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Determining Priority Factors for Executing of Reverse Logistics in Palm Oil Industry of Indonesia

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Abstract

As the country's largest palm oil producer in the world, Indonesian palm oil production is still encounter political barriers or non-tariff economy of several countries. Sustainable development policies have a role to overcome these obstacles. The generation of solid waste and liquid waste from Indonesian palm oil processing factories tends to be increased. To overcome the problem, Indonesia must be able to implement a sustainable supply chain with the concept of reverse logistics, which focuses on reduction, reuse, and recycling areas. The research method used is a quantitative method with data collection by distributing web-based questionnaires to experts in the palm oil industry in Indonesia with samples that are adjusted and match the Fuzzy VIKOR technique (Visekriterijumsko Kompromisno) and Fuzzy TOPSIS technique (Technique for Order Preference by Similarity to Ideal Solution). A web-based questionnaire was developed for data collection, which was then distributed to thirty experts. From the comparison results between Fuzzy VIKOR and Fuzzy TOPSIS, there are almost similarities in the Reverse Logistics options, only different in the first and second options. For Fuzzy VIKOR, the first option is Reuse, while for Fuzzy TOPSIS, the first option is Repair. As for the results of the third to fifth options, there is no difference between Fuzzy VIKOR and Fuzzy TOPSIS, namely, Refurbishment, Recycling, and Remanufacturing.

Keywords: *palm oil industry, priority factors, reserve logistics, Fuzzy VIKOR, Fuzzy TOPSIS.*

Introduction

Palm oil output from Indonesia and Malaysia was adversely affected by drought and reduced fertiliser application in 2019. This was compounded by workers shortage and movement restrictions due to the Covid-19 pandemic in 2020. Indonesia and Malaysia produce about 85% of the total global palm oil supply. The lower-than-expected supply of other edible oils, particularly sunflower and rapeseed oils, had induced the sharp rise in vegetable oil prices, which then had a spill-over effect onto crude palm oil (CPO) prices (https://gapki.id/en/news/21136/palm-oil-performance-in-2021-and-prospect-in-2022).

Oil World recently forecasted vegetable oil prices in 2021 should trade higher due to improved demand and a tighter supply of soft oils such as soybean and sunflower oils. It indicated soy oil would lead the way. The rally in sunflower oil due to lower crop harvest has also made soy oil and palm oil attractive to pricesensitive buyers. China's edible oils re-stocking policy is expected to continue in the months ahead with fund buying. Combined with Argentina's soybean crushing problems, this could further boost palm oil prices (https://gapki.id/en/news/21136/palm-oil-performance-in-2021-and-prospect-in-2022).

Seasonally low yield cycle amid unfavourable weather conditions reduced 2022/23 Indonesia palm oil production to 46.2 million metric tonnes (mt), down <1% from the last update. Indonesia's palm oil production has been weaker than expected, partly due to heavy rainfall and the low crop season. Some Indonesian palm oil producers have reported a double-digit decline in output. On a separate note, the country will enhance efforts to replant oil palms and to achieve a target of 180,000 hectares this year amid heightened scrutiny for sustainability. Although replanting might curb output in the short term, replacing unproductive trees without expanding areas is necessary to maintain or enhance yields over the long run (Tan, Kian Pang & Lim, Suet Yiing. 2023).

Prolonged flooding risks lowered our 2022/23 Malaysia palm oil production estimate to 18.6 million mt, down <1% from the last update. Palm oil production continued to decline in February, weighed on by the

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seasonal low yields and unfavourable wet conditions, hampered palm oil harvesting and transportation. Heavy rains also impacted the quality of crude palm oil (high Free Fatty Acids), resulting in an unfavourable month for production. However, production is set to recover on seasonality and more labour inflows in Q2. The government has expedited the hiring process and expected an improvement in the availability of plantation workers by June. Malaysian Palm Oil Board (MPOB) showed that Malaysia's crude palm oil (CPO) production for January 2023 dropped by 14.7% month-on-month to 1.38 million mt due to heavy rains in key producing states that slowed down harvesting and crop evacuation. Indonesia's palm oil production for January 2023 has yet to be announced (Tan, Kian Pang & Lim, Suet Yiing. 2023).

The palm oil commodity, which has been continuously boosted by the Indonesian government, has not only caused various environmental problems related to the destruction of Indonesia's tropical rain forests in various regions and various endemic species. Oil palm plantations, during the period of planting and production, also pose serious problems for the communities living around the plantations. One of the things that often happens is the pollution of community water sources by palm oil waste. The impacts that occur, ranging from decreased water quality, reduced water quantity, and contamination of community water sources are still happening today. Damage to water quality also makes it difficult for people to carry out agricultural activities. Along with the massive expansion of oil palm, screams due to environmental losses and damage continue to be conveyed by residents, especially those who live around oil palm plantations. In the past year, various cases of water pollution by oil palm plantations and processing factories occurred in various regions in Indonesia (https://www.mongabay.co.id/2012/09/03/dari-sabang-sampai-merauke-kelapa-sawit-cemari-air-tanahku/)

Indonesia suspended some existing palm oil export permits until the end of April to ensure sufficient domestic cooking oil supplies to meet high festive demand. Indonesia's export restrictions will likely be relaxed after Ramadan and Eid al-Fitr. The Indonesian government raised the domestic market obligation programme to 450,000 mt a month from February to April 2023, a 50% increase from the current allocation of 300,000 mt a month to meet the rising demand for cooking oil ahead of the festive season. However, The Indonesian Trade Ministry stated that the domestic obligation market (DMO) realisation reached only 50% of the target. As of Feb 20, cooking oil DMO from producers reached 196,032 mt or 43.56% of the entire DMO allocation of 450,000 mt. Of 196,032 mt, the Minyakita cooking oil brand accounted for 42,685 mt (21.77%) of the total tons of palm oil distributed under the DMO, while bulk cooking oil still dominates the market with 153,347 mt (78.23%) (Tan, Kian Pang & Lim, Suet Yiing. 2023).

According to Malaysian Palm Oil Board (MPOB), Malaysia's palm oil exports for January decreased by 23% month-on-month to 1.14 million mt. Shipments for February 2023 are estimated to increase by 2.3% month-on-month to 1.16 million mt, cargo surveyor's data showed. Ramadan has supported the demand for palm oil. Also, shipments to China picked up after the Spring Festival and improved social activities as the peak of China's COVID-19 has passed. Regarding export taxes, Malaysia kept its March 2023 export taxes for crude palm oil (CPO) at 8% and lowered its reference price to RM3,710.35/mt from RM3,893.25/mt last month. The payable export tax for Malaysia's crude palm oil (CPO) for March is RM296.83/mt versus RM311.38/mt for February. Meanwhile, The Indonesian government set the crude palm oil reference price for Mar 1-15 at $889.77/mt, up from $880.03/mt for Feb 16-28. Exporters need to pay the export tax and export levy on crude palm oil (CPO) at $74/mt and $95/mt, respectively, for Mar 1-15. As a result, the total payable export duty and levy on crude palm oil (CPO) are $169/mt. 2022/23 world palm oil imports are estimated at 49.7 million mt, inching up by 0.4% from last month's estimates at 49.5 million mt, and up 16.1% from the 2021/22 season. The continued price discounts of palm oil relative to competing vegetable oils and the likelihood of stronger import growth from major consuming countries are expected to support global demand for palm oil (Tan, Kian Pang & Lim, Suet Yiing. 2023).

Indonesia must be able to implement a sustainable supply chain with the concept of reverse logistics in the palm oil industry. The reverse logistics is an industrial concept that focuses on reduction, reuse and recycling. The application of the reverse logistics concept can provide benefits for the palm oil industry, namely the efficiency of raw materials, reduction of waste, and increased production of recyclable goods. However, it is necessary to know in advance the key factors in the application of the concept. This study aims to determine what priority factors are key in executing economic circulation in supply chain

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management (SCM) using reverse logistics in the palm oil industry of Indonesia. There are research objectives that are sought as well as to identify related profiling actors that influence the implementation of reverse logistics in the Indonesian palm oil industry.

Literature Review

A circular economy model relies on Reverse Logistics (RL) implementation. Oppositely to Forward Logistics, The American Reverse Logistics Executive council defines RL as "the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal". In order to implement RL, a company must conceive disassembly and recovery facilities that integrate the reverse flow of End of Life (EOL) products (i.e. collection centers, dismantlers, recycling centers). Those new facilities constitute the Reverse Supply Chain (RSC). When the RSC works in coordination with the classic Forward Supply Chain (FSC) of the company, the whole system is called Closed-Loop Supply Chain (CLSC), examples are numerous and their number increase every year, but the global supply networks are still far away from circular economy. Since the 1990s, the number of academic studies dedicated to Reverse Supply Chain (RSC) and Closed-Loop Supply Chain (CLSC) design and planning increase as well. The aim of design is to determine strategic (long-term) decision variables like the number of facilities implemented or their locations and capacity. In the planning stage, the most important decision variables are the quantities of flows between the different facilities of the network, known as mid-term decision variables (Zoé, Krug, 2020).

Reverse Logistics (RL) is a management concept related to the recall of products originating from consumers or actors throughout the Reverse Logistics (RL) system to return to the company by utilizing the potential value that still exists in the product. The concept of Reverse Logistics (RL) has been widely developed by companies in developed countries to achieve several goals, including: minimizing the use of natural resources by utilizing secondary materials, minimizing waste problems, and meeting regulatory demands on an international, regional and domestic scale. In recent decades, reverse supply chain research has begun to emerge due to several problems such as social concerns, environmental regulations and end-of-life products. The research topic emerged as a consequence of the relationship between supply chain management and environmental factors. While the scope of reverse supply chain research can be categorized as a closed-loop system or an open-loop system. The concept above indicates that the reverse supply chain process includes issues such as defective products, material replacement, and the process flow can be in the form of products or materials to be returned to the company, repair processes, remanufacturing and recycling (Pulansari, Farida, 2017).

A strategic vision of the expansion of the Closed-Loop Supply Chain (CLSC) has been introduced through multi-period models where facilities can be set up at any period of time. These models are more relevant for the context of reverse logistics. For instance, considered a multi-period Closed-Loop Supply Chain (CLSC) network design problem in which facility capacities could be increased or decreased dynamically over time for all echelons. Facility and depot locations could be changed and the type of depots and their general size could be modified. More examples of recent dynamic Closed-Loop Supply Chain (CLSC) models are available. The design of Reverse Supply Chain (RSC) and Closed-Loop Supply Chain (CLSC) is a complex strategic problem due to the large number of factors that must be integrated into the decision-making process (economic, legislative, ecological, logistics, etc.) and the high level of uncertainty (product demand, volume of returns, fractions of parts recovered for the various product recovery processes, etc.). On case studies of companies involved in Reverse Logistics processes that all aspect of Reverse Logistics management has to be accurately investigated in order to make the reprocessing of End of Line products (EOL) beneficial, from the prediction of the customer's behaviour to the legislation including the business model of the company (Zoé, Krug, 2020).

A comprehensive review of analyses the existing studies in this area. An important number of models have been developed for different settings. The impact of different logistics structures on the profitability of re-manufacturing systems has been analyzed. Several studies suggest that the focus on Closed-Loop Supply

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Chain (CLSC) is more relevant for Original Equipment Manufacturer (OEM) since designing the forward and reverse flows separately results in sub-optimal solutions. Nevertheless, the production cost structure, collection rate, product life cycle and component durability must be carefully coordinated in order to maximize cost savings in Closed-Loop Supply Chain (CLSC) network and companies facing large and increasing flows of EOL products should have a different Reverse Logistics network structure than the ones with a low rate of returned products. Furthermore, show that the profitability of Reverse Logistics systems is strongly dependent on the product life cycle as well as on the competition faced by OEMs. The problem that in reality, the high level of uncertainty of the different parameters makes this design of Reverse Supply Chain (RSC) or Closed-Loop Supply Chain (CLSC) very challenging. The second major challenge of Reverse Supply Chain (RSC) design regards the sustainability of the implemented systems. Historically, the implementation of Reverse Supply Chain (RSC) has mostly been done with aim to maximize the profit of the company or to minimize its environmental impact, but if the question is considered from the perspective of sustainable development, that is to say "meet the needs of the present without compromising the ability of future generations to meet their own needs" (*Bruntland Report for the World Commission on Environment and Development (1992)*) three dimensions have to be accounted simultaneously: the economic dimension, the environmental dimension and the social dimension. Then, a satisfying balance has to be found between economic performance, environmental performance and social performance. This approach is known as Triple Bottom Line (TBL) approach. In the last few years the area of sustainable Closed-Loop Supply Chain (CLSC) development has sparked growing interest among researchers. The study of particularly reviews numerous papers published in international peer-reviewed journal giving attention to this subject (in Zoé, Krug, 2020).

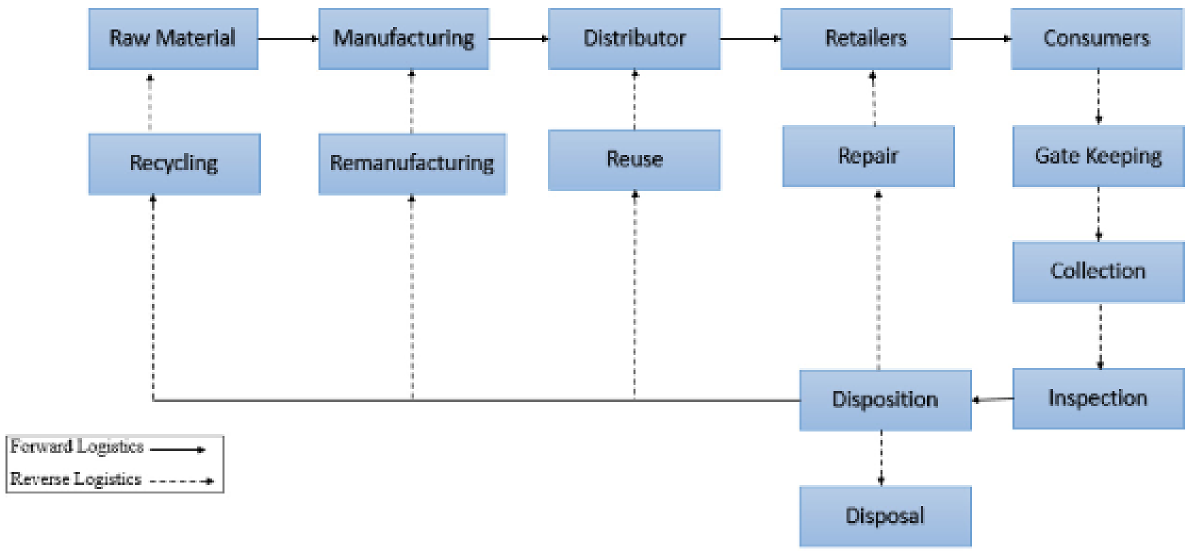

Figure 1. Basic flow of reverse and forward logistics

Source: Fleischmann, et. al, 2000 (in Ali, et. al, 2020).

However, there is a high degree of uncertainty in the planning, forecasting, allocation of capacity and resources to handle and control the flow of respect in the supply chain (Tibben Lembke and Rogers, 2002). Products may have different life cycles and different replacement policies based on the user. This can lead to systematic variations and uncertainties in the volume of goods returned over time. In addition, RL flows from multiple origins to a single destination, whereas the reverse is true for forward logistics flows. Types of difference between Forward and Reverse Logistics (in Ali, et. al, 2020).

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Table 1. Difference between Forward Logistics and Reverse Logistics

Forward Logistics	Reserve Logistics
The quality of the product is uniform	The quality of the product is not uniform
The option for disposition of a product is clear	The option for disposition of a product is not clear
Product routing in unambiguous	Product routing in ambiguous
Different points at which cost is involved is easily understood	Different points at which cost is involved is not easily understood
The distribution channels are standardized	The distribution channels are exception driven
Products are packaged is uniform process	Often the product packaging is damaged
The process of pricing product is uniform	The process of pricing product is not uniform
The management of inventory is consistent	The management of inventory is not consistent
The life cycle of a product is easily manageable	The life cycle of a product in this process is less likely managed
Issues related to financial management are visible and clear	Issues related to financial management are not clear
The type of involvement of negotiation between difference parties is straightforward	The type of involvement of negotiation between difference parties is less straightforward
Forecasting is done in the simplest way	Forecasting for Reverse Logistic is much more difficult
Transportation involved is one way	Transportation involved from many to only one
The visibility of the process is highly transparent	The visibility of the process is much less transparent

Source: Tibben-Lamke and Rogers, 2002 (in Ali, et. al, 2020)

In general, goods will flow from suppliers, manufacturers, then distributed to distributors, retailers and to consumers (based on the Forward Logistics or FL concept). While the Reverse Logistics concept, goods originating from consumers as end users will experience a return process due to product problems that do not meet specifications, are defective, repaired or the product's lifespan has ended. In the return process, products can be collected into one warehouse. This aims to minimize transportation problems before all products are sent back to the company. Damaged products will undergo a repair process. If the product can be repaired directly, the product will be returned to the distributor to then be returned to the consumer. And if the product requires further processing, the product will be sent to the company. While spare parts that cannot be reused will be disposed of in a landfill. Before the disposal process, of course, the recycle center as a place for disassembly of the company's products, repair processes, remanufacturing and recycling (Pulansari, Farida, 2017).

Forward Logistics are used to manage the forward movement of goods from raw materials to the consumer. Value is added to the product as it passes through each step along its route to the end user. Forward logistics become more divergent the further away they are from raw materials. In other words, while raw materials can sometimes only be found in a rare few places in the world, end products must get into the homes or places of business of every customer. Customer demand dictates the rate of forward logistics and inventory is kept at each stage to manage variances in that demand. **Reverse Logistics** are those used to manage the 'reverse' movement of goods, from the end user to the manufacturer, or even back into raw materials through recycling. Reverse logistics must be convergent, collecting used product from many points and transporting them back to one or more manufacturing locations. The speed of reverse logistics is entirely based on supply. Many product returns can make them busier and faster, but a lack of product returns can make the logistics stop entirely. The value of a product going through reverse logistics declines at each stage as costs rise due to the added materials handling requirements (https://www.pival.com/forward-and-reverse-logistics/).

Reverse logistics can be narrow or broad in scope. The narrow scope of reverse logistics refers to the movement and management of the actual reverse flow of products/parts/materials from customers to suppliers. The focus then is on logistics issues such as transportation modes and routes, pickup scheduling, and the use of third-party logistics providers to optimize logistics capabilities. The broader scope of reverse

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logistics includes activities that support the management of used products including retrieving them, sorting them, and reusing them in various ways. Today the focus has shifted from value recovery to environmental management to social management. More and more organizations are beginning to think about RL activities in line with the three pillars of sustainability – economic, environmental, and social (Sangwan, Kuldip Singh, 2017).

The three main activities of reverse logistics are collection, inspection and sorting, and product recovery. Collection refers to all activities that provide used products and physically move them to some point where further treatment is carried out for product recovery (Sasikumar and Kannan, 2008). Products are inspected and sorted after collection. Inspection and sorting consist of operations that determine whether a particular product can be reused or not, and if so, to what extent. Barker and Zabinsky (2008) identified that sorting/testing can be done at a centralized location or a decentralized location and discussed trade-off considerations. Product recovery is an essential activity of reverse logistics to manage the flow of products or parts destined for remanufacturing, repair, or disposal and to use resources effectively. Some of the product recovery processes include repair, reuse, refurbish, remanufacture, cannibalize, recycle or disposal. Once a product has been returned to an organization, it has many recovery options. Jayaraman (2006) has identified seven recovery options as reuse, repair, refurbish, remanufacturing, retrieval, recycle and disposal (in Sangwan, Kuldip Singh, 2017).

Table 2: Alternative Product Recovery Processes

Citation	Alternative Product Recovery Processes
Thierry et al. (1995)	Repair, refurbish, remanufacture, cannibalize and recycle
Johnson and Wang (1995)	Combination of remanufacture, reuse, and recycle
Rose and Ishii (1999)	Reuse, service, remanufacture, recycle and disposal
Guide et al.(2000)	Repair, remanufacturing and recycling
Ferguson and Browne (2001)	Reuse, remanufacture and recycle
Lee et al. (2001)	Reuse, remanufacture, recycle, landfill, and incineration
King et al. (2006)	Repair, recondition, remanufacture, and recycle
Sasikumar and Kannan (2008)	Direct reuse, recycling, remanufacturing, and repair
Skinner et al. (2008)	Destroying, recycling, refurbishing, remanufacturing, and repackaging
Srivastava (2008)	Repair & refurbish, remanufacturing, and secondary market
Lambert et al. (2011)	Repair, reuse, remanufacture, upgrade, repackage, recycle, reconfigure, and revaluation
Jindal and Sangwan (2016)	Repair, refurbishin, remanufacturing, cannibalising, and recycling

(in Sangwan, Kuldip Singh, 2017).

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The first option is to sell the product as a used product if it meets sufficient quality levels. The second option is to clean and repair the product to working order. Product repair involves fixing and replacement of failed parts. Repair operations can be performed at the customer's location or at a manufacturer controlled repair centre. The third option is to sell the product as a refurbished unit. In this the product does not lose its identity and is brought back to a specified quality level. Sometimes, refurbishing is combined with technology upgrading by replacing outdated modules and parts with technologically superior ones. The fourth option is to remanufacture. In this option the product will enter the reverse channel at the fabrication stage where it would be disassembled, remanufactured, and reassembled to flow back through the retail outlet back to the consumer as a remanufactured product. The purpose of remanufacturing is to bring the used products up to quality and reliability standards that are as rigorous as those for new products. The fifth option is to retrieve one or more valuable parts from the product. The sixth option is to recycle. In this option the product will most likely enter the reverse value channel in the raw material procurement stage where it may be reutilized with other raw materials to produce the virgin materials after some initial processing. In recycling, the identity and functionality of products and components is lost. The main purpose of recycling is to recover materials from used components and products. The seventh option is to recover the energy in the product through incineration. If the product is of no use even after re-processing the last option is waste disposal. Remanufacturing is an environmentally and economically sound way to achieve many of the goals of sustainable development. It closes the material use cycle and forms an essentially closed-loop manufacturing system. The aim of remanufacturing is to bring the product into 'as new' conditions by carrying out the necessary disassembly, overhaul, and replacement operations to get value-added recovery, rather than just materials recovery (Sangwan, Kuldip Singh, 2017).

Research Method

The research method used is a quantitative method with data collection by distributing web-based questionnaires to experts in the palm oil industry in Indonesia with samples that are adjusted and match the Fuzzy VIKOR technique (Visekriterijumsko Kompromisno) and Fuzzy TOPSIS technique (Technique for Order Preference by Similarity to Ideal Solution). A web-based questionnaire was developed for data collection, which was then distributed to thirty experts. The first part of the questionnaire consisted of demographic questions and the second part consisted of assigning weights to various criteria that influence Reverse Logistics practices based on expert opinions. The final part of the questionnaire consisted of ranking various alternatives against the proposed criteria based on expert opinions. A five-point scale of linguistic variables was used for the evaluation of the criteria. Experts were asked to select the alternative that was most important to implement and had the lowest barriers to execution. A total of five alternatives were ranked based on 14 criteria with priorities set by the participants in the ranking form. The thirty experts consisted of: a) supply chain and logistics managers in palm oil companies with a minimum of five years of professional experience; b) lecturers from reputable academic institutions, with the criteria for each academic expert, set at a minimum of five years of teaching experience with three international publications, c) Practitioners from members of the Indonesian Palm Oil Association; d) Professionals from among bureaucrats in the Palm Oil Plantation Fund Management Agency.

A five-point scale of linguistic variables was used for the evaluation of the criteria, namely:

Value	Linguistic Variables
1	Very Low
2	Low
3	Medium
4	High
5	Very High

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The alternative decision choices taken by the experts are:

Value	Alternative
A1	Recycling
A2	Remanufacturing
A3	Reuse
A4	Repair
A5	Refurbishment

There are several criteria or indicators Reverse Logistics determined by experts based on linguistic variables:

Value	Criteria
C1	The quality of the product is not uniform
C2	The option for disposition of a product is not clear
C3	Product routing is ambiguous
C4	Different points at which cost is involved is not easily understood
C5	The distribution channels are exception driven
C6	Often the product packaging is damaged
C7	The process of pricing product is not uniform
C8	The management of inventory is not consistent
C9	The life cycle of the product in this process is less likely to be managed
C10	Issues related to financial management are not clear
C11	The type of involvement of negotiation between different parties is less straightforward
C12	Forecasting for RL process is much more difficult
C13	Transportation involved from many to only one
C14	The visibility of the process is much less transparent

Fuzzy VIKOR (Vise Kriterijumska Optimizajica I Kompromiso Resenje)

VIKOR is a multi-criteria decision-making method from a decision support system that can select from one criterion. The use of VIKOR for automatic summarization is done by simulating a case to be processed, to produce a ranking order based on alternative rankings. The following are the working steps of the VIKOR method: (Primadasa Y & Juliansa, H, 2019)

a. Create a matrix of alternative decisions and criteria (F) with the equation below:

$$F = \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} C_{x1} & C_{x2} & \cdots\cdots & C_{xn} \\ x_{11} & x_{12} & \cdots\cdots & x_{1n} \\ x_{21} & x_{22} & \cdots\cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots\cdots & x_{mn} \end{bmatrix}$$

Where F is the decision matrix, A1 is the i-th alternative, i = 1,2,3...m is the alternative sequence number and Cj is the j-th criterion, j= 1,2,3..m is the criterion sequence number, and Xij is the alternative response to the criterion.

b. Determine the weight for each criterion (W) with the equation below:

$$W = \sum_j^n =_1 W_j = 1$$

Where Wj is the criteria weight and j = 1,2,3 is the criteria sequence number.

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c. Create a normalization matrix (N) by determining the maximum and minimum values to obtain the ideal solution for each criterion. N with the equation below Where Wj is the criteria weight and j = 1,2,3 is the criteria sequence number:

$$N_{ij} = \frac{(f_j^+ - f_{ij})}{(f_j^+ - f_j^-)}$$

Where fij is an alternative response to the criteria, f+j is the maximum value in one criterion, F- is the minimum value in one criterion.

d. Calculating the normalization matrix Weight (F*)

This weight normalization is done by multiplying the criteria weight (W) by the normalized data value (N), the equation is as follows:

$$F_{ij}^* = W_j . N_{ij}$$

Where F*ij is the result of normalizing the weights of the alternatives and criteria, Wj is the weight value of the criteria and Nij is the normalized data value of the alternatives and criteria.

e. Calculating the utility measure (S) and regret measure (R) of each alternative, with the equation below:

$$S_i = \Sigma_j^n =_1 \ W_j \frac{(f_j^+ - f_{ij})}{(f_j^+ - f_j^-)}$$

$$R_i = maxj \left[\frac{(f_j^+ - f_{ij})}{(f_j^+ - f_j^-)} \right]$$

Where Si is the maximum group utility and Ri is the minimum individual regret, both of which are utility measures taken from the furthest and closest points as ideal solutions.

f. Calculating the VIKOR Index with the following equation:

$$Q_i = v \left[\frac{(S_i - S^-)}{(S^+ - S^-)} \right] + (1 - v) \left[\frac{(R_i - R^-)}{(R^+ - R^-)} \right]$$

Where S- = min Si, S+ = max Si, and R- = min Ri, R+ = max Ri and V = 0.5. The smallest / lowest Qi value is the best result.

g. Performing a compromise solution with 2 conditions, the first condition is Acceptable Advante using the equation below:

$$Q(A_2) - Q(A_1) \geq DQ$$
$$DQ = \frac{1}{(m-1)}$$

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Where A2 is the second alternative in the Q ranking and A1 is the alternative with the best order in the Q ranking while DQ, where m is the number of alternatives.

Fuzzy TOPSIS (Technique for Others Preference by Similarity to Ideal Solution)

The TOPSIS method is one of the methods that can help the optimal decision-making process to solve decision problems practically. This is because the concept is simple and easy to understand, the computation is efficient and has the ability to measure the relative performance of decision alternatives in a simple mathematical form. In general, the procedure of the TOPSIS method follows the following steps (Suci, A.T., et. al. 2020):

a. Determining the normalized decision matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

with i = 1,2…,m and j = 1,2,…,n.

b. Calculating the weighted normalized decision matrix

$y_{ij} = w_i r_{ij}$

c. Calculating the positive ideal solution matrix and the negative ideal solution matrix

$A^+ = y1+, y2+, ... yn+$

$A^- = y1-, y2-, ... yn$

d. Calculate the distance between the value of each alternative with the positive ideal solution matrix and the negative ideal solution matrix.

$$D_i^{\ +} = \sqrt{\sum_{j=1}^{n} (y_i^{\ +} - y_{ij})^2}$$

$i = 1,2, \ldots m$

$$D_i^{\ -} = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^{\ -})^2}$$

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$i = 1,2,\ldots m$

e. Calculate the preference value for each alternative

$$V_i = \frac{D_i^-}{D_i^- - D_i^+}$$

Results and Discussion

From the results of the distribution of web-based questionnaires made for data collection, which were then distributed among thirty experts, validity and reliability tests were carried out. The following are the test results:

Table 3: Results of Validity Test and Reliability Test of the criteria/indicators using IBM SPSS Statistics Version 26

	Key	CRITERIA													
Alternative	Person:	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
Recycling	Expert1	3	4	3	4	3	3	3	3	4	4	4	4	4	3
Reuse	Expert2	4	4	4	4	4	5	4	4	4	4	4	4	4	4
Remanufacturing	Expert3	4	3	3	3	3	3	2	3	3	2	2	2	2	3
Refurbishment	Expert4	4	2	3	4	3	2	3	2	3	3	3	4	3	4
Repair	Expert5	3	3	3	4	4	4	3	3	3	2	1	4	2	3
Refurbishment	Expert6	4	4	3	4	4	5	4	4	4	3	3	5	4	3
Repair	Expert7	4	5	5	5	5	5	4	5	5	4	4	5	4	4
Reuse	Expert8	4	5	4	4	4	5	4	4	4	5	4	5	5	5
Recycling	Expert9	5	4	4	4	5	5	5	5	4	5	5	5	5	3
Remanufacturing	Expert10	4	4	3	3	3	4	4	4	4	4	4	4	4	4
Recycling	Expert11	4	3	3	3	3	3	3	3	3	2	2	2	2	3
Reuse	Expert12	4	5	5	4	4	5	4	4	4	4	4	5	5	5
Refurbishment	Expert13	4	4	3	3	4	4	4	4	3	3	3	3	3	3
Repair	Expert14	4	4	3	4	4	4	3	4	4	5	5	4	4	4
Remanufacturing	Expert15	4	3	3	3	3	3	3	3	1	2	3	3	3	2
Repair	Expert16	5	4	3	4	5	4	4	4	5	5	5	4	3	5
Reuse	Expert17	5	3	4	4	4	3	3	3	3	4	4	5	4	4
Remanufacturing	Expert18	5	5	4	5	5	5	5	5	5	5	5	5	5	5
Recycling	Expert19	4	5	5	4	4	5	4	4	4	5	5	5	5	4
Refurbishment	Expert20	4	4	5	5	4	5	5	5	5	2	2	2	2	3
Recycling	Expert21	4	3	3	3	3	4	2	2	2	5	4	3	3	3
Refurbishment	Expert22	5	5	4	5	5	5	5	5	5	5	5	5	5	5
Reuse	Expert23	4	4	3	4	5	5	5	4	4	3	3	4	4	4
Repair	Expert24	4	4	4	4	4	3	3	3	3	3	3	3	3	3
Remanufacturing	Expert25	3	4	4	4	3	4	4	4	3	3	2	2	3	2
Remanufacturing	Expert26	5	4	5	5	4	5	5	5	5	5	4	5	5	5
Recycling	Expert27	3	3	3	4	2	2	3	3	3	4	3	4	4	3
Reuse	Expert28	4	4	3	3	4	3	3	4	4	4	3	3	3	4
Refurbishment	Expert29	5	5	5	4	5	5	3	4	4	4	3	4	3	3
Repair	Expert30	5	4	3	4	4	3	4	4	3	5	5	5	5	5
Anti-image Correlation		.665a	.743a	.702a	.787a	.727a	.859a	.748a	.845a	.809a	.809a	.845a	.725a	.689a	.837a
Validity Test															
KMO and Bartlett's Test															

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Kaiser-Meyer-Olkin Measure of Sampling Adequacy.						.772									
Bartlett's Test of Sphericity															
Approx. Chi-Square		364.186													
	df	91													
	Sig.	.000													
Reliability Statistics															
Cronbach's Alpha	N of Items														
.933	14														
Cronbach's Alpha if Item Deleted		.932	.926	.932	.930	.928	.929	.928	.926	.927	.929	.929	.927	.926	.928

Validity Test using Kaiser-Mayer-Olkin Measure of Sampling Adequacy (KMO MSA) Value and KMO and Bartlett's Test output table is useful to know the feasibility of a variable, whether it can be further processed using this factor analysis technique or not. The method is to look at the KMO MSA (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) value. If the KMO MSA value is greater than 0.50, then the factor analysis technique can be continued. Based on the output above, it is known that the KMO MSA value of the fourteen Reverse Logistics criteria/indicators is 0.772> 0.50 and the Bartlett's Test of Sphericity (Sig.) Value is 0.00 <0.05, then the factor analysis in this study can be continued because it has met the requirements. There is a strong relationship or correlation between the criteria/indicators. This is indicated by the Anti-image Correlation value between the criteria/indicators being greater than 0.50. Thus, fourteen criteria/indicators can be declared valid.

From the output table above, it is known that there are N of Items (the number of items or questionnaire questions) there are 14 items with a Cronbach's Alpha value of 0.993. Because the Cronbach's Alpha value of 0.993> 0.60, then as the basis for decision making in the reliability test above, it can be concluded that the 14 or all questionnaire question items for the Reverse Logistics criteria/indicators are reliable or consistent. The output table above provides an overview of the statistical values for the 14 questionnaire question items. Note in the "Cronbach's Alpha if Item Deleted" column in this table, the Cronbach's Alpha value for the seven question items is> 0.60, so it can be concluded that the 14 questionnaire question items related to Reverse Logistics are reliable.

Fuzzy VIKOR

The Fuzzy VIKOR method is used to determine the priority scale in executing supply chain management using reverse logistics in the palm oil industry in Indonesia. To facilitate the analysis, the Fuzzy VIKOR calculation uses Microsoft Excel (Indonesian version). The steps taken in calculating Fuzzy VIKOR are determining the weight, creating a normalization table R, calculating the S value, calculating the R value, comparing the S value and the R value, determining the index value and the last step is determining the ranking value.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
VIKOR METHOD															
	CRITERIA														
ALTERNATIVE	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	
Repair	4,17	4,00	3,50	4,17	4,33	3,83	3,50	3,83	3,83	4,00	3,83	4,17	3,50	4,00	
Recycling	3,83	3,67	3,50	3,67	3,33	3,67	3,33	3,33	3,33	4,17	3,83	3,83	3,83	3,17	

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Remanufacturing	4,17	3,83	3,67	3,83	3,50	4,00	3,83	4,00	3,50	3,50	3,33	3,50	3,67	3,50	
Refurbishment	4,33	4,00	3,83	4,17	4,17	4,33	4,00	4,00	4,00	3,33	3,17	3,83	3,33	3,50	
Reuse	4,17	4,17	3,83	3,83	4,17	4,33	3,83	3,83	3,83	4,00	3,67	4,33	4,17	4,33	
WEIGHT	1	1	1	1	2	1	2	1	2	1	1	3	1	2	20
W=1	0,05	0,05	0,05	0,05	0,1	0,05	0,1	0,05	0,1	0,05	0,05	0,15	0,05	*0,1	1
NORMALIZATION														*=O10/$P$10	
	*=((MAX(B$5:B$9)-B4))/((MAX(B$5:B$9)-MIN(B$5:B$9)))														
	*0,32	0,34	1,00	0,00	0,00	0,76	0,75	0,25	0,25	0,20	0,00	0,19	0,80	0,28	
	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	0,00	0,00	0,60	0,40	1,00	
R	0,32	0,68	0,48	0,68	0,83	0,50	0,25	0,00	0,75	0,80	0,76	1,00	0,60	0,72	
	0,00	0,34	0,00	0,00	0,16	0,00	0,00	0,00	0,00	1,00	1,00	0,60	1,00	0,72	
	0,32	0,00	0,00	0,68	0,16	0,00	0,25	0,25	0,25	0,20	0,24	0,00	0,00	0,00	
CALCULATING THE VALUE OF S															
	*=B$11*B14												*=SUM(B21:O21)		
	*0,016	0,017	0,05	0,00	0,00	0,04	0,07	0,01	0,03	0,01	0,00	0,03	0,04	0,03	*0,34
	0,050	0,05	0,05	0,05	0,10	0,05	0,10	0,05	0,10	0,00	0,00	0,09	0,02	0,10	0,81
S	0,016	0,034	0,02	0,03	0,08	0,03	0,03	0,00	0,07	0,04	0,04	0,15	0,03	0,07	0,65
	0,000	0,02	0,00	0,00	0,02	0,00	0,00	0,00	0,00	0,05	0,05	0,09	0,05	0,07	0,34
	0,016	0	0,00	0,03	0,02	0,00	0,03	0,01	0,03	0,01	0,01	0,00	0,00	0,00	0,15
CALCULATING THE VALUE OF R															
	*0,07	*=MAX(B21:O21)													
	0,10														
R	0,15														
	0,09														
	0,03														
		*=+P21													
ALTERNATIVE	VALUE OF S	VALUE OF R													
Repair	*0,34	**0,07	**+B28												
Recycling	0,81	0,10													
Remanufacturing	0,65	0,15													

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Refurbishment	0,34	0,09	
Reuse	0,15	0,03	
MIN	0,15	*0,03	*=MIN(C35:C39)
MAX	0,81	**0,15	**=MAX(C35:C39)
DETERMINING INDEX VALUE			
	*=((B35-$B$40)/($B$41-$B$40)*0,5)+((C35-$C$40)/($C$41-$C$40)*0,5)		
		RANKING	
	*0,32	**2	**=RANK(B45;$B$45:$B$49;1)
	0,78	4	
Q	0,87	5	
	0,39	3	
	0,00	1	
	Rank:		
1	Reuse		
2	Repair		
3	Refurbishment		
4	Recycling		
5	Remanufacturing		

Based on Fuzzy VIKOR calculations to determine the priority scale in executing supply chain management using reverse logistics in the palm oil industry in Indonesia, the results obtained are that the first choice is Reuse, second: Repair, third: Refurbishment, fourth: Recycling and fifth: Remanufacturing.

Fuzzy TOPSIS

In addition, this study aims to determine the priority scale in executing supply chain management using reverse logistics in the palm oil industry in Indonesia using the Fuzzy TOPSIS method. The steps taken in calculating Fuzzy TOPSIS are determining the cost or benefit for 14 Reverse Logistics criteria, creating a normalized matrix R, creating a weighted normalized matrix Y, determining the positive ideal solution (A+), determining the negative ideal solution (A-), determining the distance between weighted values of positive and negative ideal solutions, determining the preference value and determining the ranking value.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
TOPSIS METHOD														
	CRITERIA													
ALTERNATIVE	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
Repair	4,17	4,00	3,50	4,17	4,33	3,83	3,50	3,83	3,83	4,00	3,83	4,17	3,50	4,00
Recycling	3,83	3,67	3,50	3,67	3,33	3,67	3,33	3,33	3,33	4,17	3,83	3,83	3,83	3,17
Remanufacturing	4,17	3,83	3,67	3,83	3,50	4,00	3,83	4,00	3,50	3,50	3,33	3,50	3,67	3,50
Refurbishment	4,33	4,00	3,83	4,17	4,17	4,33	4,00	4,00	4,00	3,33	3,17	3,83	3,33	3,50
Reuse	4,17	4,17	3,83	3,83	4,17	4,33	3,83	3,83	3,83	4,00	3,67	4,33	4,17	4,33
	COST	COST	COST	COST	COST	COST	BENEFIT	COST	BENEFIT	COST	BENEFIT	BENEFIT	BENEFIT	BENEFIT
WEIGHT	1	1	1	1	2	1	2	1	2	1	1	3	1	2

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CREATING A NOMALIZED MATRIX -R-														
	*=SQRT((B5^2)+(B6^2)+(B7^2)+(B8^2)+(B9^2))												**=O5/O$14	
DIVIDER	*9,251	8,805	8,204	8,808	8,767	9,035	8,287	8,510	8,287	8,528	7,997	8,816	8,299	8,325
	0,451	0,454	0,427	0,473	0,494	0,424	0,422	0,450	0,462	0,469	0,479	0,473	0,422	**0,481
R	0,414	0,417	0,427	0,417	0,380	0,406	0,402	0,391	0,402	0,489	0,479	0,434	0,462	0,381
	0,451	0,435	0,447	0,435	0,399	0,443	0,462	0,470	0,422	0,410	0,416	0,397	0,442	0,420
	0,468	0,454	0,467	0,473	0,476	0,479	0,483	0,470	0,483	0,390	0,396	0,434	0,401	0,420
	0,451	0,474	0,467	0,435	0,476	0,479	0,462	0,450	0,462	0,469	0,459	0,491	0,502	0,520
CREATE A WEIGHTED NORMALIZED MATRIX (Y)														
	*=B15*$B$11													
	*0,451	0,454	0,427	0,473	0,988	0,424	0,845	0,450	0,924	0,469	0,479	1,419	0,422	0,961
Y	0,414	0,417	0,427	0,417	0,760	0,406	0,804	0,391	0,804	0,489	0,479	1,303	0,462	0,762
	0,451	0,435	0,447	0,435	0,798	0,443	0,924	0,470	0,845	0,410	0,416	1,191	0,442	0,841
	0,468	0,454	0,467	0,473	0,951	0,479	0,965	0,470	0,965	0,390	0,396	1,303	0,401	0,841
	0,451	0,474	0,467	0,435	0,951	0,479	0,924	0,450	0,924	0,469	0,459	1,473	0,502	1,040
POSITIVE IDEAL SOLUTION														
	*=IF(B$10="BENEFIT";MAX(B$22:B$26);(MIN(B$22:B$26)))													
A+	*0,414	0,417	0,427	0,417	0,760	0,406	0,965	0,391	0,965	0,390	0,479	1,473	0,502	1,040
NEGATIVE IDEAL SOLUTION														
	**=IF(B$10="BENEFIT";MIN(B$22:B$26);(MAX(B$22:B$26)))													
A-	**0,468	0,474	0,467	0,473	0,988	0,479	0,804	0,470	0,804	0,489	0,396	1,191	0,401	0,762
DISTANCE BETWEEN THP WEIGHTED VALUES OF POSITIVE AND NEGATIVE IDEAL SOLUTIONS														
	*=SQRT(((B$29-B22)^2+(C$29-C22)^2+(D$29-D22)^2+(E$29-E22)^2+(F$29-F22)^2+(G$29-G22)^2+(H$29-H22)^2+(I$29-I22)^2													
	+(J$29-J22)^2+(K$29-K22)^2+(L$29-L22)^2+(M$29-M22)^2+(N$29-N22)^2+(O$29-O22)^2))													
	D1+	*0,316	D1-	**0,348										
	D2+	0,413	D2-	0,312										
	D3+	0,394	D3-	0,268										

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	D4+	0,378	D4-	0,287										
	D5+	2,711	D5-	2,482										
	**=SQRT(((B22-B$32)^2+(C22-B$32)^2+(D22-D$32)^2+(E22-E$32)^2+(F22-F$32)^2+(G22-G$32)^2+(H22-H$32)^2+(I22-I$32)^2													
	+(J22-J$32)^2+(K22-K$32)^2+(L22-L$32)^2+(M22-M$32)^2+(N22-N$32)^2+(O22-O$32)^2))													
PREFERENCE VALUE			RANK											
	*=E36/(E36+C36)													
		**=RANK(C46;$C$46:$C$50;0)												
	V1	*0,524	**1											
	V2	0,431	4											
	V3	0,405	5											
	V4	0,432	3											
	V5	0,478	2											
	Rank:													
1	Repair													
2	Reuse													
3	Refurbishment													
4	Recycling													
5	Remanufacturing													

Based on the Fuzzy TOPSIS calculation to determine the priority scale in executing supply chain management using reverse logistics in the palm oil industry in Indonesia, the results obtained are that the first choice is Repair, second: Reuse, third: Refurbishment, fourth: Recycling and fifth: Remanufacturing. The following is a comparison table between Fuzzy VIKOR and Fuzzy TOPSIS to determine the priority scale in executing supply chain management using reverse logistics in the palm oil industry in Indonesia.

Table 4: Comparison of Fuzzy VIKOR and Fuzzy TOPSIS Results

Ranking	Fuzzy VIKOR	Fuzzy TOPSIS
1	Reuse	Repair
2	Repair	Reuse
3	Refurbishment	Refurbishment
4	Recycling	Recycling
5	Remanufacturing	Remanufacturing

From the comparison results between Fuzzy VIKOR and Fuzzy TOPSIS, there are almost similarities in the Reverse Logistics options, only different in the first and second options. For Fuzzy VIKOR, the first option is Reuse, while for Fuzzy TOPSIS, the first option is Repair. As for the results of the third to fifth options, there is no difference between Fuzzy VIKOR and Fuzzy TOPSIS, namely, Refurbishment, Recycling, and Remanufacturing.

Reuse is an activity of managing by reusing it. By utilizing unused items, the remaining goods are reduced. Reuse is extending the life of goods through direct maintenance and reuse of goods. Reuse by reusing used goods without having to process them first, such as reusing packaging or utilizing packaging goods as a place to store something. This can extend the life of goods and the time of use of goods so that reuse can be applied in the supply chain management of the palm oil industry in Indonesia.

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Repair is an action to return something to a better or near new condition by changing, repairing, or replacing certain parts. So reconditioning is part of the activity of re-repairing so that existing goods but in poor condition become better and can be used. Repair can be interpreted as an activity to maintain or guard factory facilities or equipment and make repairs or adjustments or replacements as needed to obtain a condition. Satisfactory production operations according to what has been planned. So, with this repair activity, factory facilities and equipment can be used for production according to plan and are not damaged as long as the facilities or equipment are used for the production process or before a certain planned period is reached and the production process runs smoothly and is guaranteed because the possibility of congestion caused by the failure of production facilities or equipment has been eliminated or reduced. So that repair can be applied in supply chain management in the palm oil industry in Indonesia.

Refurbishment is an activity to maintain or care for a product so that it can function properly, repair, renew, replace components to extend the life of the product. Refurbishment is a product that is returned to a new condition because it has minimal damage. Refurbished goods are repaired with the aim of being resold to consumers. So, refurbished products are not new products, these products are modified by internal parties. Refurbished goods can be equipped with a warranty, although the period is not the same as that of truly new goods. So that refurbishment can be applied in supply chain management in the palm oil industry in Indonesia.

Recycle is a very beneficial effort for the community and the environment. Processing waste is one way to save the environment from global warming. Recycle is an activity that can help save money, energy, and natural resources. Recycle is an effort that can be done by anyone. You can recycle starting from small things such as processing plastic or paper waste. Recycle is part of the habit of preserving the environment. Recycle is the process of collecting and processing materials that should be discarded as waste and turning them into new products. Recycle is one of the three steps of waste processing, namely reduce, reuse, and recycle. Recycle is a key component of modern waste reduction. Waste production can be reduced with this recycling effort. Recycle aims for environmental sustainability. The results of recycling can also be useful for everyday life. Recycle prevents the emission of many greenhouse gases and water pollutants, and saves energy. Using recycled materials produces less solid waste. Before throwing something away, think about whether all or part of it can be recycled. So that recycling can be applied in supply chain management in the palm oil industry in Indonesia.

Remanufacturing is a series of processes starting from receiving, inspection, disassembly of non-new products or components to re-assembly, testing and wrapping using modern equipment and tools. The remanufacturing process produces products or components that have the same quality as new components, including function, usability, performance and durability. In accordance with the process standards that have been set by the principal so that it can save on several components of the cost of resources contained in the used product can reduce costs so that the selling price of the product has reliable quality with a competitive selling price and is lower than the price of new products to meet customer needs. So that remanufacturing can be applied in supply chain management in the palm oil industry in Indonesia.

Conclusion

Based on Fuzzy VIKOR calculations to determine the priority scale in executing supply chain management using reverse logistics in the palm oil industry in Indonesia, the results obtained are that the first choice is Reuse, second: Repair, third: Refurbishment, fourth: Recycling and fifth: Remanufacturing. Based on the Fuzzy TOPSIS calculation to determine the priority scale in executing supply chain management using reverse logistics in the palm oil industry in Indonesia, the results obtained are that the first choice is Repair, second: Reuse, third: Refurbishment, fourth: Recycling and fifth: Remanufacturing. From the comparison results between Fuzzy VIKOR and Fuzzy TOPSIS, there are almost similarities in the Reverse Logistics options, only different in the first and second options. For Fuzzy VIKOR, the first option is Reuse, while for Fuzzy TOPSIS, the first option is Repair. As for the results of the third to fifth options, there is no difference between Fuzzy VIKOR and Fuzzy TOPSIS, namely, Refurbishment, Recycling, and Remanufacturing.

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References

Ali, Yousaf, & Zeb, Khaqan, & Babar, Abdul Haseeb Khan, & Awan, Muhammad Asees. Identification of Critical Factors for Implementation of Reverse Logistics in The Manufacturing Industry of Pakistan. Journal of Defense Analytics and Logistics Vol. 5 No. 1, 2021 pp. 95-112.

Anggoro, V.K. & Riski, A & Kamsyakawuni, A. 2023. Penerapan Metode Fuzzy TOPSIS sebagai Sistem Pendukung Keputusan Pemilihan Mahasiswa Berprestasi. Jurnal ILMU DASAR, Vol. 24 No. 1, Januari: 31-36.

Barker, T. J. and Zabinsky, Z. B. 2011. "A multicriteria decision making model for reverse logistics using analytical hierarchy process." Omega 39(5): 558-573.

Fleischmann, M. (2001), Reverse Logistics Network Structures and Design, available at SSRN: https:// ssrn.com/abstract=370907.

Fleischmann, M., Bloemhof-Ruwaard, J.M., Dekker, R., Van der Laan, E., Van Nunen, J.A. and Van Wassenhove, L.N. (1997), "Quantitative models for reverse logistics: a review", European Journal of Operational Research, Vol. 103 No. 1, pp. 1-17.

Fleischmann, M., Krikke, H.R., Dekker, R. and Flapper, S.D.P. (2000), "A characterisation of logistics networks for product recovery", Omega, Vol. 28 No. 6, pp. 653-666.

Fleischmann, M., Van Nunen, J.A. and Gräve, B. (2003), "Integrating closed-loop supply chains and spare-parts management at IBM", Interfaces, Vol. 33 No. 6, pp. 44-56.

Ferguson, N. and Browne, J. 2001. "Issues in end-of- life product recovery and reverse logistics."Production Planning & Control 12(5): 534-547.

Guide Jr, V . D. R. 2000. "Production planning and control for remanufacturing: industry practiceand research needs." Journal of Operations Management 18(4): 467-483.

Hernandez, Jorge E. et.al. 2021. Collaborative Logistics and Intermodality, Integration in Supply Chain Network Models and Solutions for Global Environments. Liverpool: Springer.

Jindal, A. and Sangwan, K. S. 2016. "A fuzzy based decision support framework for product recovery process selection in reverse logistics." International Journal of Services and Operations Management. DOI: 10.1504/IJSOM.2016.10000346.

Jayaraman, V. 2006. "Production planning for closed-loop supply chains with product recovery andreuse: an analytical approach." International Journal of Production Research 44(5): 981-998.

Johnson, M. R. and Wang, M. H. 1995. "Planning product disassembly for material recovery opportunities." International Journal of Production Research 33(11): 3119-3142.

Kusumadewi, S & Guswaludin, I. (2005). Fuzzy Multi-Criteria Decision Making. Media Informatika, Vol. 3 No.1., 25-38.

Kusumadewi, S., Hartati, S., Harjoko, A., & Wardoyo, R. (2006). Fuzzy Multi-Atribute Decision Making (Fuzzy MADM). Yogyakarta: Graha Ilmu.

Lee, S. G., Lye, S. W. and Khoo, M. K. 2001. "A Multi-Objective Methodology for Evaluating Product End-of- Life Options and Disassembly." The International Journal of Advanced Manufacturing Technology 18(2): 148-156.

Lambert, S., Riopel, D. and Abdul-Kader, W. 2011. "A reverse logistics decisions conceptual framework." Computers & Industrial Engineering 61(3): 561-581.

King, A. M., Burgess, S. C., Ijomah, W. and McMahon, C. A. 2006. "Reducing waste: repair, recondition, remanufacture or recycle?" Sustainable Development 14(4): 257-267.

Pulansari, Farida, 2017. Desain Model Sistem Reverse Logistics pada Industri Elektronika Konsumsi. Disertasi Doktor. Surabaya: Institut Teknologi Sepuluh November Surabaya.

Primadasa, Yogi & Juliansa, Hengki. 2019. Penerapan Metode VIKOR dalam Seleksi Penerimaan Bonus pada Salesman Indihome. Jurnal Teknologi Informasi & Komunikasi Digital Zone, Volume 10, Nomor 1 , Mei 2019: 33-43.

Rogers, D.S. and Tibben-Lembke, R.S. (1999a), "Reverse logistics': stratégies et techniques", Logistique and Management, Vol. 7 No. 2, pp. 15-25.

Rogers, D.S. and Tibben-Lembke, R.S. (1999b), Going Backwards: reverse Logistics Trends and Practices, Reverse Logistics Executive Council, Pittsburgh, PA, Vol. 2.

Rose, C. M. and Ishii, K. 1999. "Product end-of- life strategy categorization design tool." Journal of Electronics Manufacturing 9(01): 41-51.

Suci, A.T. & Hasyim Asyari, H. & Prasetiawan, A.Y. & Pratomo, N.A. 2020. Metode Fuzzy TOPSIS Pada Pengambilan Keputusan Rekrutmen Karyawan PT. Erporate Solusi Global. Teknoin Vol. 26, No. 1, Maret: 14-22

Sangwan, Kuldip Singh. 2017. Key activities, decision variables and performance indicators of reverse logistics.Elsevier: Procedia CIRP 61 (2017) 257 – 262

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DOI: https://doi.org/10.62754/joe.v4i2.6382

Sasikumar, P. and Kannan, G. 2008. "Issues in reverse supply chains, part I: end of life product recovery and inventory management – an overview." International Journal of Sustainable Engineering 1(3): 154-172.

Skinner, L. R., Bryant, P. T. and Richey, R. G. 2008. "Examining the impact of reverse logistics disposition strategies "International Journal of Physical Distribution & Logistics Management 38(7): 518-539.

Srivastava, S. K. 2008. "Network design for reverse logistics." Omega 36(4): 535-548.

Tan, Kian Pang & Lim, Suet Yiing. 2023. Palm Oil Monthly Market Outlook Update. An Kuala Lumpur: LSEG Business.

Thierry, M. C., Salomon, M., Nunen, J. A. E. v. and Wassenhove, L. N. v. 1995. "Strategic issues inproduct recovery management." California Management Review 37(2): 114-135.

Zoé, Krug. 2020. Strategic design of reverse logistics chains in the context of circular economy development. Doctoral Program Dissertation. Toulouse: Universite Federale Toulouse Midi-Pyrenees.

(https://gapki.id/en/news/21136/palm-oil-performance-in-2021-and-prospect-in-2022).

(https://gapki.id/en/news/21136/palm-oil-performance-in-2021-and-prospect-in-2022).

(https://www.mongabay.co.id/2012/09/03/dari-sabang-sampai-merauke-kelapa-sawit-cemari-air-tanahku/)

(https://www.pival.com/forward-and-reverse-logistics/)