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by Rostiar Sitorus

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# Analytical Hierarchy Process For Identification Of Green Supply Chain Management Of The Palm Oil Industry In Bangka Island

Rostiar Sitorus<sup>1</sup> Maera Zasari<sup>2</sup>

<sup>1</sup>Study Program of Agribusiness, Faculty of Agricultural Fisheries and Biology, Bangka Belitung University, Bangka, Indonesia.

<sup>2</sup>Study Program of Agrotechnology, Faculty of Agricultural Fisheries and Biology, Bangka Belitung University, Bangka, Indonesia.

oty.torus72@gmail.com



**Abstract** – The palm oil industry in Bangka Belitung is not only prioritized as a contributor to community welfare but at this time no less important is the environmental aspect that must be applied in the supply chain of a company. Environmental aspects in practice tend not to be integrated into the supply chain of the company, so it runs less effectively. One way to integrate this aspect of the environment into the supply chain is green supply chain management (GSCM). The study was conducted to identify the GSCM of the palm oil processing industry on Bangka Island based on performance indicators and process hierarchy. The GSCM identification survey of palm oil processing companies in the Bangka Island area for the GSCM of the palm oil processing industry on Bangka Island based on performance indicators and process hierarchy, was seen based on Green objectives with the highest weight on the management of ISPO or RSPO certified palm oil plantations and mills by 29%, Minimization and handling of greenhouse gas emissions and waste management with weights of 16% and 12%. Meanwhile, the KPI with the highest weight is in the percentage of FFB from ispo or RSPO certified plantations at 29%, ISPO or RSPO certified CPO at 12% and greenhouse gas emissions at 7%.

**Keywords** – Industry, palm oil, GSCM, process hierarchy

## I. INTRODUCTION

Palm oil is one of the 5 potential plantation commodities in Indonesia, especially Bangka Belitung (Krisyanidayati. 2018). In BPS (2021), Bangka Belitung is one of the largest producers of palm oil after pepper and rubber. The increase in palm oil production during 2013 to 2020 averaged 5% per year. 2020 palm oil production amounted to 148 913.96 tons. The increase in palm oil production from year to year has encouraged the growth of the palm oil/CPO processing industry in Bangka Belitung. Research Saputra and Iman (2020), states that the palm oil-based industry is believed to be able to help the government alleviate poverty in Indonesia. In 2021 there are 17 Palm Oil Mills (PKS) spread across every regency in the Bangka Belitung Islands Province.

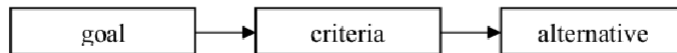
The palm oil industry is not only prioritized as a contributor to community welfare, but currently, environmental aspects are a must-apply in the company's supply chain. One way to integrate environmental aspects into the supply chain is green supply chain management (GSCM). The application of GSCM improves economic performance to shape the efficiency of the company's supply chain and the environment (Zhu and Cote 2004), by reducing environmental pollution/ elimination of waste (Natalia and Astuario 2015), including energy, emissions, hazardous chemical gases, and waste (Fortuna *et al.*, 2014).

Currently, the existing palm oil processing industry has not fully implemented supply chain management / Supply Chain Management with an environmental perspective, for this reason, by inventorying and identifying the GSCM, it strongly supports the government's efforts to improve the palm oil processing industry as the main source of income for farmers in the Bangka Belitung Islands Province, especially on Bangka Island, while overcoming the problem of degradation of environmental carrying capacity for sustainable agricultural development. So it is important to collect and identify the GSCM of the palm oil processing industry on Bangka Island based on performance indicators and process hierarchy.

II. METHOD

Field studies were conducted at palm oil processing companies (PPKS) in the Bangka island area. The data collected includes PKS supply chain, identification of stakeholder needs related to the environment in the supply chain, identification of green requirements, and green objectives of each stakeholder. The results of the literature study process and field studies were used to design the GSCM KPI (Key Performance Indicators) of the palm oil industry.

The design of KPI for GSCM measurements in the palm oil industry is carried out in several steps. The first is to identify the supply chain model of the palm oil industry. The second is to carry out supply chain mapping using the Green SCOR model. This modeling is more objective to correlate stakeholder needs regarding environmental aspects with Green SCOR's performance attributes. After the green objectives for each stakeholder have been known, the key performance indicator is made. After obtaining the GSCM KPI for the palm oil industry, the next stage is the weighting of each KPI using the AHP (Analytical Hierarchy Process) method. The basic concept of AHP is the priority of hierarchy in decision making, this is very contrary to the PSM (propensity score matching) method that was once applied by Sitorus et al (2020). In general, the structure of the hierarchy can be seen in the figure as follows:



Gambar 2. Generic Hierarchy Structure (Saaty, 2007)

II. RESULTS AND DISCUSSION

From the results of the 11th survey of PPKS in Bangka, quite a lot of input and opinions were obtained about GSCM as part of the green industry concept, both from the level of understanding and understanding as well as the things that have been done by the industry, as well as the obstacles or obstacles it faces. The condition is also found in Jaya et al.,(2021); Indriatoro et al.,(2012); Hadiguna (2012); Lestari & Dinata (2019)

The understanding and understanding of the green industry for industries in the Bangka Island area is currently still not uniform. Some define the green industry as doing greening by planting trees and cleanliness in the factory location so that it is beautiful to be seen, while others interpret the green industry as if it has handled factory waste and pollution produced due to industrial activities and finally obtained a PROPER certificate which is programmed, developed and socialized by the Ministry of Environment (KLH).

Identify Stakeholder Requirements

At this stage, we identify the requirements of each stakeholder in the supply chain. the requirements here are still general, but the requirements related to the environment (green requirements) are also identified. from stakeholders in the supply chain of the palm oil industry ranging from plantations, and transportation departments, to the process of processing and requirements shipping CPO is tabulated in Table 1.

Table 1. Stakeholder Requirements in the Palm Oil Industry Supply Chain

Stakeholder	Requirements
Supplier of Fresh Palm Fruit Bunches (Own Garden, Partnership Garden, non-partner)	<ul style="list-style-type: none"> <li>▪ The price per kilogram of FFB purchased by PPKS is high</li> <li>▪ Plantation Management in accordance with ISPO and RSPO provisions</li> </ul>

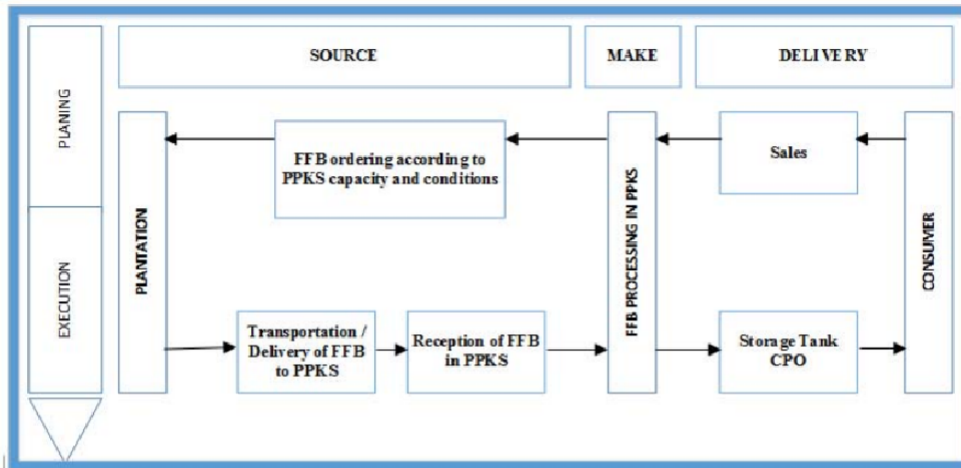
**Analytical Hierarchy Process For Identification <sup>1</sup> Of Green Supply Chain Management Of The Palm Oil Industry In Bangka Island**

	<ul style="list-style-type: none"> <li>▪ FFB sent to PPKS is clean of garbage</li> <li>▪ Processing of low emission plantations</li> </ul>
FFB reception section (on PPKS weighbridge and grading section)	<ul style="list-style-type: none"> <li>▪ FFBs that enter PPKS as planned the day before</li> <li>▪ Low percentage of FFB</li> <li>▪ The percentage of waste participating in FFB is low</li> <li>▪ High percentage of odors</li> </ul>
Transportation Section (Delivery of Palm Fresh Fruit Bunches to PPKS)	<ul style="list-style-type: none"> <li>▪ Value of each FFB transportation to PPKS is high</li> <li>▪ Minimum number of trucks with the maximum possible tonnage of FFB transported</li> <li>▪ Environmentally friendly transportation</li> <li>▪ Minimal fuel use</li> <li>▪ The queue on the PPKS weighbridge is not long</li> </ul>
Processing Department (CPO Production)	<ul style="list-style-type: none"> <li>▪ The resulting CPO has a high yield</li> <li>▪ Minimal waste</li> <li>▪ Emissions from each workstation are minimal</li> <li>▪ Breakdown of the processing process is minimal</li> <li>▪ The processing process of obtaining quality certificates, ISPO certificates, RSPO certificates</li> <li>▪ Minimal waste generated</li> <li>▪ Well treated waste</li> </ul>
Sales and Marketing Department	<ul style="list-style-type: none"> <li>▪ High CPO selling price</li> <li>▪ Fulfillment of legality and environmentally friendly requirements to reduce complaints from customers</li> <li>▪ Barges used for CPO delivery according to their capacity</li> </ul>

Source : Primary Data Processing Results

**Supply Chain Mapping Using the Green SCOR Pattern**

<sup>3</sup> An overview of the palm oil industry supply chain adapted to the Green SCOR model is shown in Figure 2.



<sup>17</sup> Figure 2. Palm Oil Industry Supply Chain Flow Pattern in Bangka

Source : Primary Data Processing Results

**Identify Green Objectives**

Green objectives <sup>9</sup> are the goal of every stakeholder in the supply chain regarding reducing the impact on the environment. The green objectives of the palm oil industry that have been arranged are shown in Table 2.

Table 2. Green Objectives <sup>3</sup> of the Palm Oil Industry Supply Chain in Bangka

<i>Green Objectives</i>	<i>Stakeholder</i>
Environmentally friendly Garden Management	Garden, FFB Supplier
Minimal waste	FFB processing departement (PPKS)
CPO storage that is able to maintain low acidity (Low FFA)	Sales, Sub- departement of CPO storage tank management
Minimization and handling of greenhouse gas emissions	Plantation, transportation section, CPO processing departement, sales
Management of ISPO or RSPO certified palm oil plantations and mills	Plantations, PPKS (FFB management)
Minimal water use and does not interfere with people's water needs	Garden, PPKS
Waste management	Garden, Transportation departement, FFB Processing departement ( PPKS), sales
Maximise the use of new and renewable energy	Transportation, PPKS, sales
Consumer satisfaction related to CPO products from an environmental aspect	Sales

Source : Primary Data Processing Results

**GSCM Indicator Hierarchy of Palm Oil Industry in Bangka**

Before obtaining the GSCM Indicator Hierarchy, the Key Performance Indicators (KPIs) adopted from Natalia & Asturio (2015) are first determined. The GSCM KPI of the Bangka palm oil industry is compiled from lowering the green objectives that have been compiled in table 2. The following is shown the KPIs that have been arranged.

Tabel 3. Key Performance Indicators (KPI) Industri Sawit in Bangka

<b>Green Objectives</b>	<b>KPI</b>
Environmentally friendly Garden Management	No protected forest land is used as plantation land
	Percentage of pesticide toxic content level
	Safe disposal of pesticide containers
	Forest fire prevention
Minimal waste	Irrigation practices that can minimize erosion
	CPO Amendments
CPO storage that is able to maintain low acidity (Low FFA)	Moisture content in CPO
	FFA CPO Levels
Minimization and handling of greenhouse gas emissions	Greenhouse gas emissions
	Amount of fuel use in FFB shipments
	Percent of emissions from POME (Palm Oil Mill Effluent)
	Emissions from CPO delivery to consumers
Management of ISPO or RSPO certified palm oil plantations and mills	Percentage of FFB from ISPO or RSPO certified farms
Minimal water use and does not interfere with people's water needs	Percent of water use per ton of FFB in PPKS
	The use of water in the garden does not interfere with the needs of the community
Waste management	BOD of wastewater according to standards
	COD wastewater according to standards
	Safe storage of B3 waste
	Utilization of liquid waste for land applications
	Good waste disposal
Maximise the use of new and renewable energy	Use of renewable energy per ton FFB
	Utilization of solid waste (shells and empty blanks) in exchange for fossil fuels
Consumer satisfaction related to CPO products from an environmental aspect	% of ISPO or RSPO certified CPO

Source: adopted from Natalia & Asturio (2015).

Furthermore, it can be drawn in Figure 3 Hierarchy of the GSCM KPI of the palm oil industry in Bangka.

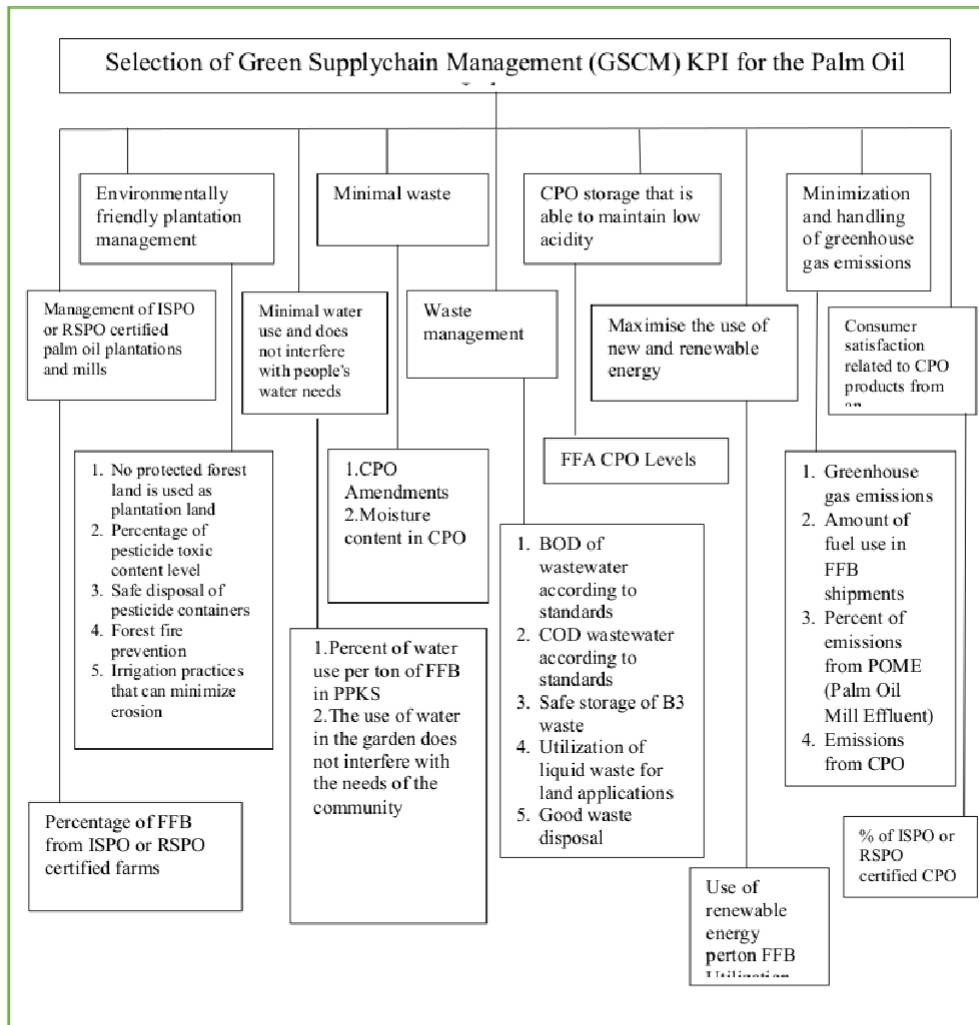


Figure 3 Hierarchy of the GSCM KPI of the palm oil industry in Bangka

Once the hierarchy is formed, the weight of the importance level is then measured. A comparison questionnaire between indicators from a total of 10 experts in the palm oil industry was asked for their preferences. All experts filled out the questionnaire carefully based on their experience in the palm oil industry. The comparison scale used between KPIs is 1 to 9 (1 = equal, 3 = medium, 5 = strong, 7 = very strong, 9 = extreme). The consistency Ratio (CR) is used to check the consistency of the comparison. If the CR is less than 1 it means that the comparison is accepted. Based on CR calculations, the value is between 0.0168 and 0.0957, which means that the comparison of pairs is consistent because it is in an acceptable range. This shows that experts provide a consistent assessment in weighting the KPI of the green supply chain management of the palm oil industry in Bangka. The GSCM KPI table for the palm oil industry in Bangka can be seen in Table 4.



Table 4. The GSCM KPI <sup>6</sup> for the palm oil industry in Bangka

Green Objectives (GO)	Bobot	KPI	Bobot
Environmentally friendly Garden Management	0.09	1 No protected forest land is used as plantation land	0.02
		2 Percentage of pesticide toxic content level	0.02
		3 Safe disposal of pesticide containers	0.01
		4 Forest fire prevention	0.02
		5 Irrigation practices that can minimize erosion	0.02
Minimal waste	0.06	6 CPO Amendments	0.05
		7 Moisture content in CPO	0.01
CPO storage that is able to maintain low acidity (Low FFA)	0.03	8 FFA CPO Levels	0.03
Minimization and handling of greenhouse gas emissions	0.16	9 Greenhouse gas emissions	0.07
		10 Amount of fuel use in FFB shipments	0.04
		11 Percent of emissions from POME (Palm Oil Mill Effluent)	0.03
		12 Emissions from CPO delivery to consumers	0.02
Management of ISPO or RSPO certified palm oil plantations and mills	0.29	13 Percentage of FFB from ISPO or RSPO certified farms	0.29
Minimal water use and does not interfere with people's water needs	0.07	14 Percent of water use per ton of FFB in PPKS	0.06
		15 The use of water in the garden does not interfere with the needs of the community	0.02
Waste management	0.12	16 BOD of wastewater according to standards	0.04
		17 COD wastewater according to standards	0.03
		18 Safe storage of B3 waste	0.01
		19 Utilization of liquid waste for land applications	0.02
		20 Good waste disposal	0.01



Maximise the use of new and renewable energy	0.05	21	Use of renewable energy per ton FFB	0.02
		22	Utilization of solid waste (shells and empty blanks) in exchange for fossil fuels	0.03
Consumer satisfaction related to CPO products from an environmental aspect	0.12	23	% of ISPO or RSPO certified CPO	0.12

Sumber: AHP, 2022

### III. CONCLUSION

The GSCM of the palm oil processing industry in Bangka Island based on performance indicators and process hierarchy is seen based on green objectives with the highest weight on the management of ISPO or RSPO certified palm oil plantations and mills by 29%, minimization, and handling of greenhouse gas emissions and waste management with weights of 16% and 12%. Meanwhile, the KPI with the highest weight is in the percentage of FFB from ISPO or RSPO certified plantations at 29%, ISPO or RSPO certified CPO at 12%, and greenhouse gas emissions at 7%.

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