded into transportation to be sent to the customer. In addition, there is an additional stage which is in the form of confirmation of product delivery through order receipts made by the company to the customer which aims to notify that the product ordered by the customer has been sent.

4.2 Data Processing

In data processing, it will be explained in a structured manner the data that has been collected where this data collection is obtained through the results of observations and interviews with PT. Hari Mukti Teknik. The data to be processed is data related to the SustainableSCOR indicator as defined in the SCOR guidebook version 12.0. Based on the data that has been collected, will be processed with a formula for each SustainableSCOR indicator to determine the percentage of each indicator and will be compared with some company metrics owned by PT. Hari Mukti Teknik and at the end of data processing, the Analytical Hierarchy Process (AHP) process will be carried out to determine the priority scale of each problem contained in each indicator.

4.2.1 Identification and Validation of SustainableSCOR Indicators

In this study, the indicator selection used refers to the SCOR GuideBook version 12.0 made by APICS (2017) which was selected from SustainableSCOR. SustainableSCOR itself is defined as a model that works like SCOR in general which defines the scope of a supply chain and processes operations and measures supply chain performance and provides a good foundation for the environmental context in a supply chain. SuistainableSCOR uses the GRI (Global Reporting Initiative) definitions and measurements when dealing with sustainable environmental topics (GRI 300 Series Special Topic Standards).

This approach is used to help an expert in a supply chain context gain visibility into environmental topics that exist in their supply chain and value chain networks and enable them to model and manage their impacts. GRI (Global Reporting Initiative) is an independent international organization that helps businesses or other organizations to identify and analyze their impacts and be able to manage their impacts, by providing a common language to communicate these impacts. GRI standards help organizations to understand and report their impact on the economy, environment, and people in a comparable and credible manner, so it can increase transparency or their contribution to sustainable development (GRI - Standards, n.d.). Below are the details of the SustainableSCOR level-1 indicator that will be used in this study.

Table 4.2 Identification and Validation of SustainableSCOR Level-1 Indicators.

Level-1 Indicator	Unit	Characteristic	Description
SS.1.003 Total Supply Chain Non-Renewable Materials Used	Weight or volume (GRI Standard 301)	Smaller better	Total amount of material classified into non-renewable materials originating from the plan, source, make, deliver, and return processes.
SS.1.004 Total Supply Chain Renewable Materials Used	Weight or volume (GRI Standard 301)	Higher better	Total amount of material classified into non-renewable materials originating from the plan, source, make, deliver, and return processes.
SS.1.005 Total Supply Chain % of Recycled Input Materials Used	Percent (GRI Standart 301)	Higher better	Percentage of recycled input materials used on manufacture or company. Based on GRI, recycled material input is material that replaces main materials, which are purchased or obtained from internal or external sources, and also not by-product and non-product outputs (NPO) produced by the organization.
SS.1.013 Total Supply Chain Water Reused or Recycled	Gallons, liters, or multiples (GRI Standard 303)	Higher better	Total amount of water that is recycled and reused by the organization or company to plan, source, make, deliver, and return processes.
SS.1.025 Total Supply Chain Non-Hazardous Waste	Gallons, liters or multiples, weight or volume (GRI Standard 306)	Higher better	Total amount of non-hazardous waste generated from the plan, source, make, deliver and return processes.
SS.1.026 Total Supply Chain Hazardous Waste	Gallons, liters or multiples, weight or volume (GRI Standard 306)	Smaller better	Total amount of hazardous waste generated from the plan, source, make, deliver and return processes.

Source: Association for Supply Chain Management (APICS) (2017).

After identifying and validating the SustainableSCOR level-1 indicator metrics that correlate to the company's business processes, the next step is to identify the SustainableSCOR level-2 indicator metrics, not all existing level-2 metrics can be used in this study because some indicators are not carried out on certain processes in the company business processes under research at this time. Below is a breakdown of the level-2 indicator metrics used following the use of the level-1 indicator metrics.

Table 4.3 Identification and Validation of SustainableSCOR Level-2 Indicators.

Performance Indicator		**Description**	**Formula**
Level-1	**Level-2**		
SS.1.003 Total Supply Chain Non-Renewable Materials Used	SS.2.008 Make Non-Renewable Materials Used	Total amount of materials with non-renewable source classification used in the make process.	*Make Non-Renewable Material Used = Sum of Make Non-Renewable Material Used*
	SS.2.009 Deliver Non-Renewable Materials Used	The total amount of materials with non-renewable source classification used in the deliver process.	*Deliver Non-Renewable Material Used = Sum of Deliver Non-Renewable Material Used*
SS.1.004 Total Supply Chain Renewable Materials Used	SS.2.005 Make Renewable Materials Used	Total amount of materials with renewable source classification used in the make process.	*Make Renewable Material Used = Sum of Make Renewable Material Used*
	SS.2.006 Deliver Renewable Material Used	Total amount of materials with renewable source classifications used in the deliver process.	*Deliver Renewable Material Used = Sum of Deliver Renewable Material Used*
SS.1.005 Total Supply Chain % of Recycled Input Materials Used	SS.2.010 Make % of Recycled Input Materials Used	Total percentage of recycled input material used to make process of primary products which are purchased or obtained from internal or external sources, and also not by-product and non-product outputs (NPO) produced by the organization.	*Make % Recycled Input Materials Used = Sum of Make % Recycled Input Materials Used*
	SS.2.011 Deliver % of Recycled Input Materials Used	Total percentage of recycled input material used to deliver process of primary products which are purchased or obtained from internal or external sources, and also not by-product and non-product outputs (NPO)	*Deliver % Recycled Input Materials Used = Sum of Deliver % Recycled Input Materials Used*

Performance Indicator		Description	Formula
Level-1	Level-2		
		produced by the organization.	
SS.1.013 Total Supply Chain Water Reused or Recycled	SS.2.040 Make Water Reused or Recycled.	Total amount of water reused or recycled by the company related to the make process.	*Make Water Reused or Recycled = Sum of Make Water Reused or Recycled*
SS.1.025 Total Supply Chain Non-Hazardous Waste.	SS.2.075 Make Non-Hazardous Waste.	Total amount of non-hazardous waste generated from the make process.	*Make Non-Hazardous Waste = Sum of Make Non-Hazardous Waste*
SS.1.026 Total Supply Chain Hazardous Waste.	SS.2.080 Make Hazardous Waste.	Total amount of hazardous waste generated from the make process.	*Make Hazardous Waste = Sum of Make Hazardous Waste*

Source: Association for Supply Chain Management (APICS) (2017).

4.2.2 Data Processing of SS.1.003 Total Supply Chain Non-Renewable Materials Used and SS.1.004 Total Supply Chain Renewable Materials Used

This indicator calculates the amount of material included between the classification of non-renewable materials and renewable materials. According to the CK-12 Foundation (2022), non-renewable resources or materials are defined as natural resources that are in fixed quantity and can be used until they are exhausted. Examples include fossil fuels such as oil, coal, and natural gas. These resources are formed from the remains of plants that were sedimented for hundreds of millions of years, or in other words these resources can be used much faster than they can be reproduced by natural processes, other examples are minerals and metals, although 2 (two) these types of raw materials are classified as non-renewable raw materials but have the greatest potential to be recycled indefinitely, 2 (two) types of these raw materials are also not biodegradable and from their elemental properties have an indefinite lifespan (Norgate et al., 2007). However, according to the CK-12 Foundation (2022) and El-Mously (2018), renewable resources are defined as a resource obtained from nature that can be reproduced by natural processes as quickly as humans use them.

Data processing in this indicator is only carried out in the make and deliver processes because in other processes (source, return, and enable) there is no material used in the process. The first step in data processing this time is to identify the bill of material (BOM) of the Kanaba Washer Barrier Softmount. BOM itself is a list containing the structure of a product which includes raw materials, sub-assemblies, intermediate assemblies, sub-components, parts, and any quantities required in the production process to make the end-product. After knowing the BOM, the next step is to identify the weight of each raw material, sub-assemblies, intermediate assemblies, sub-components, parts, and any quantities required and classify between renewable materials and non-renewable materials. Below is a table containing the BOM identification of the Kanaba Washer Barrier Softmount and its classification in terms of the make and delivery process.

Table 4.4 Materials Identification Make Process.

No	Part Name	Quantity	Unit	Material Composition	Weight (Kg)	Total Weight (Kg)
1	Round Bar VCN - 100mm x 6,7m	1	pcs	Alloy Steel	41,308	41,308
2	Round Bar SS 304 - 19mm (3/4")	30	cm	Stainless Steel	0,02	0,68
3	Round Bar SS 304 - 16mm (5/8")	1	pcs	Stainless Steel	9,6	9,6
4	Round Bar SS 304 - 12mm	300	cm	Stainless Steel	0,01	2,70
5	Round Bar SS 304 - 5mm	0,1	pcs	Stainless Steel	0,9	0,09
6	Round Bar SS 304 - 3mm	0,5	pcs	Stainless Steel	0,35	0,18
7	Round Bar Screw Thread / Long Drat M10	0,5	pcs	Steel	0,51	0,26
8	Round Bar Screw Thread / Long Drat M14	0,5	pcs	Stainless Steel	0,48	0,24
9	Round Bar Screw Thread / Long Drat SS M6	0,3	pcs	Stainless Steel	0,23	0,07
10	Acrylic - 8mm - 120 x 240	0,07	sht	Polymethyl Methacrylate (PMMA)	1,4	0,10
11	Bearing 6315-ZZ / C3 SKF	1	pcs	Steel	3,17	3,17
12	Bearing NUP 2218 ECP	1	pcs	Steel	3,28	3,28
13	Pipe MS 8 1/2" (Thickness: 10mm)	10	kg	Steel	1	10
14	Seemless Pipe - 1 1/2" x 3,7m	370	cm	Steel	0,041	15,17
15	Pipe SS 304 - 1 1/2" x 1.2mm x 6m	42	cm	Stainless Steel	0,011	0,46
16	Pipe SS 304 - 76,2mm (3″) x 6m	140	cm	Stainless Steel	0,36	50,4
17	Pipe SCH 20 - SS 304 - 1" x 3mm	200	cm	Stainless Steel	0,02	4,54
18	Pipe SS 304 - 5/8" (15,87mm) x 1,2mm x 6m	150	cm	Stainless Steel	0,016	2,35
19	Pipe SS 304 - 1" (25,4mm) x 1mm x 6m	60	cm	Stainless Steel	0,01	0,35
20	Pipa SS 304 - 3/8 x 9.525mm x 6m - Thickness 0,8mm	150	cm	Stainless Steel	0,002	0,253
21	Eser Plate MS - 50mm x 4ft (1,2192m) x 8ft (2,4384m)	0,03	sht	Steel	1166,862	35,01
22	Eser Plate MS - 16mm x 4ft (1,2192m) x 8ft (2,4384m) - Frame	1	sht	Steel	373,396	373,396
23	Eser Plate MS - 8mm x 4ft (1,2192m) x 8ft (2,4384m)	0,5	sht	Steel	186,698	93,35
24	Eser Plate MS - 5,8mm x 4ft (1,2192m) x 8ft (2,4384m)	1	sht	Steel	135,356	135,36
25	Eser Plate MS - 1mm x 4ft (1,2192m) x 8ft (2,4384m)	0,5	sht	Steel	23,337	11,67
26	Plate SS 304 - HL (2-side) - 1,5mm x 4ft (1,2192m) x 8ft (2,4384m) - Case	2	sht	Stainless Steel	35,4	70,8
27	Plate SS 304 - HL (2-side) - 1,2mm x 4ft (1,2192m) x 8ft (2,4384m)	9	sht	Stainless Steel	28,32	254,88
28	Plate SS 304 - 1B - 4mm x 4ft (1,2192m) x 8ft (2,4384m)	0,25	sht	Stainless Steel	94,40	23,60
29	Perforated Plate SS 304 - 2mm x 4ft (1,2192m) x 8ft (2,4384m) - Ø 6mm	1	sht	Stainless Steel	32	32

No	Part Name	Quantity	Unit	Material Composition	Weight (Kg)	Total Weight (Kg)
30	Strip Plate MS - 1" (25,4mm) x 4mm x 6m	1	pcs	Steel	4,785	4,785
31	Strip Plate SS 304 - 3mm x 30mm x 6m	500	cm	Stainless Steel	0,007	3,465
32	Stall Pipe SS 304 - 15 x 30 x 1,5mm x 6m	40	cm	Stainless Steel	0,01	0,34
33	Angle Bar - 40mm x 40mm x 4mm x 6m	2	pcs	Steel	14,5	29
34	Angle Bar - 70 x 70 x 7mm x 6m	0,5	pcs	Steel	44,28	22,14
35	Steel Bar - 8mm x 12m	2	pcs	Steel	4,74	9,48
36	Spiral Spring	4	pcs	Brass	0,653	2,61
37	Shock Breaker KYB KYKA 2604BZ (L300, T120)	5	set	Brass	2,3	11,5
38	Nok Seal Washex 40 and 50	1	pcs	Aluminium	0,2	0,2
39	Nok Seal TC 100 135 15 NBR NOK AE4079-E0	1	pcs	Nitrile	0,0367	0,0367
40	Red Tapered Piu Bushing Shock	16	pcs	Polyurethane	0,01	0,16
41	Red Flat Piu Bushing Shock	16	pcs	Polyurethane	0,01	0,16
42	Washex Door Rubber (White) - Diameter 38	1	pcs	Nitrile Butadine Rubber	0,563	0,563
43	Drain Valve Seal 3" - Input	1	pcs	Nitrile Butadine Rubber	0,009071 847	0,0090718 47
44	Drain Valve Seal 3" - Output / Bout Spiral - Diameter 89 x 150	2	pcs	Nitrile Butadine Rubber	0,009071 847	0,0181436 94
45	Rubber Shock Guard for KLX	1	pcs	Styrene-Butadiene Rubber	0,13	0,13
46	Cooling Van - 20cm x 20cm - AC 220V	1	pcs	Steel	1,7	1,7
47	Small Panel Locks	1	Pcs	Aluminium	0,0968	0,0968
48	Door Latch for Washext	5	pcs	Aluminium	0,12	0,6
49	Hanger Clamp 1" (25mm)	27	pcs	Aluminium	0,04	1,08
50	Hanger Clamp 2" (50,8mm)	4	pcs	Aluminium	0,08	0,3
51	Hanger Clamp 5" (127mm)	2	pcs	Aluminium	0,3	0,6
52	Hose Clamp 2" (50,8mm)	4	pcs	Stainless Steel	0,02	0,08
53	Hose Clamp 3" (76,2mm)	6	pcs	Stainless Steel	0,04	0,26
54	Hose Clamp 3,5" (88,9mm)	4	pcs	Stainless Steel	0,04	0,17
55	Hose Hanger Clamp 5/8"	2	pcs	Stainless Steel	0,08	0,16
56	Elbow 90 Rucika 3" PVC AW Knie 90	2	pcs	Thermoplastic Polymers	0,7	1,4
57	Elbow SS 201 1,5"	2	pcs	Stainless Steel	0,18	0,35
58	Rivet Nut / Nutsert / Rivnut M6 - 6mm x 1mm	12	pcs	Aluminium	0,003	0,036
59	Rivet Nut / Nutsert / Rivnut M6 Steel AVP-SM6	48	pcs	Steel	0,005	0,24
60	Pulley Bowl B2 x 24"	1	pcs	Aluminium	10,08	10,08
61	Pulley B2 x 3"	1	pcs	Steel	1,4	1,4
62	MCB Box - MASKO	1	pcs	Plastic	0,21	0,21
63	Spark Plug - C7HSA	5	pcs	Nickel-Alloy	0,3	1,5
64	Hose Fitting - Automatic Faucet	1	pcs	Plastic	0,0257	0,0257
65	Inverter VFS-15 10HP 380V - Toshiba	1	pcs	Plastic	1	1
66	NYAF Cable - 1 x 0,75mm - Blue Federal	250	cm	Polyvinyl Chloride (PVC) & Copper	0,00013	0,0325
67	NYAF Cable - 1 x 0,75mm - Black Federal	800	cm	Polyvinyl Chloride (PVC) & Copper	0,00013	0,104
68	NYAF Cable - 1 x 0,75mm - Red Federal	100	cm	Polyvinyl Chloride (PVC) & Copper	0,00013	0,013
69	NYAF Cable - 1 x 0,75mm - Yellow	500	cm	Polyvinyl Chloride (PVC) & Copper	0,00013	0,065

No	Part Name	Quantity	Unit	Material Composition	Weight (Kg)	Total Weight (Kg)
70	NYAF Cable - 1 x 1,5mm - Black Eterna	1000	cm	Polyvinyl Chloride (PVC) & Copper	0,000022	0,022
71	NYYH Cable - 3 x 1.5 - 1 pcs = 50m	200	cm	Polyvinyl Chloride (PVC) & Copper	0,00004	0,008
72	NYYHY Cable - 5 Core x 1.5mm² - Jembo Fiber	300	cm	Polyvinyl Chloride (PVC) & Copper	0,0016	0,48
73	Contactor ST-10 220V - Mitsubishi	2	pcs	Silver (Ag) Alloy	0,25	0,5
74	Pilot Lamp - Green - Indicator Lamp Panel 220	8	pcs	Polycarbonate	0,05	0,4
75	Limit Switch V 155 1A5 Omron / Microswitch	1	pcs	Silver (Ag) Alloy	0,062	0,062
76	MCB 1P 6A Domae Schneider - 3606485121956	1	pcs	Plastic	1,105	1,105
				Steel	0,849	0,849
77	MCB 3P 10A Domae Schneider - 3606485122083	2	pcs	Plastic	1,105	2,210
				Steel	0,849	1,697
78	Motor 10HP 380V Mitshubishi	1	unt	Cast Iron	55,63	55,63
79	Pilot Lamp Alarm Red Buzzer	1	pcs	Polycarbonate	0,035	0,035
80	Pilot Lamp - Green LED - Kinogawa/CIC Green	2	pcs	Polycarbonate	0,035	0,07
81	Push button Green 25mm CR 2511 Hanyoung	1	pcs	Polycarbonate	0,035	0,035
82	Push Button Red 25mm CR 2511 Hanyoung	1	pcs	Polycarbonate	0,035	0,035
83	Push Button Reset 25mm Hanyoung Emergency Stop Reset	1	pcs	Polycarbonate	0,035	0,035
84	Water Pump 128 Bit Shimizu	1	pcs	Polycarbonate	7	7
85	PG 11 / Cable Connector	2	pcs	Plastic	0,078	0,156
86	Relay LY 2N 220V	10	pcs	Silver	0,04	0,4
87	Relay LY 4N	1	pcs	Silver	0,05	0,05
88	Cable Duct - 33mm x 33mm - Grey (170cm/pcs)	1,5	pcs	Polyvinyl Chloride (PVC) & Copper	1	1,5
89	Fort Rail MCB Alumunium - 1m/pcs	100	cm	Aluminium	0,00115	0,115
90	Discrete I/O Extension Module - SR3XT101FU - Schneider - 3389110550139	1	pcs	Plastic	0,2	0,2
91	Cable Lug - Y 3.5-5 - Fork	17	pcs	Copper	0,001	0,017
92	Selector Switch 25mm CRSL-252A12 (ON-OFF) (2-Potition) - HanyoungNux	3	pcs	Polycarbonate	0,09	0,27
93	Selector Switch CRSL-253-A1 (On-Off-On) (3-Position) - HanyoungNux	1	pcs	Polycarbonate	0,75	0,75
94	Solenoid Water Valve - 3/4" - Inlet 90°	3	pcs	Plastic	0,115	0,345
95	Solenoid Input - 1" - ZW-25 Water - ARITA Solenoid ZW 220V WTR&GAS 1	2	pcs	Brass	1,1	2,2
				Stainless Steel	1	2
96	Solenoid Valve Output - 3" - Drain o Valve (DoD) Depend O Drain	1	pcs	Brass	1	1
97	Heat Shrink Tube - 4mm	120	cm	Polyolefin	0,00004	0,0048
98	Heat Shrink Tube - 6mm	120	cm	Polyolefin	0,000084	0,01
99	Spiral Wrapping - 10 mm - KS-10	200	cm	Polyethylene	0,0002	0,0428
100	Spiral Wrapping - 8mm - KS-8	300	cm	Polyethylene	0,000016	0,0049
101	Spiral Wrapping - 6mm - KS-6	300	cm	Polyethylene	0,0001	0,0227
102	Fiberglass Sleeve 8mm I.D. PVC Insulation Tube	100	cm	Fiberglass	0,0002	0,0210
103	Vibration Sensor	2	pcs	Piezoceramic (Lead Zirconate Titanate / PZT)	0,0043	0,0086

No	Part Name	Quantity	Unit	Material Composition	Weight (Kg)	Total Weight (Kg)
104	Rounded Cable Lug - All Size 2-4	14	pcs	Copper	0,008	0,112
105	Flat Cable Lug 3.5 - Insulated and Non-Insulated - All Size	123	pcs	Copper	0,0005	0,0615
106	Modular Smart Relay - SR3B261FU - Schneider - 3389110550009	1	pcs	Polycarbonate	0,1076	0,1076
				Paper	0,0064	0,0064
				Cardboard	0,044	0,044
				Electronic Components	0,2424	0,2424
107	2 Pins Electrical Wire Connector Male Female Terminal Housing Universal	4	pcs	Acrylonitrile Butadiene Styrene (ABS)	0,004	0,016
108	2.8mm 2 Pin Electrical Wire Connector Male Female Terminal Housing for Motorcycle	8	pcs	Acrylonitrile Butadiene Styrene (ABS)	0,108	0,864
109	Socket Relay - LY 4	1	pcs	Silver (Ag) Alloy	0,07	0,07
110	Relay Socket PTF08A-E by OMI (Socket Relay LY2)	10	pcs	Silver (Ag) Alloy	0,068	0,68
111	Terminal Strip - 12 Pole	4	pcs	Plastic	0,09	0,36
112	Water Level Controller AFR-1	3	pcs	Plastic	0,16	0,48
113	Zinc Cromate Belkote - Black (Finishing)	0,25	gln	Alkyd	5	1,25
114	Alfa Gloss Epoxy / Y Poxy	0,5	kg	Epoxy Amine Adduct	0,5	0,5
115	Panzer Paint P.U - Black (Set)	1,5	ltr	Polyurethane	1,5	1,5
116	Bolt 16mm x 70mm	24	pcs	Steel	0,1452	3,4848
117	Bolt 5/8 x 50mm	8	pcs	Steel	0,18	1,44
118	Bolt M10 x 25mm	26	pcs	Steel	0,02522	0,65572
119	Bolt M12 x 25mm	16	pcs	Steel	0,03686	0,58976
120	Bolt M16 x 40mm	1	pcs	Steel	0,09799	0,09799
121	Bolt M8 x 15mm	10	pcs	Steel	0,01157	0,1157
122	Bolt M6 x 20mm	6	pcs	Steel	0,006742	0,040452
123	Bolt M6 x 15mm	8	pcs	Steel	0,00593	0,04744
124	Bolt M6 x 10mm	18	pcs	Steel	0,004712	0,084816
125	Bolt SS M16 x 50mm	1	pcs	Stainless Steel	0,13624	0,13624
126	Bolt SS M8 x 25mm	53	pcs	Stainless Steel	0,01871	0,99163
127	Bolt SS M6 x 20mm	5	pcs	Stainless Steel	0,00812	0,0406
128	Bolt SS M6 x 15mm	22	pcs	Stainless Steel	0,00743	0,16346
129	Bolt SS M6 x 10mm	8	pcs	Stainless Steel	0,004712	0,037696
130	Bolt L Key SS M6 x 25mm	7	pcs	Stainless Steel	0,00759	0,05313
131	Bolt L Key SS M8 x 28mm	8	pcs	Stainless Steel	0,015	0,12
132	Kontra Bolt M8 x 10mm	4	pcs	Steel	0,009394	0,037576
133	Kontra Bolt M10 x 10mm	2	pcs	Steel	0,01668	0,03336
134	Kontra Bolt M12 X 16mm	6	pcs	Steel	0,02948	0,17688
135	JP Bolt M4 x 6mm	8	pcs	Steel	0,00133	0,01064
136	JP Bolt M4 x 10mm	14	pcs	Steel	0,00164	0,02296
137	JP Bolt M5 x 10mm	8	pcs	Steel	0,00263	0,02104
138	JP Bolt M5 x 15mm	12	pcs	Steel	0,00337	0,04044
				Total Weight		**1375,36**

Table 4.5 Materials Identification of the Delivery Process.

No	Part Name	Quantity	Unit	Material Composition	Weight (Kg)	Total Weight (Kg)

1	Plank - Thickness 1,5cm	15,0056	m2	Silk-Cotton Wood	3,867	58,021
2	Nail - 2,5" (6,35cm)	150	pcs	Brass	0,005	0,794
3	Plastic Wrap	45,0168	m2	Polyethylene	0,000	0,002
4	Styrofoam - Thickness 2,54cm	12,6604	m2	Polyethylene	0,116	1,463
						60,279

From the material identification of Kanaba Washer Barrier Softmount based on the bill of material (BOM), it can be classified in the context of the material used, there are 29 types of material used in the production and delivery of Kanaba Washer Barrier Softmount. Below are details of the types of materials used and their classification for each process.

Table 4.6 Materials Classification for Make Process.

No	Material Composition	Total Weight (Kg)	Percentage (%)	Classification	Reference
1	Stainless Steel	461,55	33,5585	Non-Renewable Material	Johnson et al. (2008).
2	Steel	758,841	55,1739	Non-Renewable Material	Morecambe Metals (2020), Freedman (2018).
3	Brass	17,31	1,2586	Non-Renewable Material	Pindór (2018), Freedman (2018).
4	Polyurethane	1,82	0,1323	Renewable Material	Ratna (2022), Fink (2018), Schulzke et al. (2018).
5	Aluminium	13,1078	0,9530	Renewable Material	Morecambe Metals (2020), Freedman (2018),.
6	Plastic	6,092	0,4429	Non-Renewable Material	Chen & Yan (2020), Kosior & Mitchell (2020), Piletic (2017).
7	Polyvinyl Chloride (PVC) & Copper	2,2245	0,1617	Non-Renewable Material	Freedman (2018), British Plastics Federation (n.d.).
8	Polycarbonate	8,7376	0,6353	Non-Renewable Material	Chen & Yan (2020), Takeuchi (2012).
9	Silver (Ag) Alloy	1,312	0,0954	Non-Renewable Material	Freedman (2018).
10	Copper	0,191	0,0139	Non-Renewable Material	Morecambe Metals (2020), Freedman (2018).
11	Polyethylene	0,0704	0,0051	Non-Renewable Material	Jain & Tiwari (2015).
12	Alloy Steel	41,308	3,0034	Non-Renewable Material	Freedman (2018).
13	Polymethyl Methacrylate (PMMA)	0,10	0,0071	Non-Renewable Material	Petrochemicals Europe (2015).
14	Nitrile Butadiene Rubber	0,6270	0,0456	Non-Renewable Material	Karp et al. (2017), Rajasekar (2009).
15	Styrene-Butadiene Rubber	0,13	0,0091	Non-Renewable Material	TRP Polymer Solutions (2020), United States Department of Labor (n.d.).
16	Thermoplastic Polymers	1,4	0,1018	Non-Renewable Material	British Plastics Federation (n.d.).
17	Nickel-Alloy	1,5	0,1091	Non-Renewable Material	Freedman (2018).
18	Cast Iron	55,63	4,0448	Non-Renewable Material	Freedman (2018).
19	Silver	0,45	0,0327	Non-Renewable Material	Freedman (2018).

No	Material Composition	Total Weight (Kg)	Percentage (%)	Classification	Reference
20	Polyolefin	0,0149	0,0011	Non-Renewable Material	Plastics Europe (2022).
21	Fiberglass	0,0210	0,0015	Non-Renewable Material	The International Agency for Research on Cancer (2002).
22	Piezoceramic (Lead Zirconate Titanate / PZT)	0,0086	0,0006	Non-Renewable Material	Waqar et al. (2015), Rahman et al. (2014).
23	Paper	0,0064	0,0005	Renewable Material	Bozell (2001), American Forest & Paper Association (n.d.).
24	Cardboard	0,044	0,0032	Renewable Material	Bozell (2001), American Forest & Paper Association (n.d.).
25	Electronic Components	0,2424	0,0176	-	-
26	Acrylonitrile Butadiene Styrene (ABS)	0,88	0,0640	Non-Renewable Material	European Environment Agency (2021).
27	Alkyd	1,25	0,0909	Renewable Material	Jones (2017).
28	Epoxy Amine Adduct	0,5	0,0364	Non-Renewable Material	Yang et al (2020).
	Total	**1375,36**	**100,00**		

Table 4.7 Materials Classification for Delivery Process.

No	Material Composition	Total Weight (Kg)	Percentage (%)	Classification	Reference
1	Silk-Cotton Wood	58,021	96,254	Renewable Material	-
2	Brass	0,794	1,317	Non-Renewable Material	Pindór (2018), Freedman (2018).
3	Polyethylene	1,464	2,429	Non-Renewable Material	Jain & Tiwari (2015).
	Total	**60,279**	**100,00**		

After classifying and identifying each material used in the make and delivery process of Kanaba Washer Barrier Softmount, the next step is to calculate the percentage of each classification used in this indicator which is non-renewable material and renewable material. Below is a table containing the conclusions related to material classification which contains the total weight and percentage for each classification.

Table 4.8 Materials Classification Result of the Kanaba Washer Barrier Softmount.

Classification	Make Process		Delivery Process		Whole Process	
	Weight (Kg)	**%**	**Weight (Kg)**	**%**	**Weight (Kg)**	**%**
Non-Renewable Materials	1371,999	99,773	2,258	3,746	1374,257	95,740
Renewable Materials	3,120	0,227	58,021	96,254	61,142	4,260
Total	**1375,119**	**100**	**60,279**	**100**	**1435,399**	**100**

After completing the identification and classification of each material used in the make and delivery process, the next step is to calculate the SustainableSCOR level-1 indicator which is SS.1.004 Total Supply Chain Renewable Material Used and SS.1.003

Total Supply Chain Non-Renewable Material Used including calculations for each process (level-2 indicator) in each level-1 indicator, below is the calculation.

1. Data Processing of SS.1.003 Total Supply Chain Non-Renewable Materials Used

This indicator calculates the percentage of the amount of material included in the classification of non-renewable materials. This indicator will be analyzed on each type of material used in each process and will be compared between the actual data and the company's specific metrics related to the use of non-renewable raw materials. Below is the calculation formula used for this indicator which is quoted from the SCOR Guidebook version 12 created by APICS (2017).

Total Supply Chain Non-Renewable Material Used = Plan Non-Renewable Material Used + Source Non-Renewable Material Used + Make Non-Renewable Material Used + Deliver Non-Renewable Material Used + Return Non-Renewable Material Used...SS.1.003

Below is the calculation of the indicator level-2 which at level-2 is calculated on each of the main processes in the company, namely plan, source, make, deliver and return. In this case, related to the plan, source, and return processes, no calculations or data processing was carried out due to the none of raw materials used in this process, so only calculations and data processing were carried out on make and deliver processes.

1) Data Processing of SS.2.008 Make Non-Renewable Materials Used

In this level-2 indicator which focuses on the make process, according to the explanation in the SCOR GuideBook version 12.0 made by APICS (2017), make is defined as a process of adding value from something already available (in the context of this research, it is raw material) through the manufacturing process or in the service industry is the creation of service. In this data processing, an analysis of each part that composes Kanaba Washer Barrier Softmount will be carried out wherein the details of each component of the product will be carried out by analyzing the bill of materials (BOM) of the product and classifying for each component. Below is the formula used on this level-2 indicator quoted from the SCOR Guidebook version 12.0 created by APICS (2017).

Make Non-Renewable Material Used = Sum of Make Non-Renewable Material Used ...SS.2.008

After knowing the constituent parts of Kanaba Washer Barrier Softmount and their classification, in the final stage, a percentage will be made between materials that are included in the classification of non-renewable materials. Based on Table 4.8 it can be concluded that the use of non-renewable materials used in the make process is around 1371,999 kg or around 99,773% of the total product weight.

2) Data Processing of SS.2.009 Deliver Non-Renewable Materials Used

In this level-2 indicator which focuses on the deliver process, according to the explanation in the SCOR GuideBook version 12.0 made by APICS (2017), the delivery process is defined as a process that is related to the implementation of order management and order fulfillment activities. In this data processing, an analysis of the raw materials used in the deliver process will be carried out by analyzing all types of materials used during the deliver process. From the observations and interviews, it is known that wood plank, nails, plastic wrap, and styrofoam are used in deliver process to reduce friction or impact during shipping which can cause damage to the product. Below is the formula used for this level-2 indicator which is quoted from the SCOR Guidebook version 12.0 made by APICS (2017).

Deliver Non-Renewable Material Used = Sum of Deliver Non-Renewable Material Used …SS.2.009

After knowing the material used in the delivery process of Kanaba Washer Barrier Softmount and their classification, in the final stage, a percentage will be made between materials that are included in the classification of non-renewable materials. Based on Table 4.8 it can be concluded that the use of non-renewable materials used in the deliver process is around 2,258 kg or around 3,746% of the total product weight.

2. Data Processing of SS.1.004 Total Supply Chain Renewable Materials Used

This indicator calculates the percentage of the amount of material included in the classification of renewable materials. This indicator will be analyzed for each material used in the whole process of Kanaba Washer Barrier Softmount and will be compared between the actual data and the company's specific metrics related to the use of renewable raw materials. Below is the calculation formula used for this indicator which is cited from the SCOR Guidebook version 12 created by APICS (2017).

$$\textit{Total Supply Chain Renewable Material Used} = \textit{Plan Renewable Material Used} + \textit{Source Renewable Material Used} + \textit{Make Renewable Material Used} + \textit{Deliver Renewable Material Used} + \textit{Return Renewable Material Used} \ldots SS.1.004$$

Below is the calculation of the indicator level-2 which at level-2 is calculated on each of the main processes in the company, namely plan, source, make, deliver and return. In this case, related to the plan, source, and return processes, no calculations or data processing was carried out due to the none of raw materials used in this process, so only calculations and data processing were carried out on make and deliver processes.

1) Data Processing of SS.2.005 Make Renewable Materials Used

In this level-2 indicator which focuses on the make process, according to the explanation in the SCOR GuideBook version 12.0 made by APICS (2017), make is defined as a process of adding value from something already available (in the context of this research, it is raw material) through the manufacturing process or in the service industry is the creation of service. In this data processing, an analysis of each part that composes Kanaba Washer Barrier Softmount will be carried out wherein the details of each component of the product will be carried out by analyzing the bill of materials (BOM) of the product and classifying for each component. Below is the formula used on this level-2 indicator quoted from the SCOR Guidebook version 12.0 created by APICS (2017).

$$\textit{Make Renewable Material Used} = \textit{Sum of Make Renewable Material Used} \ldots SS.2.005$$

After knowing the constituent parts of the product and their classification, in the final stage, a percentage will be made between materials that are included in the classification of renewable materials. Based on Table 4.8 it can be concluded that the use of renewable materials in the make process is around 3,12 kg or around 0,227% of the total product weight.

2) Data Processing of SS.2.006 Deliver Renewable Materials Used

In this level-2 indicator which focuses on the deliver process, according to the explanation in the SCOR GuideBook version 12.0 made by APICS (2017), the delivery process is defined as a process that is related to the implementation of order management and order fulfillment activities. In this data processing, an analysis of the raw materials used in the deliver process will be carried out by analyzing all types of materials used during the deliver process. From the observations and interviews, it is known that wood plank, nails, plastic wrap, and styrofoam are used in deliver process to reduce friction or impact during shipping which can cause damage to the product. Below is the formula used for this level-2 indicator which is quoted from the SCOR Guidebook version 12.0 made by APICS (2017).

Deliver Renewable Material Used = Sum of Deliver Renewable Material Used ...SS.2.006

After knowing the materials used in the process of delivering Kanaba Washer Barrier Softmount, at the final stage of processing this indicator data, a percentage will be made between materials classified as renewable materials. Based on Table 4.7 it can be concluded that the use of renewable materials used in the deliver process is around 58,021 kg or around 96,254% of the total product weight.

4.2.3 Data Processing of SS.1.005 Total Supply Chain % of Recycled Input Materials Used

This level-1 indicator calculates the percentage of recycled input materials used in manufacturing or company. According to research conducted by Chauhan et al. (2022), recycling is an activity of reprocessing waste or material from a product that has the aim of being able to be utilized or reused, the output of this activity can be a new product, or it can be how many raw materials can be reused to produce the same product or other products. In addition, according to GRI recycled material input is material that replaces main materials, which are purchased or obtained from internal or external sources, and also not by-product and non-product outputs (NPO) produced by the organization. Below is the formula used for this level-2 indicator which is quoted from the SCOR Guidebook version 12.0 made by APICS (2017).

$$Total\ Supply\ Chain\ \%\ of\ Recycled\ Input\ Materials\ Used = \left(\frac{Total\ Supply\ Chain\ Recycled\ Input\ Materials\ Used}{Total\ Supply\ Chain\ Input\ Material\ Used}\right) x100 \ldots SS.1.005$$

The first step in this indicator is to analyze and identify the material used in each process in the manufacture of Kanaba Washer Barrier Softmount. In this indicator, there is a level-2 indicator which includes the recycled input materials used in the plan, source, make, deliver, and return processes. But in this research, only calculations are made on the process of make and deliver the product. In this case, related to the plan, source, and return processes, no calculations or data processing was carried out due to the none of raw materials used in this process.

1. Data Processing of SS.2.010 Make % of Recycled Input Materials Used

In this level-2 indicator which focuses on the make process, according to the explanation in the SCOR guidebook version 12.0 made by APICS (2017), make is defined as a process of adding value from something already available (in the context of this research, it is raw material) through the manufacturing process or in the service industry is the creation of service. In this data processing, an analysis of each part that composes the Kanaba Washer Barrier Softmount will be carried out wherein the details of each component of the product will be carried out by analyzing the bill of materials (BOM) of the product and classifying for each component. Below is the formula used on this level-2 indicator quoted from the SCOR Guidebook version 12.0 created by APICS (2017).

$$Make\ \%\ Recycled\ Input\ Materials\ Used = Sum\ of\ Make\ \%\ Recycled\ Input\ Materials\ Used \ldots SS.2.005$$

After knowing the constituent parts of the product and their classification, in the final stage, a percentage will be made between materials that are included in the classification of recycled materials. Based on Table 4.5 can know the type of material used in each part used in the product, below are details of each material and its classification.

Table 4.9 Materials Classification for Make Process.

No	Material Composition	Total Weight (Kg)	Percentage (%)	Classification	Reference
1	Stainless Steel	461,55	33,5585	Recycled Materials	Universal Eco (2022), Morecambe Metals (2020), Johnson et al. (2008).
2	Steel	758,841	55,1739	Recycled Materials	Universal Eco (2022), Morecambe Metals (2021), Kementerian Perindustrian Republik Indonesia (2020), Zulhan (2013).
3	Brass	17,31	1,2586	Recycled Materials	Morecambe Metals (2020), Zulhan (2013).
4	Polyurethane	1,82	0,1323	Non-Recycled Materials	Ratna (2022), University of Minnesota (2020), Kemona & Piotrowska (2020), Fink (2018), Schulzke et al. (2018).
5	Aluminium	13,1078	0,9530	Recycled Materials	Universal Eco (2022), Morecambe Metals (2020)
6	Plastic	6,092	0,4429	Recycled Materials	Kementerian Perindustrian Republik Indonesia (2020).
7	Polyvinyl Chloride (PVC) & Copper	2,2245	0,1617	Recycled Materials	Universal Eco (2022), VinylPlus. (2022), Morecambe Metals (2020). Direktorat Standardisasi Pangan Olahan Deputi Bidang Pengawasan Pangan Olahan Badan POM RI. (2019).
8	Polycarbonate	8,7376	0,6353	Recycled Materials	(Liu et al., 2017).
9	Silver (Ag) Alloy	1,312	0,0954	Recycled Materials	Silver Institute (2015).
10	Copper	0,191	0,0139	Recycled Materials	Universal Eco (2022), Morecambe Metals (2020)
11	Polyethylene	0,0704	0,0051	Recycled Materials	Abedsoltan (2021), Ferrario (2021).
12	Alloy Steel	41,308	3,0034	Recycled Materials	Universal Eco (2022), Morecambe Metals (2021), Zulhan (2013).
13	Polymethyl Methacrylate (PMMA)	0,10	0,0071	Recycled Materials	Nikolaidis & Achilias (2018).
14	Nitrile Butadiene Rubber	0,6270	0,0456	Recycled Materials	Ai et Al. (2018), Noriman & Ismail (2011).
15	Styrene-Butadiene Rubber	0,13	0,0091	Recycled Materials	Baeta et al. (2009).
16	Thermoplastic Polymers	1,4	0,1018	Recycled Materials	Redwing (2017), Boria et al. (2016).
17	Nickel-Alloy	1,5	0,1091	Recycled Materials	Fajrian (2021), Nickel Institute (2016).
18	Cast Iron	55,63	4,0448	Recycled Materials	Morecambe Metals (2021), Kementerian Perindustrian Republik Indonesia (2020), Zulhan (2013).
19	Silver	0,45	0,0327	Recycled Materials	Silver Institute (2015).
20	Polyolefin	0,0149	0,0011	Recycled Materials	Hadi et al. (2012), Karlsson (2004).
21	Fiberglass	0,0210	0,0015	Recycled Materials	Oliveux et al. (2015).

No	Material Composition	Total Weight (Kg)	Percentage (%)	Classification	Reference
22	Piezoceramic (Lead Zirconate Titanate / PZT)	0,0086	0,0006	Recycled Materials	Yang et al. (2010).
23	Paper	0,0064	0,0005	Recycled Materials	Kementerian Perindustrian Republik Indonesia (2020).
24	Cardboard	0,044	0,0032	Recycled Materials	Kementerian Perindustrian Republik Indonesia (2020).
25	Electronic Components	0,2424	0,0176	Recycled Materials	Universal Eco (2022)
26	Acrylonitrile Butadiene Styrene (ABS)	0,88	0,0640	Recycled Materials	Wang et al. (2014).
27	Alkyd	1,25	0,0909	Non-Recycled Materials	-
28	Epoxy Amine Adduct	0,5	0,0364	Non-Recycled Materials	-
	Total	**1375,36**	**100,00**		

After knowing the materials used in Kanaba Washer Barrier Softmount and their classification, in the final stage, a percentage will be made between materials that are included in the classification of recycled materials. Below is the result of the data identification of recycled material used.

Table 4.10 Materials Classification Result for Make Process.

Classification	Weight (Kg)	Percentage (%)
Recycled Material	1371,792	99,74
Non-Recycled Material	3,57	0,26
Total	1375,36	100,000

Based on Table 4.9 it can be concluded that the use of recycled materials in the make process is around 1371,792 kg or around 99,74% of the total product weight.

2. Data Processing of SS.2.011 Deliver % of Recycled Input Materials Used

In this level-2 indicator which focuses on the deliver process, according to the explanation in the SCOR GuideBook version 12.0 made by APICS (2017), the delivery process is defined as a process that is related to the implementation of order management and order fulfillment activities. In this data processing, an analysis of the materials used in the deliver process will be carried out by analyzing all types of materials used during the deliver process. From the observations and interviews, it is known that wood plank, nails, plastic wrap, and styrofoam are used in deliver process to reduce friction or impact during shipping which can cause damage to the product. Below is the formula used for this level-

2 indicator which is quoted from the SCOR Guidebook version 12.0 made by APICS (2017).

$$\textit{Deliver \% Recycled Input Materials Used} = \textit{Sum of Deliver \% Recycled Input Materials Used...SS.2.011}$$

After knowing the constituent parts of the product and their classification, in the final stage, a percentage will be made between materials that are included in the classification of recycled materials. Based on Table 4.6 can know the type of material used in each part used in the deliver process of the product, below are details of each material and its classification.

Table 4.11 Materials Classification for Deliver Process.

No	Material Composition	Total Weight (Kg)	Percentage (%)	Classification	Reference
1	Silk-Cotton Wood	58,021	96,254	Non-Recycled Materials	-
2	Brass	0,794	1,317	Recycled Materials	Morecambe Metals (2020), Zulhan (2013).
3	Polyethylene	1,464	2,429	Recycled Materials	Abedsoltan (2021), Ferrario (2021).
	Total	**60,279**	**100,00**		

After knowing the materials used in Kanaba Washer Barrier Softmount and their classification. In the final stage, a percentage will be made between materials that are included in the classification of recycled materials. Below is the result of the data identification of recycled material used.

Table 4.12 Materials Classification Result for Deliver Process.

Classification	Weight (Kg)	Percentage (%)
Recycled Material	2,258	3,746
Non-Recycled Material	58,021	96,254
Total	60,28	100

Based on Table 4.11 it can be concluded that the use of recycled materials in the deliver process is around 2,258 kg or around 3,746% of the total product weight.

4.2.4 Data Processing of SS.1.013 Total Supply Chain Water Reused or Recycle

This indicator is defined as the total water from a supply chain that is recycled and reused by the organization or company associated with the SCOR level-1 process for plan, source, make, deliver, and return. Water recycling and reuse is an environmental conservation measure by reprocessing used water and wastewater through another cycle before being discharged into the environment or reused by companies for their supply chain processes. According to the SCOR guidebook version 12.0 made by APICS (2017), in this indicator, there is a formula for performing calculations which can be seen below.

$$Total\ Supply\ Chain\ Water\ Reused\ or\ Recycled = Plan\ Water\ Reused\ or\ Recycled + Source\ Water\ Reused\ or\ Recycled + Make\ Water\ Reused\ or\ Recycled + Deliver\ Water\ Reused\ or\ Recycled + Return\ Water\ Reused\ or\ Recycled \ldots SS.1.013$$

Below is the calculation of the indicator level-2 which is calculated on each of the main processes in the company, namely plan, source, make, deliver and return. In this case, related to the plan, source, deliver and return processes, no calculations or data processing were carried out due to the none of water use or water recycling processes, so only calculations and data processing were carried out on make. After knowing the amount of water used and the amount of water that is recycled or reprocessed before being discharged or reused, a comparison is made between the actual data on the total amount of water that is recycled with the target total amount of water that is recycled or reused. Below is a calculation of the total amount of water used and recycled in the make process.

1. Data Processing SS.2.040 Make Water Reused or Recycled

This indicator is defined as the total water that is recycled and reused by the organization or company in the make process. According to the SCOR guidebook version 12.0 made by APICS (2017) below is a calculation formula used for this indicator.

$$Make\ Water\ Reused\ or\ Recycled = Sum\ of\ Make\ Water\ Reused\ or\ Recycled \ldots SS.2.040$$

According to the observation and interview with several employees that have responsibility for the case in this indicator, they said the average use of water in make process of Kanaba Washer Barrier Softmount is around 1500 liters which is used for the testing of the product before the product deliver to the customer and in term of historical data, they said they once used about 5200 liters of water in the process of product testing. The type of water used in this process didn't get from the recycling of water used by the company. After conducting the trial of the product, the water used is discharged directly into the ground without reprocessing. So, the result for this indicator is 0 liters of water recycled used.

4.2.5 Data Processing of SS.1.025 Total Supply Chain Non-Hazardous Waste and SS.1.026 Total Supply Chain Hazardous Waste

The term “waste” is any material, substance, or by-product that is removed or disposed of because it is no longer useful or necessary after the completion of a process. Another definition of waste is explained in the guidebook published by the United States Environmental Protection Agency (2019), where waste is defined as any material that is discarded, rejected, abandoned, unwanted, or excess, whether intended for sale or recycling, reprocessing, recovery or purification by operation separate from those produced. Meanwhile, hazardous waste includes any unwanted or discarded materials (excluding radioactive materials), which due to their physical, chemical, or infectious characteristics can cause significant harm to human health or the environment if not treated, stored, transported, disposed of, or managed correctly.

Both indicators will conduct data processing only in the make process because in the other 4 (four) processes which are plan, source, deliver, and return no waste is generated. The first step in processing data on this indicator is to analyze the amount of waste generated in the process of making Kanaba Washer Barrier Softmount and classify the waste into 2 (two) categories, namely solid waste and liquid waste.

Based on interviews and observations in the make process there are 2 (two) types of waste generated, namely solid waste and liquid waste, the solid waste itself is aluminum and steel waste from the cutting process which is cutting the body and several other product parts or can be said with scrap which is the average mass of the waste itself is around 321 kg for every production activity. In research conducted by Rosseland (1990) which examined the environmental effects caused by aluminum, this study classify aluminum as a hazardous material for aquatic ecosystems such as fish and invertebrates, by causing the loss of plasma ions and hemolymph which causes osmoregulation failure. In fish, inorganic (labile) monomeric aluminum reduces the activity of gill enzymes which are important in the active absorption of ions. Dietary organically complexed aluminum in synergistic effect with other contaminants can be easily absorbed and interfere with important metabolism in mammals and birds. However, in make process of Kanaba Washer Barrier Softmount the solid waste, which is from the cutting process, the waste still reuses by the company for other product manufacturing. According to an interview with the company with someone that has responsibility for this case, the rest of the solid waste (scrap) from the production activity will send to the company that has responsible to recycle the scrap.

According to the observation and interview with several employees that have responsibility for the case in this indicator. For the liquid waste produce, they said the type of liquid waste produced in their production activity is just water and the average use of water in make process of Kanaba Washer Barrier Softmount is around 1500 liters which is used on the testing of the product before the product deliver to the customer and in term of historical data, they said they once used about 5200 liters of water in the process of product testing. After conducting the trial of the product, the water used is discharged directly into the ground.

After completing the identification and classification of each waste produced in the make process, the next step is to calculate the SustainableSCOR level-1 indicator which is SS.1.025 Total Supply Chain Non-Hazardous Waste and SS.1.026 Total Supply Chain Hazardous Waste including calculations for each process (level-2 indicator) in each level-1 indicator, below is the calculation.

1. Data Processing of SS.1.025 Total Supply Chain Non-Hazardous Waste

This indicator is defined as the total non-hazardous waste generated from the entire SCOR level-2 process which is plan, source, make, deliver, and return. In processing data on this indicator, processing will only be carried out in the make process because in the other 4 (four) processes which are plan, source, deliver and return no waste is generated. Referring to the SCOR guidebook version 12.0 made by APICS (2017) below is a calculation formula used for this indicator.

$$\text{Total Supply Chain Non-Hazardous Waste} = \text{Plan Non-Hazardous Waste} + \text{Source Non-Hazardous Waste} + \text{Make Non-Hazardous Waste} + \text{Deliver Non-Hazardous Waste} + \text{Return Non-Hazardous Waste} \ldots \text{SS.1.025}$$

The data processing on this indicator will only be carried out in the make process because in the plan, source, delivery, and return processes there is no waste generated from these 4 (four) processes. Below is the indicator data processing in the make process.

1) Data Processing of SS.2.075 Make Non-Hazardous Waste

This indicator is defined as the total non-hazardous waste from a supply chain associated with all SCOR level-2 processes to make. According to the explanation in the SCOR GuideBook version 12.0 made by APICS (2017), make is defined as a process of adding value from something already available (in the context of this research, it is raw material) through the manufacturing process or in the service industry is the creation of service. Referring to the SCOR guidebook version 12.0 made by APICS (2017) below is a calculation formula used for this indicator.

$$\textit{Make Non-Hazardous Waste} = \textit{Sum of Make Non-Hazardous Waste} \ldots \textit{SS.2.075}$$

After knowing the waste produced and its classification, in the final stage, a percentage will be made between both waste classifications. According to observation and interview, it can be concluded the solid non-hazardous waste produced in the make process is 0 kg or 0% of the total waste produced, and the liquid non-hazardous waste produced in the make process is around 1500 liters or 100% of the total waste produced.

2. Data Processing of SS.1.026 Total Supply Chain Hazardous Waste

This indicator is defined as the total hazardous waste generated from the entire SCOR level-2 process which is plan, source, make, deliver, and return. In processing data on this indicator, processing will only be carried out in the make process because in the other 4 (four) processes which are plan, source, deliver and return no waste is generated. Referring to the SCOR guidebook version 12.0 made by APICS (2017) below is a calculation formula used for this indicator.

$$\textit{Total Supply Chain Hazardous Waste} = \textit{Plan Hazardous Waste} + \textit{Source Hazardous Waste} + \textit{Make Hazardous Waste} + \textit{Deliver Hazardous Waste} + \textit{Return Hazardous Waste} \ldots \textit{SS.1.026}$$

The data processing on this indicator is only carried out in the make process because in the plan, source, delivery, and return processes there is no waste generated from these 4 (four) processes. Below is the indicator data processing in the make process.

1) Data Processing of SS.2.079 Make Hazardous Waste

This indicator is defined as the total hazardous waste from a supply chain associated with all SCOR level-2 processes to make. According to the explanation in the SCOR GuideBook version 12.0 made by APICS (2017), make is defined as a process of adding value from something already available (in the context of this research, it is raw material) through the manufacturing process or in the service industry is the creation of service. Referring to the SCOR guidebook version 12.0 made by APICS (2017) below is a calculation formula used for this indicator.

$$Make\ Hazardous\ Waste = Sum\ of\ Make\ Hazardous\ Waste \ldots SS.2.079$$

After knowing the waste produced and its classification, in the final stage, a percentage will be made between both waste classifications. Based on Table 4.12 and Table 4.13 it can be concluded that the solid hazardous waste produced in the make process is 321 kg or 100% of the total waste produced but all the solid waste and the rest of the solid waste (scrap) on the company already reuse and recycle by the third parties company so it can be said solid waste or scrap that have possibility harm the environment already solved by the company. The liquid hazardous waste produced in the making process is 0-liter or 0% of the total liquid waste produced.

4.2.6 Indicators Data Processing and Comparison Result

At this stage, it will be concluded the results of the calculations on each indicator used in this research and a comparison will be made between the results of the actual data on each indicator and the company-specific metric data that are related to the indicator used in this research. In this research, company-specific metric or key performance indicator (KPIs) decided by the company, which in determining the company KPIs has standards that must be met, namely: clarity (it should be easily understood), comparable (if KPIs are comparable, it is possible to compare to different industries), monitor (a KPIs should always be under constant observation because it might be influenced by business activity), and relevance (KPIs should cover all relevant aspects), this is in line with the explanation provided in a study by Pinna et al. (2018). KPIs are intended to translate how to achieve the company's vision and mission as well as become a benchmark for how the company sustains the ability to change and improve. In addition, the basis for determining KPIs at PT. Hari Mukti Teknik is through discussions and interviews conducted by the company with stakeholders to address the goals of the company and stakeholders and is based on the capabilities possessed by the company. In order to address some of the major innovation struggles that the company had to deal with, it had been expected that some of the proposed KPIs might assist motivate certain behaviors (Lakiza & Deschamps, 2018). Below is the table containing data from the calculation of indicators along with the gaps obtained.

Table 4.13 Indicators Data Processing and Comparison Result.

Level-1	Level-2	Unit	Actual Data		Company Specific Metric		GAP	
			Level-2	Level-1	Level-2	Level-1	Level-2	Level-1
SS.1.003 Total Supply Chain Non-Renewable Materials Used	SS.2.008 Make Non-Renewable Materials Used	kg	1371,999	1374,257	1351,2	1351,2	+20,799	+23,057
	SS.2.009 Deliver Non-Renewable Materials Used	kg	2,258		0		+2,258	
			Level-2	Level-1	Level-2	Level-1	Level-2	Level-1
SS.1.004 Total Supply Chain Renewable Materials Used	SS.2.005 Make Renewable Materials Used	kg	3,120	61,141	1	61,28	+2,120	-0,139
	SS.2.006 Deliver Renewable Material Used	kg	58,021		60,28		-2,259	
			Level-2	Level-1	Level-2	Level-1	Level-2	Level-1
SS.1.005 Total Supply Chain % of Recycled Input Materials Used	SS.2.010 Make % of Recycled Input Materials Used	%	99,74 (1371,792Kg)	95,7 (1374,05Kg)	100 (1375,36Kg)	100 (1435,64Kg)	-0,26 (3,568Kg)	-4,3 (61,589Kg)
	SS.2.011 Deliver % of Recycled Input Materials Used	%	3,746 (2,258Kg)		100 (60,28Kg)		-96,3 (58,021Kg)	
SS.1.013 Total Supply Chain Water Reused or Recycled	SS.2.040 Make Water Reused or Recycled.	liters	0		700		-700	
SS.1.025 Total Supply Chain Non-Hazardous Waste.	SS.2.075 Make Non-Hazardous Waste.	kg (Solid Waste)	0		0		0	
		liters (Liquid Waste)	1500		700		-800	
SS.1.026 Total Supply Chain Hazardous Waste.	SS.2.080 Make Hazardous Waste.	kg (Solid Waste)	0		0		0	
		liters (Liquid Waste)	0		0		0	

4.2.7 Data Weighting of Level-1 Indicators Using *Analytical Hierarchy Process* (AHP) Calculation

Analytical Hierarchy Process (AHP) is a theory used to decide a decision or in other words, AHP is a structured technique to organize and analyze complex decisions which are based on mathematics and psychology. According to Saaty (1994) AHP is a framework of thought that is used to unify a framework of thought or logic and problem-solving that has a spectrum ranging from an instant awareness to a fully integrated consciousness by organizing perceptions, feelings, judgments, and memories into a hierarchy of powers that have an influence on the outcome of the decision. In this data processing concept, a pairwise comparison weighting questionnaire is needed for each alternative used which will be filled out by someone who has expertise in that field (Saaty, 1994; Susanty et al., 2016).

In research conducted by Grzybowski & Starczewski (2020), it is said that the priority determination technique used in the AHP framework is based on what is called a pairwise comparison matrix (PCM). PCM contains the decision maker (DM) evaluation of the priority weight ratio. This evaluation is often called a DM assessment which is usually expressed in the value of a predetermined set of numbers called a scale (Saaty, 1994; Dong et al., 2008; Franek & Kresta, 2014; Kou et al., 2016). In the pairwise comparison matrix (PCM) process, there are many types of weighting scales, but this study will use the original normal scale created by Saaty (1994) where the scale is from 1 to 9. Below is an example of a weighting questionnaire and the definition of each scale used in this study (Saaty, 2008).

Table 4.14 Pairwise Comparison Questionnaire Example.

No	Indicator	Scale																	Indicator
1	SS.1.003 Total Supply Chain Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.004 Total Supply Chain Renewable Material Used
…	…	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	…
…	…	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	…

…	SS.1.025 Total Supply Chain Non-Hazardous Waste	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.026 Total Supply Chain Hazardous Waste.

Table 4.15 Weight Scale Definition of Pairwise Comparison Questionnaire.

Intensity of Importance	**Definition**	**Explanation**
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	-
3	Moderate importance	Experience and judgment slightly favour one activity over another
4	Moderate plus	-
5	Strong importance	Experience and judgment strongly favour one activity over another
6	Strong plus	-
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	-
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation

Source: Saaty (2008).

In the pairwise comparison matrix (PCM), the weighting will be carried out using a questionnaire as described previously to someone that has responsibility regarding the case in this research. The respondents selected to fill out the weighting questionnaire in this research is:

Name	:	M. Amin Syukron, S.T, M.T.
Position	:	Business Development Manager
Company	:	PT. Hari Mukti Teknik
Years of Work	:	5 Years

After the weighting is done, the next step is to normalize the data and later the results of data normalization will be totaled for each indicator and these results will be used in calculating the eigen vector, multiplication matrix, eigen value (λ), λ_{max}, consistency index (CI), index ratio (IR), and consistency ratio (CR), which is as described in Table 2.3 which explains all the calculation indicators and formulas used in data processing this time.

As explained earlier, indicator weighting aims to determine the priority of the indicator used. Indicator weighting uses data derived from questionnaires that are entered into the pairwise comparison matrix (PCM) as shown below.

Table 4.16 Weighting Classification of Level-1 Indicators.

Indicators	**SS.1.003**	**SS.1.004**	**SS.1.005**	**SS.1.013**	**SS.1.025**
SS.1.003	1	1/7	1/8	1/7	1/7
SS.1.004	7	1	7	7	7
SS.1.005	8	1/7	1	1/5	6
SS.1.013	7	1/7	5	1	6
SS.1.025	7	1/7	1/6	1/6	1
Total	30,000	1,571	13,292	8,510	20,143

Exp:
SS.1.003: Total Supply Chain Non-Renewable Material Used
SS.1.004: Total Supply Chain Renewable
SS.1.005: Total Supply Chain % of Recycled Input Material Used
SS.1.013: Total Supply Chain Water Reused or Recycled
SS.1.025: Total Supply Chain Non-Hazardous Waste

The next step is followed by normalization and the calculation of consistency. The normalization method is important to find the balanced weight between indicators so it can be used to calculate the score of green supply chain management performance. Below shown the normalized weight of each level-1 indicator used followed by a consistency ratio to determine if each indicator has a consistent pairwise comparison.

Table 4.17 Weighting Normality Calculation of Level-1 Indicators.

Indicators	**SS.1.003**	**SS.1.004**	**SS.1.005**	**SS.1.013**	**SS.1.025**
SS.1.003	0,0333	0,0909	0,0094	0,0168	0,0071
SS.1.004	0,2333	0,6364	0,5266	0,8226	0,3475
SS.1.005	0,2667	0,0909	0,0752	0,0235	0,2979
SS.1.013	0,2333	0,0909	0,3762	0,1175	0,2979
SS.1.025	0,2333	0,0909	0,0125	0,0196	0,0496
Total	1	1	1	1	1

Table 4.18 Consistency Ratio Calculation of Level-1 Indicators.

Indicators	**Total Weight Matrix**	**Eigen Vector**	**Multiplication Matrix**	**Eigen Value (ʎ)**	**$ʎ_{max}$**	**CI**	**IR**	**CR**
SS.1.003	0,1575	0,0315	0,1672	5,3060	6,5785	0,3946	1,12	0,3524
SS.1.004	2,5665	0,5133	3,9202	7,6374				
SS.1.005	0,7542	0,1508	1,0081	6,6831				
SS.1.013	1,1158	0,2232	1,7584	7,8796				
SS.1.025	0,4060	0,0812	0,4374	5,3865				
Total	5	1	7,2913	32,8927				

For the calculation of the consistency ratio (CR), in a study conducted by Garminia, Hafiyusholeh & Astuti (2011) said that related to the problem of decision data, it contains subjective views and considerations to produce a pairwise comparison matrix (PCM) which is not transitive or usually referred to as PCM is interrupted. Therefore, in the research of Garminia, Hafiyusholeh & Astuti (2011), they provide a scale of disturbance in CR which is classified as acceptable. Below is the acceptable fault interval for each n used.

Table 4.19 Acceptable Fault Interval for Each *n* Used for Consistency Ratio.

n	**IR**	**Interval CR, with IR ≤ 10%**
3	0,58	(0.493, 2.029)
4	0,90	(0.321, 3.119)
5	1,12	(0.218, 4.582)
6	1,24	(0.159, 6,305)
7	1,32	(0.120, 8.348)
8	1,41	(0.091, 10.93)
9	1,45	(0.073, 13.67)
10	1,49	(0.059, 16.84)
11	1,51	(0.049, 20.22)

Based on the table below, from the calculation of consistency result conducted before, it can be said still acceptable with the score of consistency is 0,3524 (n = 5; acceptable fault interval = 0,218 – 4,582)

4.2.8 Data Weighting of Level-2 Indicators Using *Analytical Hierarchy Process* (AHP) Calculation

Based on calculations before, the normalized weight of each indicator level-1 has been obtained. Before conducting the next calculation, needed to know the normalized weight of level-2 indicators. The weighting at level-2 is carried out in the same way as the weighting process carried out at the level-1 indicators. Below is the final weighting of the level-1 and level-2 indicators.

Table 4.20 Final Weighting of The Level-1 and Level-2 Indicators.

Level-1 Indicators	Normalized Weight	Level-2 Indicators	Normalized Weight
SS.1.003	0,0315	SS.2.008	0,857
		SS.2.009	0,143
SS.1.004	0,5133	SS.2.006	1
SS.1.005	0,1508	SS.2.010	0,875
		SS.2.011	0,125
SS.1.013	0,2232	SS.2.040	1
SS.1.025	0,0812	SS.2.075	1
	1,0000		

Exp:
SS.1.003: Total Supply Chain Non-Renewable Material Used
SS.1.004: Total Supply Chain Renewable
SS.1.005: Total Supply Chain % of Recycled Input Material Used
SS.1.013: Total Supply Chain Water Reused or Recycled
SS.1.025: Total Supply Chain Non-Hazardous Waste
SS.2.008: Make Non-Renewable Material Used
SS.2.009: Deliver Non-Renewable Material Used
SS.2.006: Deliver Renewable Material Used
SS.2.010: Make % of Recycled Input Material Used
SS.2.011: Deliver % of Recycled Input Material Used
SS.2.040: Make Water Reused or Recycled
SS.2.075: Make Non-Hazardous Waste

4.2.9 Priority Scale Data Processing

After processing data from data processing on each indicator followed by weighting and processing using AHP, below is a recapitulation of the entire data processing process and can be seen in the table below that there are actual data, company-specific metric data and gaps for each indicator. In addition, there are a weight for each indicator at level-1 and level 2 and there is an overall weight, from the data it can be seen the priority scale of each indicator, below is a data processing recapitulation table.

Table 4.21 Priority Scale Data Processing Recapitulation.

Level-1 Indicators	Local Weight	Level-2 Indicators	Local Weight	Actual Data	Targeted	GAP	Global Weight	Priority Scale
SS.1.003	0,0315	SS.2.008	0,857	1371,999	1351,2	20,799	0,0270	5
		SS.2.009	0,143	2,258	0	2,258	0,0045	7
SS.1.004	0,5133	SS.2.006	1	58,021	60,28	-2,259	0,5133	1
SS.1.005	0,1508	SS.2.010	0,875	99,74	100	-0,26	0,1320	3
		SS.2.011	0,125	3,746	100	-96,254	0,0189	6
SS.1.013	0,2232	SS.2.040	1	0	1500	-1500	0,2232	2
SS.1.025	0,0812	SS.2.075	1	1500	0	1500	0,0812	4
	1,0000						1,0000	

Exp:
SS.1.003: Total Supply Chain Non-Renewable Material Used
SS.1.004: Total Supply Chain Renewable
SS.1.005: Total Supply Chain % of Recycled Input Material Used
SS.1.013: Total Supply Chain Water Reused or Recycled
SS.1.025: Total Supply Chain Non-Hazardous Waste
SS.2.008: Make Non-Renewable Material Used
SS.2.009: Deliver Non-Renewable Material Used
SS.2.006: Deliver Renewable Material Used
SS.2.010: Make % of Recycled Input Material Used
SS.2.011: Deliver % of Recycled Input Material Used
SS.2.040: Make Water Reused or Recycled
SS.2.075: Make Non-Hazardous Waste

According to Table 4.21, the result of the analytical hierarchy process (AHP) calculating to know the priority scale of each indicator that didn't reach the company specific-matric, below is the table that explains the priority scale for each indicator refer to the AHP calculation.

Table 4.22 Priority Scale Result Based on AHP Calculation.

Level-2 Indicators	Priority Scale
SS.2.006 Deliver Renewable Material Used	1
SS.2.040 Make Water Reused or Recycled	2
SS.2.010 Make % of Recycled Input Material Used	3
SS.2.075 Make Non-Hazardous Waste	4
SS.2.008 Make Non-Renewable Material Used	5
SS.2.011 Deliver % of Recycled Input Material Used	6
SS.2.009 Deliver Non-Renewable Material Used	7

4.2.10 Green Supply Chain Management Performance Score Calculation

To find the green supply chain management (GSCM) performance score, it is needed to use snorm de boer normalization with the purpose to balance the value parameter of each indicator because each indicator has a different weight and parameter (Susanty et al., 2016). Based on the research conducted by Susanty et al. (2016), there are 2 (two) type of snorm formula, which is used for the indicator that has larger value is better and vice versa, below is the formula used for snorm calculation to know the overall GSCM score in this research (Susanty et al., 2016).

$$Larger\ is\ better: snorm = \left(\frac{S_i - S_{min}}{S_{max} - S_{min}}\right) * 100$$

$$Lower\ is\ better: snorm = \left(\frac{S_{max} - S_i}{S_{max} - S_{min}}\right) * 100$$

Where:

S_i : Actual score of each indicator

S_{min} : Minimum scale

S_{max} : Maximum scale

These calculations will produce performance indicators values from the object of the research. If the value is greater than 90 then it can be categorized as "excellent" (shown in Table 4.23). Below shows the performance indicators monitoring system used in the research conducted by Pulansari & Putri (2020) and the snorm de boer normalization calculation to find out the green supply chain performance (GSCM) overall score and classification.

Table 4.23 Performance Indicator Monitoring Systems.

Monitoring Score	**Performance Indicator Classification**
< 40	Poor
40 – 50	Marginal
51 – 70	Average
71 – 90	Good
> 90	Excellent

Source: Pulansari & Putri (2020).

Table 4.24 GSCM Performance Score Calculation.

Level-1 Indicators	Local Weight	Level-2 Indicators	Local Weight	Actual Data	Min (Smin)	Max (Smax)	Snorm	Level-2 Normalize Weight	Level-1 Normalize Weight
SS.1.003	0,0315	SS.2.008	0,857	1371,999	1351,2	1370	10,633	9,1140	0,287
		SS.2.009	0,143	2,258	0	5	54,840	7,8343	0,247
SS.1.004	0,5133	SS.2.006	1	58,021	55	60,28	57,216	57,2159	29,369
SS.1.005	0,1508	SS.2.010	0,875	99,74	90	100	97,400	85,2250	12,855
		SS.2.011	0,125	3,746	0	100	3,746	0,4683	0,071
SS.1.013	0,2232	SS.2.040	1	0	0	700	0,000	0,0000	0,000
SS.1.025	0,0812	SS.2.075	1	1500	700	5200	82,222	82,2222	6,677
	1,0000								49,505

Exp:
SS.1.003: Total Supply Chain Non-Renewable Material Used
SS.1.004: Total Supply Chain Renewable
SS.1.005: Total Supply Chain % of Recycled Input Material Used
SS.1.013: Total Supply Chain Water Reused or Recycled
SS.1.025: Total Supply Chain Non-Hazardous Waste
SS.2.008: Make Non-Renewable Material Used
SS.2.009: Deliver Non-Renewable Material Used
SS.2.006: Deliver Renewable Material Used
SS.2.010: Make % of Recycled Input Material Used
SS.2.011: Deliver % of Recycled Input Material Used
SS.2.040: Make Water Reused or Recycled
SS.2.075: Make Non-Hazardous Waste

From Table 4.24, it can be said the overall score of green supply chain management (GSCM) on PT. Hari Mukti Teknik in terms of the production activity of Kanaba Washer Barrier Softmount is 49,505 which can be said of “marginal” classification because the value is between 40 and 50. Based on the overall GSCM performance indicator monitoring system, they need to do some improvements on their supply chain if they want to achieve “good” or “excellent” GSCM in their supply chain activity of Kanaba Washer Barrier Softmount production process.

CHAPTER V
RESULT AND DISCUSSION

5.1 Calculation Result of SustainableSCOR Indicators Performance

In the previous calculation, there are several SustainableSCOR indicators used refer to the current condition of the company (the object of research) and also refer to the SCOR guidebook version 12.0 made by APICS (2017) which is the SustainableSCOR indicator used in this research has 2 (two) levels which are level-1 and level-2, level-1 is the main indicator of SustainableSCOR while level-2 is the breakdown of the main indicator (level-1) which includes 5 (five) main activities which are plan, source, make, deliver, and return (APICS, 2017).

Referring to the previous processing, several indicators used in this research have a fairly large gap. The gap itself is from the calculation of the actual data obtained for each indicator compared to the company-specific matrix as shown in Table 4.13. The next step is data processing using the AHP method which is used to prioritize indicators that have gaps where the weighting of each indicator is carried out by someone who has responsibility in the company related to the problems raised in this research. In the AHP calculation, weighting is carried out for each indicator that does not reach the company target with the aim of obtaining a priority scale for each indicator, the results of the calculation can be seen in the table below.

Table 5.1 Priority Scale Result Based on AHP Calculation.

Level-2 Indicators	Priority Scale
SS.2.006 Deliver Renewable Material Used	1
SS.2.040 Make Water Reused or Recycled	2
SS.2.010 Make % of Recycled Input Material Used	3
SS.2.075 Make Non-Hazardous Waste	4
SS.2.008 Make Non-Renewable Material Used	5
SS.2.011 Deliver % of Recycled Input Material Used	6
SS.2.009 Deliver Non-Renewable Material Used	7

After knowing the gaps and also the priority scale of each indicator, the next step is to propose improvements for each indicator, the proposed improvement given in this research are expected to help companies achieve the green supply chain performance that they targeting and this approach is expected to help an expert in a supply chain context gain visibility into environmental topics that exist in their supply chain and value chain networks and enable them to model and manage their impacts. Below is the proposed suggestion or improvement for each indicator.

Table 5.2 Proposed Suggestion Based on Indicators Problem.

Priority Scale	Level-1 Indicators	Level-2 Indicators	Suggestions
1	SS.1.004 Total Supply Chain Renewable Material Used	SS.2.006 Deliver Renewable Material Used	***Ensuring raw materials used***, in the deliver process there are 2 (two) types of non-renewable materials which are brass and polyethylene, in the previous discussion it was said that renewable materials had not been found that could replace both of the materials, so this study only suggests ensuring the materials used on the part from recycled and can be reused properly, for brass and polyethylene it is certain that they can be recycled continuously (Morecambe Metals, 2020; Zulhan, 2013; Abedsoltan, 2021; Ferrario, 2021).
2	SS.1.013 Total Supply Chain Water Reused or Recycled	SS.2.040 Make Water Reused or Recycled	***Water recycle and reuse system***, based on the discussion of water use in this research, water use can be classified as large enough to produce 1 (one) product, which in this study is recommended to create a water treatment system so that the wastewater produced can be processed and reused, and can also reduce the company's annual cost in term of water supply. There are several water treatment options provided in this research which were quoted from research conducted by Cisneros (2014) where the treatment is adjusted to the concern and cause of the wastewater produced. In addition, there is an energy-friendly water treatment concept or system quoted from the research conducted by Ming et al. (2020), which is called 3D Macroscopic Graphene Oxide/MXene or GMA-3 which utilizes solar heat and 3D Macroscopic Graphene Oxide/Mxene (GMA-3) sheets to help evaporate and purify water.
3	SS.1.005 Total Supply Chain % of Recycled Input Material Used	SS.2.010 Make % of Recycled Input Material Used	***Ensuring materials used***, there are 3 (three) types of non-recycled material used on make process, which are polyurethane, alkyd, and epoxy amine adduct. Regarding the use of polyurethane, in this research, it was considered not to be a significant problem because polyol (main substances) can be obtained through renewable resources such as vegetable oils obtained from castor, soybean, pongamia glabra, neem, and cotton seeds (Ratna, 2022). In addition, polyurethane can be recycled to obtain polyol for use in making new polyurethane, but this method requires high energy input into the

Priority Scale	Level-1 Indicators	Level-2 Indicators	Suggestions
			reactor either to heat the batch or to apply. While the other 2 (two) materials are alkyd and epoxy amine adducts, both of which cannot be recycled due to their characteristic. However, this can be overcome by ensuring the use of raw materials for both the materials comes from post-consumer products such as bottles or drinking can obtain polyethylene terephthalate (PET) (Maiti et al., 2022; Memon et al., 2022; Senra et al., 2022; Atta et al., 2007; Dullius et al., 2006).
4	SS.1.025 Total Supply Chain Non-Hazardous Waste	SS.2.075 Make Non-Hazardous Waste	***Water recycle and reuse system***, based on the discussion of water use in this research, water use can be classified as large enough to produce 1 (one) product, which in this study is recommended to create a water treatment system so that the wastewater produced can be processed and reused, and can also reduce the company's annual cost in term of water supply. There are several water treatment options provided in this research which were quoted from research conducted by Cisneros (2014) where the treatment is adjusted to the concern and cause of the wastewater produced. In addition, there is an energy-friendly water treatment concept or system quoted from the research conducted by Ming et al. (2020), which is called 3D Macroscopic Graphene Oxide/MXene or GMA-3 which utilizes solar heat and 3D Macroscopic Graphene Oxide/Mxene (GMA-3) sheets to help evaporate and purify water.
5	SS.1.003 Total Supply Chain Non-Renewable Material Used	SS.2.008 Make Non-Renewable Material Used	***Ensuring materials used***, there are 3 (three) main types of non-renewable material used to make process which is metal, plastic, and epoxy. Based on the analysis, around 98,243% of the part used in the manufacture of the product uses metal material. The suggestion related to the use of metal material is only suggested to ensure the materials used on the part are recycled properly and can be reused. However, metal is classified as a material that can be recycled many times (Universal Eco, 2022; Morecambe Metals, 2021; Kementerian Perindustrian Republik Indonesia, 2020; Zulhan, 2013). Regarding the uses of plastic materials, the following are some types of plastic used in the make process in this research, such as polyurethane, polyvinyl chloride (PVC), polycarbonate, polyethylene, polymethyl methacrylate (PMMA), thermoplastic polymers, polyolefin, and acrylonitrile butadiene styrene (ABS). From the 8 (eight) types of plastic used,

Priority Scale	Level-1 Indicators	Level-2 Indicators	Suggestions
			there is only 1 (one) type of plastic which is polyurethane that is classified as non-recyclable into the same type or product but this material is from a renewable resource, 7 (seven) other materials are classified into recyclable materials and become the same product or material (Universal Eco, 2022; VinylPlus, 2022; Abedsoltan, 2021; Ferrario, 2021; Nikolaidis & Achilias, 2018; Redwing, 2017; Boria et al., 2016; Hadi et al., 2012; Wang et al., 2014; Karlsson, 2004). The last non-renewable material is epoxy amine adduct, due to their permanent crosslinked structures, traditional epoxy resins cannot be reprocessed, repaired, or recycled (Memon et al., 2022). According to Atta et al. (2007), this material can be produced from the recycling of polyethylene terephthalate (PET) from the post-consumer product such as packaging foods and beverages, especially convenience-sized soft drinks, juices, and water (Senra et al., 2022; Dullius et al., 2006).
6	SS.1.005 Total Supply Chain % of Recycled Input Material Used	SS.2.011 Deliver % of Recycled Input Material Used	***Material reuse***, there are 3 (three) main materials used in the delivery process, namely silk-cotton wood, brass, and polyethylene. However, only 1 (one) material is classified as non-recycled input material used which is silk-cotton wood, which has the function of protecting the product during the shipping process. In this study, the only suggestion that can be given is to reuse wood materials that have been used in the shipping process, because this material is classified as a renewable material and is also environmentally friendly (Galic et al., 2021) compared to the use of other synthetic materials such as plastic which harms environment if no further processing after use.
7	SS.1.003 Total Supply Chain Non-Renewable Material Used	SS.2.009 Deliver Non-Renewable Material Used	***Ensuring materials used***, there are 2 (two) main types of non-renewable materials used in deliver process which are brass and polyethylene. Regarding the use of brass, brass is an alloy of copper (Cu) and zinc (Zn), which can be recycled like other types of metal (Morecambe Metals, 2020; Zulhan, 2013). While polyethylene is the most widely used plastic. It is a polymer that is mostly used in packaging (plastic bags, plastic films, geomembranes, and containers including bottles, etc.), where this material can also be recycled and can be reused (Abedsoltan, 2021; Ferrario, 2021). In this study, no renewable raw

Priority Scale	Level-1 Indicators	Level-2 Indicators	Suggestions
			materials were found that could replace both of the types of materials which have the same characteristics, therefore the only suggestion that can be given by the company can be reassured regarding the manufacture of each part they have using recycled materials if the company want their products to have a value of 100% environmentally friendly products.

5.1.1 Discussion of SS.1.003 Total Supply Chain Non-Renewable Materials Used and SS.1.004 Total Supply Chain Renewable Materials Used

This indicator calculates the amount of material included between the classification of non-renewable materials and renewable materials. According to the CK-12 Foundation (2022), non-renewable resources or materials are defined as natural resources that are in fixed quantity and can be used until they are exhausted. Examples include fossil fuels such as oil, coal, and natural gas. These resources are formed from the remains of plants that were sedimented for hundreds of millions of years, or in other words these resources can be used much faster than they can be reproduced by natural processes, other examples are minerals and metals, although 2 (two) these types of raw materials are classified as non-renewable raw materials but have the greatest potential to be recycled indefinitely, 2 (two) types of these raw materials are also not biodegradable and from their elemental properties have an indefinite lifespan (Norgate et al., 2007). However, according to the CK-12 Foundation (2022) and El-Mously (2018), renewable resources are defined as a resource obtained from nature that can be reproduced by natural processes as quickly as humans use them.

Based on Table 4.8, it is explained the total weight of the supply chain of non-renewable materials used and renewable used. Non-renewable material used is known to be around 1374,257 kg or around 95,740 % of the total weight of the product. From the identification and classification of the bill of material (BOM) Kanaba Washer Barrier Softmount, it is known that around 1351,2 kg or around 98,243% of the part used in the manufacture of the product uses metal material and around 21,337 kg or about 1,551% of the part use plastic as materials composition in which 2 (two) types of material composition classified as non-renewable materials (some few types of plastic) because both of the materials are derived from mining of natural resources which takes a long time to be reproduced naturally. Based on this indicator PT. Hari Mukti Teknik has a specific target for the use of non-renewable material which is around 98% of Kanaba Washer Barrier Softmount total weight or around 1351,2 kg, so it can be concluded that there is a gap between the actual data and the target of the use of non-renewable which has around 23,057 kg on all process of Kanaba Washer Barrier Softmount (make and deliver process). So, this research will suggest the problem of using non-renewable materials to produce Kanaba Washer Barrier Softmount.

Based on the analysis of the Kanaba Washer Barrier Softmount bill of materials (BOM) it can be seen the majority of the material used is from metal and plastic. According to an article made by worldsteel (2022), they forecasted that steel demand will grow by 0,4% in 2022 to reach 1840,2 Mt. In 2023, steel demand will see further growth of 2,2% to reach 1881,4 Mt, or it can be said the demand for metal use is still high over the years. Regarding the amount of metal used, this material can be recycled many times (Universal Eco, 2022; Morecambe Metals, 2021; Kementerian Perindustrian Republik Indonesia, 2020; Zulhan, 2013). So, this research gives suggestions regarding the use of metal material for Kanaba Washer Barrier Softmount part is only to ensure all parts of the product used made from metal can be recycled and reused properly because for now recycled is the only best way to preserve natural resource or non-renewable materials. From the article made by Morecambe Metals (2021), for every steel material recycled it's possible to save 1,5 tonnes of iron ore, 70% of the energy, 40% of the water, and 75% of CO_2 emissions. This is also proven in research conducted by Shemi et al. (2018), beside of environmental sustainability, recycling activities can also save costs in the manufacture of a metal, in their research which takes the example of the zinc recycling process, which consumes about 4kWh/kg, compares favorably to the 12kWh/kg consumed in the production of virgin tungsten monocarbide using the indirect conversion route. According to U.S. Environmental Protection Agency (2021), make a table containing data on ferrous metals (iron and steel) generated, recycled, combustion with energy recovery, and also landfilled ferrous metals, from the table below it can be seen the energy recovery for each mass of ferrous metals recycled.

Figure 5.1 Summary Table of Ferrous Metals Management Pathway.

Management Pathway	1960	1970	1980	1990	2000	2005	2010	2015	2017	2018
Generation	10,300	12,360	12,620	12,640	14,150	15,210	16,920	18,190	18,890	19,200
Recycled	50	150	370	2,230	4,680	5,020	5,800	6,070	6,170	6,360
Composted	-	-	-	-	-	-	-	-	-	-
Combustion with Energy Recovery	-	60	250	1,690	1,610	1,640	1,810	2,150	2,290	2,310
Landfilled	10,250	12,150	12,000	8,720	7,860	8,550	9,310	9,970	10,430	10,530

Source: U.S. Environmental Protection Agency (2021).

In addition to the use of metal materials in the process of making Kanaba Washer Barrier Softmount, several other materials are classified as non-renewable materials, such as plastic. The classification is based on several types of plastic that require several elements that can only be obtained from petroleum and several types of plastic that cannot be reprocessed into the plastic of the same type or in other words can be recycled but become derivative materials that are not the same as the type of plastic previously (for example polyurethane (University of Minnesota, 2020). The following are some types of plastic used in the make and deliver process in this research, such as polyurethane, polyvinyl chloride (PVC), polycarbonate, polyethylene, polymethyl methacrylate (PMMA), thermoplastic polymers, polyolefin, and acrylonitrile butadiene styrene (ABS). From the 8 (eight) types of plastic used, there is only 1 (one) type of plastic which is polyurethane that is classified as non-recyclable into the same type or product but this material is from a renewable resource and only 1 (one) type of plastic which is acrylonitrile butadiene styrene (ABS) that is classified as non-recyclable and also non-renewable material used, 6 (six) other materials are classified into recyclable materials and become the same product or material (Universal Eco, 2022; VinylPlus, 2022; Abedsoltan, 2021; Ferrario, 2021; Nikolaidis & Achilias, 2018; Redwing, 2017; Boria et al., 2016; Hadi et al., 2012; Wang et al., 2014; Karlsson, 2004).

Regarding the use of several types of plastic materials, the suggestion is just the company can re-assure the process of making every part of the product use recycled material (if the material is from non-renewable resources) if the company wants its products to have 100% sustainable to environmental in term of materials used. In addition, this research has not found a substitute material that can be used to replace the 8 (eight) types of plastic used with the same function and character of material otherwise with the metal used.

The third non-renewable material used is epoxy amine adduct, epoxies are polymerized that used a variety of reactants, such as polyfunctional amines, acids, anhydrides, phenols, alcohols, and thiols (Greene, 2021). Epoxy resins are a type of reactive polymer that contains epoxide groups. Due to their superior mechanical performance, adhesive capacity, dimensional stability, heat resistance, and chemical resistance. Amine adducts are prepared by reacting excess primary amines with epoxy resin (Weinmann, 1996). Epoxy resins are used in a wide range of industrial applications, including adhesives, coatings, electronic encapsulants, and polymer matrices for advanced composites. However, due to their permanent crosslinked structures, traditional epoxy resins cannot be reprocessed, repaired, or recycled (Memon et al., 2022). According to Atta et al. (2007), glycolysis of polyethylene terephthalate (PET), waste using trimethylol propane (TMP), triethanolamine (TEA), diethylene glycol (DEG) and diethanolamine (DEA) was used to produce suitable hydroxy-oligomers for epoxy. PET products as the basic resin for epoxy resins add a new trend of recycled PET applications. PET can be obtained from a post-consumer product such as packaging foods and beverages, especially convenience-sized soft drinks, juices, and water (Senra et al., 2022; Dullius et al., 2006).

The conclusion in increasing the amount of renewable material used and reduce the amount of non-renewable material used. First, regarding metal used in the bodies, product frames and several other small parts that cannot be replaced, when this research was carried out there was no suitable renewable material source and easy to get to replace metal materials, it is advisable to use materials from the recycling process. For the use of plastic, the suitable suggestion is to use recycled plastic in certain types of plastic, from the 8 (eight) types of plastic used, there is only 1 (one) type of plastic which is polyurethane that is classified as non-recyclable the same type or product but this material is from a renewable resource and only 1 (one) type of plastic which is acrylonitrile butadiene styrene (ABS) that is classified as non-recyclable and also non-renewable material used, 6 (six) other materials are classified into recyclable materials and become the same product or material, of which 20,457 kg can be anticipated by using materials from recycled processes on make process, but this amount has not been able to reach the target due to the use of acrylonitrile butadiene styrene (ABS) that is classified as non-recyclable and also non-renewable material used. For the deliver process, the use of polyethylene-type plastic can be anticipated by using this material which comes from the recycled process, then 1,464 kg of non-renewable material used can be anticipated. In addition, the use of brass material or one type of metal is 0.794 kg which has not yet found a suitable type of renewable material to replace this type of material, the suitable anticipation is to use materials from recycled processes. It can be concluded that the overall weight of non-renewable material used in the deliver process can be anticipated by using materials originating from recycled processes, so the target of 0 kg of non-renewable material used can be met.

5.1.2 Discussion of SS.1.005 Total Supply Chain % of Recycled Input Materials Used

This indicator calculates the percentage of recycled input materials used in manufacturing or company. According to research conducted by Chauhan et al. (2022), recycling is an activity of reprocessing waste or material from a product that has the aim of being able to be utilized or reused, the output of this activity can be a new product, or it can be how many raw materials can be reused to produce the same product or other products. In addition, according to GRI recycled material input is material that replaces main materials, which are purchased or obtained from internal or external sources, and also not by-product and non-product outputs (NPO) produced by the organization. The first step in this indicator is to analyze and identify the material used in each process in the manufacture of Kanaba Washer Barrier Softmount. In this indicator, there is a level-2 indicator which includes the recycled input materials used in the plan, source, make, deliver, and return processes. In this research, only calculations are made on the process of make and deliver the process of the product. Related to the plan, source, and return processes, no calculations or data processing was carried out due to the none of raw materials used in this process. Based on the calculations that have been made, on this indicator, the company has a target for the make and deliver process to be 100% using recycled materials.

In this indicator, it is known there are 4 (four) types of materials classified into non-recycled input materials used which are polyurethane, alkyd, epoxy amine adduct, and silk-cotton wood. Polyurethane, this material can be recycled but cannot be recycled and reused like the original polyurethane material, in other words, it can be down-recycled into other new products (University of Minnesota, 2020; Kemona & Piotrowska, 2020;

Schulzke et al., 2018). Polyurethane is one of the most versatile materials on the market. Traditional polyurethane is made from fossil fuels, just like other polymers, and it may be produced in a variety of forms and used in a wide range of markets (Enderus & Tahir, 2017; Liang et al., 2021). Polyurethane which is mainly used urethane oils (obtained by reacting diisocyanates with natural unsaturated oils) and urethane-alkyd resins modified with unsaturated oils as a material composition (Ardebili et al., 2019; Janik et al., 2014). Polyurethanes are organic polymers created when a polyol (an alcohol with more than two reactive hydroxyl groups per molecule) is reacted with a polymeric isocyanate or a diisocyanate in the presence of the proper catalysts and additives (Fink, 2018; “Polyurethanes,” 2016). To produce polyurethane materials sustainably, polyols can be sourced from natural and renewable sources, such as vegetable oils. These renewable resources can be fatty acids or dimer fatty acids derived from vegetable oils such as castor, soybean, pongamia glabra, neem, and cotton seeds (Ratna, 2022). Nowadays, polyurethane still widely uses as shape memory polymers, as foams, coatings, adhesives, and on medicine (scaffolds, dental obturation materials) (Fałtynowicz et al., 2022; Varma & Gopi, 2021) and also on car manufacture polyurethane makes car seats comfortable, bumpers, interior “headline”, ceiling sections, car bodies, spoilers, doors, and windows (Madhav et al., 2019). Most polyurethane goods are either burned or landfilled once their useful lives are up, which harms the environment by using resources and emitting toxins and greenhouse gases (Liang et al., 2021). According to research conducted by Kemona & Piotrowska (2020), they said polyurethane can be recycled to get polyols, and the resulting polyols can be used as additives to the original polyol in polyurethane production or as fuel by hydrolysis, but this method requires high energy input into the reactor either to heat up the batch or to apply.

Regarding the use of alkyd, Alkyd resins are low molecular weight polyesters that have been changed by the condensation process of polyhydric alcohols, monobasic and polybasic acids, vegetable oils, and fatty acids (Maiti et al., 2022). Alkyd resins are widely utilized in the application of surface coatings due to their superior mechanical properties, reliability, higher drying speed, high gloss, and less expensive price than acrylic binders. Alkyd-based coatings are used to decorate and protect metals, wood, and concrete walls. In several studies that have been carried out, alkyd can be obtained through a recycling process from post-consumer polyethylene terephthalate (PET) which is widely used for packaging foods and beverages, especially convenience-sized soft drinks, juices, and water (Senra et al., 2022; Dullius et al., 2006). In the research conducted by Ma et al. (2020), they provide a simple and environmentally acceptable method of recycling polyethylene terephthalate (PET) waste into zanthoxylum bungeanum seed oil (ZSO)-based alkyd resin from post-consumer PET bottles. Trimethylolpropane (TMP) was used to glycolyze PET waste, producing tetra-functional glycolyzate.

The third non-recycled material is epoxy amine adduct, epoxies are polymerized that used a variety of reactants, such as polyfunctional amines, acids, anhydrides, phenols, alcohols, and thiols (Greene, 2021). Epoxy resins are a type of reactive polymer that contains epoxide groups. Due to their superior mechanical performance, adhesive capacity, dimensional stability, heat resistance, and chemical resistance. Amine adducts are prepared by reacting excess primary amines with epoxy resin (Weinmann, 1996). Epoxy resins are used in a wide range of industrial applications, including adhesives, coatings, electronic encapsulants, and polymer matrices for advanced composites. However, due to their permanent crosslinked structures, traditional epoxy resins cannot be reprocessed, repaired, or recycled (Memon et al., 2022). According to Atta et al. (2007), glycolysis of polyethylene terephthalate (PET), waste using trimethylol propane (TMP), triethanolamine (TEA), diethylene glycol (DEG) and diethanolamine (DEA) was used to produce suitable hydroxy-oligomers for epoxy. PET products as the basic resin for epoxy resins add a new trend of recycled PET applications.

The last non-recycled input material used is the silk-cotton wood plank which is used for the product packaging while the product is delivered to the customer. The use of the material is because of the characteristic which is durable, environmentally friendly (renewable materials), and low cost. Nowadays, wood is widely used for packaging a product because of its characteristics. Compared to other raw packaging materials, wood is considerably less expensive, and unlike alternative materials such as plastics, wood is a sustainable resource and safer for the environment. Wooden packaging is recyclable, reusable, and can be repaired. At the end of its life, wood becomes a renewable energy source, and it is also a single resource that is infinitely renewable, making it an important part of the circular economy (Galic et al., 2021). In the end, nowadays wood is the best packaging material compared to plastic and other metal materials, both of which have a negative impact on the environment. Regarding the use of wood materials in this study, it is recommended to ensure the reuse of packaging wood plank if the company targets its entire process to use recycled materials which is a form of concern for environmental sustainability. So, the suggestion related to the use of wood material is company suggested to be able to reuse wood materials used in the deliver process because nowadays wood is suitable material for packaging some products because this material is classified as a renewable material and is also environmentally friendly.

The conclusion is the SS.2.010 Make % of Recycled Input Materials Used indicator gets a value of 99,74% and cannot reach the target which is 100% make of recycled input materials used, due to the nature of the materials used such as alkyd, polyurethane, and epoxy amine adducts. Alkyd and polyurethane are included in the non-recycled materials used but these materials can be obtained from renewable materials sources. As for epoxy amine adduct, it is categorized into non-recycled material used due to its nature, but the basic ingredients for making this material can be obtained from the material recycling process of glycolysis of polyethylene terephthalate (PET), waste using trimethylol propane (TMP), triethanolamine (TEA), diethylene glycol (DEG) and diethanolamine (DEA) was used to produce suitable hydroxy-oligomers for epoxy. PET products as the basic resin for epoxy resins add a new trend of recycled PET applications. Whereas for SS.2.011 Deliver % of Recycled Input Materials Used, the target can be achieved if PT. Hari Mukti Teknik reused the entire plank used in the previous delivery process.

5.1.3 Discussion of SS.1.013 Total Supply Chain Water Reused or Recycled

This indicator is defined as the total water from a supply chain that is recycled and reused by the organization or company associated with the SCOR level-1 process for plan, source, make, deliver, and return. Water recycling and reuse is an environmental conservation measure by reprocessing used water and wastewater through another cycle before being discharged into the environment or reused by companies for their supply chain processes. In this case, related to the plan, source, deliver and return processes, no calculations or data processing were carried out due to the none of water use or water recycling processes, so only calculations and data processing were carried out on make.

According to the observation and interview with several employees that have responsibility for the case in this indicator, they said the average use of water in make process of Kanaba Washer Barrier Softmount is around 1500 liters which is used for the testing of the product before the product deliver to the customer. The type of water used in this process didn't get from the recycling of water used by the company. After conducting the trial of the product, the water used is discharged directly into the ground without reprocessing. So, the result for this indicator is 0 liters of water recycled used.

Regarding the use of water recycled and reused which is the way to realize environmental sustainability, there are a lot of several ways related to water purification processing, so that the water used can be reprocessed or reused. According to research conducted by Cisneros (2014), there are several treatments or methods to recycle and reuse the water used by industries, and also the type of water to be reused or recycled has differences from one place to another and among industries. Below is the table that served on the research conducted by Cisneros (2014) containing the water treatment options classified according to concern and cause.

Table 5.3 Concerns for Industrial Water Reuse and Procedures to Solve.

Concern	**Cause**	**Treatment Options**
Scaling	Inorganic compounds	Scaling inhibitor
	Salts	Adsorption into activated carbon
		Ionic exchange
		Regulation of flow
Corrosion	Dissolved and suspended solids	Corrosion inhibitors
	pH imbalance	Reverse osmosis
		Nanofiltration
Biological growth	Organic residues	Biocides
	Ammoniacal nitrogen	Biological treatment
	Phosphorus	Filtration
Clogging and biofilm formation	Phosphates	Antiscaling agents
	Dissolved and suspended solids	Corrosion control
		Biological growth control
	Organic residues	Filtration
		Physical and chemical treatment

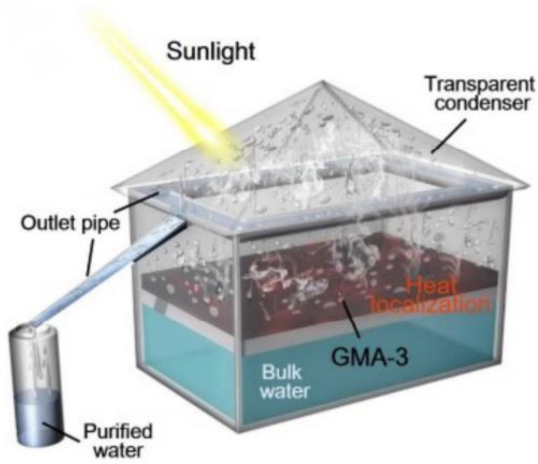
Source: Cisneros (2014).

Cisneros (2014) on that research also explains the advantage and disadvantages of reusing water in the industrial field, for the advantage of reusing water are that enables the recovery of energy (in the form of heat) from used effluents, conserves water while lowering production costs, enables prime matter to be recovered, minimizes the expense of treating and discharging wastewater (discharging fees). Otherwise, several disadvantages have a probability to occur when some industries reuse their water such as various health issues due to exposure to organic volatile chemicals or pathogens (such as Legionella) that may be transmitted through aerosols. If appropriate water quality criteria are not established, the background compounds in water that are existing during recycling will increase in each cycle of recycling to the point where the concentrations reached may affect the quality of the product. The quality of the final product may also be impacted, and industrial processes may become less effective or degrade. So, it can be concluded industries need to well define their wastewater to choose the appropriate method to treat their wastewater if they want to reuse it.

According to research conducted by Ming et al. (2020), they made a tool called 3D macroscopic graphene oxide/MXene for multifunctional water purification. In this study, two-dimensional (2D) transition metal carbides/carbonitrides materials (MXene) were reassembled into macroscopic aerogel monoliths by graphene oxide (GO)-assisted process as an independent solar-driven interfacial evaporator for efficient and all-around water purification. Particularly, it has been demonstrated that MXene (Ti_3C_2) is a superior photothermal conversion material with a theoretical light-to-heat conversion efficiency of 100%, capable of completely absorbing and dissipating electromagnetic radiation as heat (Ming et al., 2020; Zhao et al., 2019).

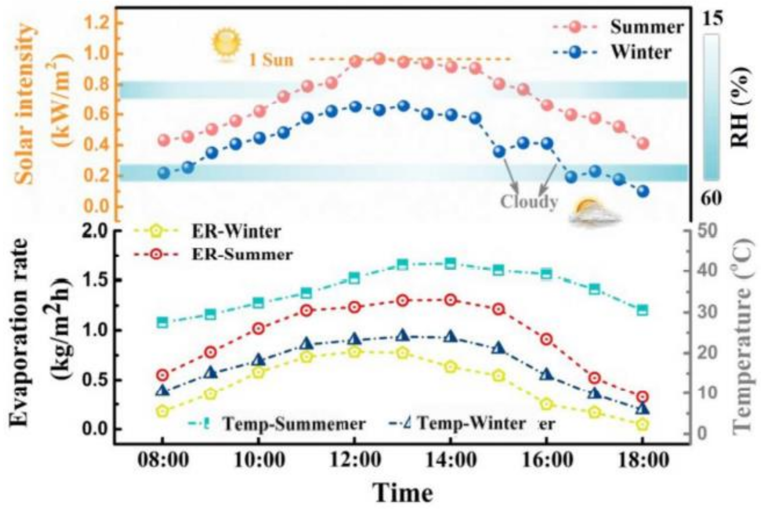
MXene nanosheet's inherent hydrophilicity is also helpful for water movement and adsorption. An optimal solar interfacial evaporator should meet four key criteria which are good photothermal conversion, low parasitic thermal loss, appropriate water supply, and quick vapor escape. Meanwhile, graphene oxide (GO), a representative functional 2D material, has the ability to be easily controlled in terms of its surface chemical composition, allowing for the creation of sophisticated multi-dimensional materials. A self-enhanced photothermal conversion approach is used to generate an all-in-one solar-driven interfacial evaporator based on the hierarchical hybrid MXene/GO aerogel (GMA). With the help of a hierarchical hybrid aerogel system, Ming et al. (2020) show extreme proximity to the theoretical energy conversion maximum (evaporation efficiency of 100% and evaporation rate of 1,47 kg/m^{2}h under one sun irradiation) by demonstrating high evaporation efficiency up to 90,7% and evaporation rate of 1,27 kg/m^{2}h under 1 (one) sun irradiation without the addition of any additional forms of energy. Below is the architecture design of 3D Macroscopic Graphene Oxide/Mxene (GMA-3) and the result of testing their device in 2 (two) weather conditions which are summer and winter conducted by Ming et al. (2020).

Figure 5.2 3D Macroscopic Graphene Oxide/MXene Architectures for Multifunctional Water Purification.



Source: Ming et al. (2020).

Figure 5.3 3D Macroscopic Graphene Oxide/MXene Testing.



Source: Ming et al. (2020).

This system supported by a floating layer is composed of light-clear quartz glasses and 2 (two) freshwater collection tubes. Inside the GMA-3 system, there is a floating layer on the surface, which is continually and locally transformed into steam by solar-powered interfacial evaporation. In order to produce fresh water, the heated steam condenses on the walls and flows into collection tubes. Based on Figure 5.3, in both seasons (which is summer and winter) the peak of interfacial evaporation caused by solar radiation occurred between 12 am and 2 pm, peaking at 1,25 kg/m^{2}h in the summer and 0,73 kg/m^{2}h in the winter. In the study by Ming et al. (2020), measurements were made on wastewater that had high concentrations of H^+ or OH^- (pH values ranging from 1 to 14). Water that has completed purification has an ion rejection rate of 99,9%, and its pH values are all in the range of 7, but in their research, they don't recommend consuming the water because they suggest doing another process to be used as drinking water. Additionally, the GMA-3 was effective at removing heavy metal ions from industrial sewage. After purification, the concentrations of heavy metal ions including Mn^{6+}, Cd^{2+}, Pb^{2+}, Cu^{2+}, Ni^{2+}, Zn^{2+}, and Fe^{2+} are all better than the WHO standards with an ion rejection rate of 99,9%. The GMA-based solar-driven interfacial evaporator effectively separates emulsified oil/water mixtures, which is a prevalent type of wastewater, due to the inherent ultra-hydrophilic feature of GMA. For detail can see the research conducted by Ming et al. (2020) with the title “3D Macroscopic Graphene Oxide/MXene Architectures for Multifunctional Water Purification”. From the previous explanation, if this system is implemented by PT. Hari Mukti Teknik, with an average solar intensity rate in Yogyakarta, is around 0,9 kW/m^2 (Badan Pusat Statistik Kota Yogyakarta, 2019), the average temperature of Bantul is 28^{o}C and humidity ranges from 75% - 95% (Badan Meteorologi, Klimatologi, dan Geofisika, 2023), for that condition this system can produce from 0,8 kg/m^{2}h to 1,1 kg/m^{2}h clear water. If it is assumed that the company makes a system with a surface size of 4m^2 with an evaporation rate of 0,8 kg/m^{2}h, then the 1 (one) product requires approximately 45 days of the production process and it is estimated that there is evaporation activity for 6 (six) hours per day with the condition explained previously, then the company estimate can obtain around 864 kg clear water, where this amount has reached the target of reprocessing and reuse of water of the PT. Hari Mukti Teknik, where the target is 700 liters.

5.2 Discussion Result

After conducting discussions on every problem that occurs in each indicator and has provided proposed suggestions for the existing problems. The stage this time is the stage of summary and recalculation of the gap analysis and recalculation of the overall score of GSCM on the indicators discussed at PT. Hari Mukti Teknik to determine the effect of the proposed suggestion provided in this research. Below it can be seen the gap analysis table and the GSCM overall score calculation table at PT. Hari Mukti Teknik.

Table 5.4 Indicators Data Processing and Comparison Result.

<table>
<tr><th>Level-1</th><th>Level-2</th><th>Unit</th><th colspan="2">Actual Data</th><th colspan="2">Company Specific Metric</th><th colspan="2">GAP</th></tr>
<tr><td colspan="3"></td><td>Level-2</td><td>Level-1</td><td>Level-2</td><td>Level-1</td><td>Level-2</td><td>Level-1</td></tr>
<tr><td rowspan="2">SS.1.003 Total Supply Chain Non-Renewable Materials Used</td><td>SS.2.008 Make Non-Renewable Materials Used</td><td>kg</td><td>1351,542</td><td rowspan="2">1374,257</td><td>1351,2</td><td rowspan="2">1351,2</td><td>+0,342</td><td rowspan="2">+0,342</td></tr>
<tr><td>SS.2.009 Deliver Non-Renewable Materials Used</td><td>kg</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="3"></td><td>Level-2</td><td>Level-1</td><td>Level-2</td><td>Level-1</td><td>Level-2</td><td>Level-1</td></tr>
<tr><td rowspan="2">SS.1.004 Total Supply Chain Renewable Materials Used</td><td>SS.2.005 Make Renewable Materials Used</td><td>kg</td><td>3,120</td><td rowspan="2">61,141</td><td>1</td><td rowspan="2">61,28</td><td>+2,120</td><td rowspan="2">+2,120</td></tr>
<tr><td>SS.2.006 Deliver Renewable Material Used</td><td>kg</td><td>60,28</td><td>60,28</td><td>0</td></tr>
<tr><td colspan="3"></td><td>Level-2</td><td>Level-1</td><td>Level-2</td><td>Level-1</td><td>Level-2</td><td>Level-1</td></tr>
<tr><td rowspan="2">SS.1.005 Total Supply Chain % of Recycled Input Materials Used</td><td>SS.2.010 Make % of Recycled Input Materials Used</td><td>%</td><td>99,96
(1374,862Kg)</td><td rowspan="2">95,7
(1374,05Kg)</td><td>100
(1375,36Kg)</td><td rowspan="2">100
(1435,64Kg)</td><td>-0,223
(0,5Kg)</td><td rowspan="2">-0,223
(0,5Kg)</td></tr>
<tr><td>SS.2.011 Deliver % of Recycled Input Materials Used</td><td>%</td><td>100
(60,28Kg)</td><td>100
(60,28Kg)</td><td>0
(0Kg)</td></tr>
<tr><td>SS.1.013 Total Supply Chain Water Reused or Recycled</td><td>SS.2.040 Make Water Reused or Recycled.</td><td>liters</td><td colspan="2">864</td><td colspan="2">700</td><td colspan="2">+164</td></tr>
<tr><td rowspan="2">SS.1.025 Total Supply Chain Non-Hazardous Waste.</td><td rowspan="2">SS.2.075 Make Non-Hazardous Waste.</td><td>kg (Solid Waste)</td><td colspan="2">0</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td>liters (Liquid Waste)</td><td colspan="2">1500</td><td colspan="2">700</td><td colspan="2">-636</td></tr>
</table>

Table 5.5 GSCM Performance Score Calculation.

Level-1 Indicators	Local Weight	Level-2 Indicators	Local Weight	Actual Data	Min (Smin)	Max (Smax)	Snorm	Level-2 Normalize Weight	Level-1 Normalize Weight
SS.1.003	0,0315	SS.2.008	0,857	1351,542	1351,2	1370	98,181	84,1550	2,651
		SS.2.009	0,143	0	0	5	100,000	14,2857	0,450
SS.1.004	0,5133	SS.2.006	1	60,28	55	60,28	100,000	100,0000	51,329
SS.1.005	0,1508	SS.2.010	0,875	99,96	90	100	99,600	87,1500	13,145
		SS.2.011	0,125	100	0	100	100,000	12,5000	1,885
SS.1.013	0,2232	SS.2.040	1	864	0	864	100,000	100,0000	22,316
SS.1.025	0,0812	SS.2.075	1	700	700	5200	100,000	100,0000	8,120
	1,0000								99,898

Exp:
SS.1.003: Total Supply Chain Non-Renewable Material Used
SS.1.004: Total Supply Chain Renewable
SS.1.005: Total Supply Chain % of Recycled Input Material Used
SS.1.013: Total Supply Chain Water Reused or Recycled
SS.1.025: Total Supply Chain Non-Hazardous Waste
SS.2.008: Make Non-Renewable Material Used
SS.2.009: Deliver Non-Renewable Material Used
SS.2.006: Deliver Renewable Material Used
SS.2.010: Make % of Recycled Input Material Used
SS.2.011: Deliver % of Recycled Input Material Used
SS.2.040: Make Water Reused or Recycled
SS.2.075: Make Non-Hazardous Waste

From the calculation above, in the gap analysis, which is Table 5.4, 2 (two) indicators have not yet reached the target, namely, SS.2.008 Make Non-Renewable Materials Used and SS.2.010 Make % of Recycled Input Materials Used where this occurs due to the characteristic of the material which at the time this research was conducted no substitute material could replace the material. Furthermore, in calculating the GSCM overall score of PT. Hari Mukti Teknik, if the proposed suggestion is carried out and the results of the proposed suggestion are estimated according to the discussion in this study, it can be seen in Table 5.5, there is a significant increase in the GSCM overall score from the previous which in this calculation got a score of 99,8 which is classified as "excellent" (Pulansari & Putri, 2020).

CHAPTER VI
CONCLUSION AND SUGGESTION

6.1 Conclusion

Based on the research that has been done by the researcher, the conclusion of this research based on the problem formulated is:

1. Before choosing the performance indicator used in this research, the first step is to identify the company's business process and also define clear limitations of the research so that the research results are more focused and clearer. After completing identifying the business process of PT. Hari Mukti Teknik, the next step is to ensure the SustainableSCOR indicators in accordance with the conditions of the company which in this research used 6 (six) level-1 indicators and 9 (nine) level-2 indicators which are:
    a. SS.1.003 Total Supply Chain Non-Renewable Material Used in the make (SS.2.008) and deliver (SS.2.009) process of Kanaba Washer Barrier Softmount, which discusses the total amount of materials with non-renewable source classification used on Kanaba Washer Barrier Softmount.
    b. SS.1.004 Total Supply Chain Renewable Material Used in the make (SS.2.005) and deliver (SS.2.006) process of Kanaba Washer Barrier Softmount, which discusses the total amount of materials with renewable source classification used on Kanaba Washer Barrier Softmount.
    c. SS.1.005 Total Supply Chain % of Recycled Input Material Used in the make (SS.2.010) and deliver (SS.2.011) process of Kanaba Washer Barrier Softmount, which discuss the total percentage of recycled input material used to make process of primary products (Kanaba Washer Barrier Softmount) which are purchased or obtained from internal or external sources, and also not by-product and non-product outputs (NPO) produced by the organization.
    d. SS.1.013 Total Supply Chain Water Reused or Recycled in the make (SS.2.040) process of Kanaba Washer Barrier Softmount, which discusses the total amount of water reused or recycled by the company related to the make process.
    e. SS.1.025 Total Supply Chain Non-Hazardous Waste in the make (SS.2.075) process of Kanaba Washer Barrier Softmount, which discusses the total

amount of non-hazardous waste generated (solid and liquid waste) from the make process.

f. SS.1.026 Total Supply Chain Hazardous Waste in the make (SS.2.080) process of Kanaba Washer Barrier Softmount, which discusses the total amount of hazardous waste generated (solid and liquid waste) from the make process.

After validating the SustainableSCOR used in this research, the next step is to conduct a gap analysis, which is comparing the actual data from the analysis of each indicator used and company specific-matric. Based on the gap analysis of the indicators that have not reached the target of the company (company specific matric) are:

a. SS.2.008 Make Non-Renewable Material Used
b. SS.2.009 Deliver Non-Renewable Material Used
c. SS.2.006 Deliver Renewable Material Used
d. SS.2.010 Make % of Recycled Material Used
e. SS.2.011 Deliver % of Recycled Material Used
f. SS.2.040 Make Water Reused or Recycled
g. SS.2.075 Make Non-Hazardous Waste

2. Based on data processing and analysis it is found that there are 7 (seven) out of 9 (nine) level-2 indicators that have not reached the company target (company specific-matric). Before giving a proposed solution for each indicator, the weighting priority for each indicator that has a problem in it is conducted by using the analytical hierarchy process (AHP) and also needs to conduct green supply chain management (GSCM) overall calculation to know the rate of GSCM on PT. Hari Mukti, from the GSCM calculation it is known that the rate of PT. Hari Mukti Teknik is 49,505 which is classified as “marginal”. Based on the GSCM overall score PT. Hari Mukti Teknik needs to conduct improvement to its supply chain if they want to reach “excellent” performance indicator classification. Below is the proposed solution for each indicator according to the priority scale to improve their GSCM performance:

a. SS.2.006 Deliver Renewable Material Used: ***Ensuring raw materials used***, there are 2 (two) types of non-renewable materials which are brass and polyethylene, in the previous discussion it was said that renewable materials had not been found that could replace both the materials, so this research only suggests ensuring the materials used on the part from recycled and can be reused properly, for brass and polyethylene it is certain that they can be recycled continuously (Morecambe Metals, 2020; Zulhan, 2013; Abedsoltan, 2021; Ferrario, 2021).

b. SS.2.040 Make Water Reused or Recycled: ***Water recycles and reuses systems***, creates a water treatment system so that the wastewater produced can be processed and reused, and can also reduce the company's annual cost in terms of water supply. There are several water treatment options provided in this research which were quoted from research conducted by Cisneros (2014) where the treatment is adjusted to the concern and cause of the wastewater produced. In addition, there is an energy-friendly water treatment concept or system quoted from the research conducted by Ming et al. (2020), which is called 3D Macroscopic Graphene Oxide/MXene or GMA-3 which utilizes solar heat and 3D Macroscopic Graphene Oxide/Mxene (GMA-3) sheets to help evaporate and purify water.

c. SS.2.010 Make % of Recycled Input Material Used: ***Ensuring materials used***, there are 3 (three) types of non-recycled material used in make process, which are polyurethane, alkyd, and epoxy amine adduct. Regarding the use of polyurethane, in this research, it was considered not to be a significant problem because polyol (main substances) can be obtained through renewable resources such as vegetable oils obtained from castor, soybean, pongamia glabra, neem, and cotton seeds (Ratna, 2022). In addition, polyurethane can be recycled to obtain polyol for use in making new polyurethane, but this method requires high energy input into the reactor either to heat the batch or to apply. While the other 2 (two) materials are alkyd and epoxy amine adducts, both of which cannot be recycled due to their characteristic. However, this can be overcome by ensuring the use of raw materials for both the materials comes from post-consumer products such as bottles or drinking can obtain polyethylene terephthalate (PET) (Maiti et al., 2022; Memon et al., 2022; Senra et al., 2022; Atta et al., 2007; Dullius et al., 2006).

d. SS.2.075 Make Non-Hazardous Waste: ***Water recycle and reuse system***, create a water treatment system so that the wastewater produced can be processed and reused, and can also reduce the company's annual cost in terms of water supply. There are several water treatment options provided in this research which were quoted from research conducted by Cisneros (2014) where the treatment is adjusted to the concern and cause of the wastewater produced. In addition, there is an energy-friendly water treatment concept or system quoted from the research conducted by Ming et al. (2020), which is called 3D Macroscopic Graphene Oxide/MXene or GMA-3 which utilizes solar heat and 3D Macroscopic Graphene Oxide/Mxene (GMA-3) sheets to help evaporate and purify water.

e. SS.2.008 Make Non-Renewable Material Used: ***Ensuring materials used***, there are 3 (three) main types of non-renewable material used to make process which are metal, plastic, and epoxy. Based on the analysis, around 98,243% of the part used in the manufacture of the product uses metal material. The suggestion related to the use of metal material is only suggested to ensure the materials used on the part are recycled properly and can be reused. However, metal is classified as a material that can be recycled many times (Universal Eco, 2022; Morecambe Metals, 2021; Kementerian Perindustrian Republik Indonesia, 2020; Zulhan, 2013). Regarding the uses of plastic materials, the following are some types of plastic used in the make process in this research, such as polyurethane, polyvinyl chloride (PVC), polycarbonate, polyethylene, polymethyl methacrylate (PMMA), thermoplastic polymers, polyolefin, and acrylonitrile butadiene styrene (ABS). From the 8 (eight) types of plastic used, there is only 1 (one) type of plastic which is polyurethane that is classified as non-recyclable into the same type or product but this material is from a renewable resource, 7 (seven) other materials are classified into recyclable materials and become the same product or material (Universal Eco, 2022; VinylPlus, 2022; Abedsoltan, 2021; Ferrario, 2021; Nikolaidis & Achilias, 2018; Redwing, 2017; Boria et al., 2016; Hadi et al., 2012; Wang et al., 2014; Karlsson, 2004). The last non-renewable material is epoxy amine adduct, due to their permanent crosslinked structures, traditional epoxy resins cannot be reprocessed, repaired, or recycled (Memon et al., 2022). According to Atta et al. (2007), this material can be produced from the recycling of polyethylene terephthalate (PET) from the post-consumer product such as packaging foods and beverages, especially convenience-sized soft drinks, juices, and water (Senra et al., 2022; Dullius et al., 2006).

f. SS.2.011 Deliver % of Recycled Input Material Used: ***Material reuse***, there are 3 (three) main materials used in the delivery process, namely silk-cotton wood, brass, and polyethylene. However, only 1 (one) material is classified as non-recycled input material used which is silk-cotton wood, which has the function of protecting the product during the shipping process. In this study, the only suggestion that can be given is to reuse wood materials that have been used in the shipping process, because this material is classified as a renewable material and is also environmentally friendly (Galic et al., 2021) compared to the use of other synthetic materials such as plastic which harms environment if no further processing after use.

g. SS.2.009 Deliver Non-Renewable Material Used: ***Ensuring materials used***, there are 2 (two) main types of non-renewable materials used in deliver process which are brass and polyethylene. Regarding the use of brass, brass is an alloy of copper (Cu) and zinc (Zn), which can be recycled like other types of metal (Morecambe Metals, 2020; Zulhan, 2013). While polyethylene is the most widely used plastic. It is a polymer that is mostly used in packaging (plastic bags, plastic films, geomembranes, and containers including bottles, etc.), where this material can also be recycled and can be reused (Abedsoltan, 2021; Ferrario, 2021). In this study, no renewable raw materials were found that could replace both types of materials which have the same characteristics, therefore the only suggestion that can be given by the company can be reassured regarding the manufacture of each part they have using recycled materials if the company want their products to have a value of 100% environmentally friendly products.

Based on the proposed suggestion provide in this research, if the company do the proposed suggestion and estimate as discussion in this research it can be seen in the gap analysis of the proposed suggestion, 2 (two) indicators have not yet reached the target, namely SS.2.008 Make Non-Renewable Materials Used and SS.2.010 Make % of Recycled Input Materials Used where this occurs due to the characteristic of the material which at the time this research was conducted no substitute material could replace the material. Furthermore, in calculating the GSCM overall score of

PT. Hari Mukti Teknik, there is a significant increase in the GSCM overall score from the previous which in this calculation got a score of 99,8 which is classified as "excellent”.

6.2 Suggestion

Based on the analysis and discussion, the following suggestions can be provided:

1. For PT. Hari Mukti Teknik

   From this research, companies can consider the suggestions provided in this research which take into consideration the results of data analysis on each indicator used to improve supply chain performance considering environmental conservation aspects, in accordance with the company's vision and mission.

2. For further research

   Develop in more detail the existing problems by using more indicators provided in the SCOR guidebook version 12, especially on SustainableSCOR, and adding other aspects that can be considered, for example, such as finance and the availability of raw materials or suppliers around the research object location.

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APPENDIX

Pairwise Comparison Questionnaire

PENGUKURAN SKALA PRIORITAS DENGAN MENGGUNAKAN METODE *ANALYTICAL HIERARCHY PROCESS* (AHP) BERBASIS *PAIRWISE COMPARISON MATRIX* (PCM)

Pada pengukuran skala prioritas ini, peneliti mengharapkan pendapat anda terhadap skala prioritas permasalah yang didapatkan dari pengukuran kinerja perusahaan mengenai konservasi linkungan yang telah dihitung menggunakan metode SCOR versi 12 yang dibuat oleh APICS (2017). Diharapkan dari pengisian lembar pengukuran ini dapat diolah kembali oleh peneliti untuk menjadi sebuah masukan bagi perusahaan untuk mencapai perusahaan dengan sistem rantai pasok yang ramah lingkungan.

Data Responden:

Nama	:	M. Amin Syukron, ST. MT
Usia	:	47 Tahun.
Perusahaan	:	PT. Hari Mukti Teknik
Jabatan	:	Manager Business & Marketing
Lama Kerja	:	5 tahun.

Yogyakarta 30 November 2022

(M. Amin Syukron, ST, MT)

PENGUKURAN SKALA PRIORITAS INDIKATOR LEVEL-1

Comparison Between **Level-1 Indicators**

No	Indicator	Scale																	Indicator
1	SS.1.003 Total Supply Chain Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.004 Total Supply Chain Renewable Material Used
2	SS.1.003 Total Supply Chain Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.005 Total Supply Chain % of Recycled Input Material Used
3	SS.1.003 Total Supply Chain Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.013 Total Supply Chain Water Reused or Recycled.
4	SS.1.003 Total Supply Chain Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.025 Total Supply Chain Non-Hazardous Waste
5	SS.1.004 Total Supply Chain Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.005 Total Supply Chain % of Recycled Input Material Used
6	SS.1.004 Total Supply Chain Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.013 Total Supply Chain Water Reused or Recycled.
7	SS.1.004 Total Supply Chain Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.025 Total Supply Chain Non-Hazardous Waste
8	SS.1.005 Total Supply Chain % of Recycled Input Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.013 Total Supply Chain Water Reused or Recycled.
9	SS.1.005 Total Supply Chain % of Recycled Input Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.025 Total Supply Chain Non-Hazardous Waste
10	SS.1.013 Total Supply Chain Water Reused or Recycled.	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.1.025 Total Supply Chain Non-Hazardous Waste

*Silahkan silang (X) pada skala yang dipilih.

PENGUKURAN SKALA PRIORITAS INDIKATOR LEVEL-2

Comparison Between Level-2 Indicators																			
No	Indicator	Scale																	Indicator
1	SS.2.008 Make Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.009 Deliver Non-Renewable Material Used
2	SS.2.008 Make Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.006 Deliver Renewable Material Used
3	SS.2.008 Make Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.010 Make % of Recycled Input Material Used
4	SS.2.008 Make Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.011 Deliver % of Recycled Input Material Used
5	SS.2.008 Make Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.040 Make Water Reused or Recycled
6	SS.2.008 Make Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.075 Make Non-Hazardous Waste
7	SS.2.009 Deliver Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.006 Deliver Renewable Material Used
8	SS.2.009 Deliver Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.010 Make % of Recycled Input Material Used
9	SS.2.009 Deliver Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.011 Deliver % of Recycled Input Material Used
10	SS.2.009 Deliver Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.040 Make Water Reused or Recycled

Comparison Between Level-2 Indicators

No	Indicator	Scale																	Indicator
11	SS.2.009 Deliver Non-Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.075 Make Non-Hazardous Waste
12	SS.2.006 Deliver Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.010 Make % of Recycled Input Material Used
13	SS.2.006 Deliver Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.011 Deliver % of Recycled Input Material Used
14	SS.2.006 Deliver Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.040 Make Water Reused or Recycled
15	SS.2.006 Deliver Renewable Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.075 Make Non-Hazardous Waste
16	SS.2.010 Make % of Recycled Input Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.011 Deliver % of Recycled Input Material Used
17	SS.2.010 Make % of Recycled Input Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.040 Make Water Reused or Recycled
18	SS.2.010 Make % of Recycled Input Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.075 Make Non-Hazardous Waste
19	SS.2.011 Deliver % of Recycled Input Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.040 Make Water Reused or Recycled
20	SS.2.011 Deliver % of Recycled Input Material Used	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.075 Make Non-Hazardous Waste

Comparison Between Level-2 Indicators

No	Indicator	Scale																	Indicator
21	SS.2.040 Make Water Reused or Recycled	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	SS.2.075 Make Non-Hazardous Waste