Designing the performance measurement for sustainable supply chain of the crude palm oil (CPO) companies using lean & green supply chain management (LGSCM) approach (Case Study: Indonesia's palm oil company)

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Abstract. One of the important activities to achieve a sustainable palm oil company is by improving the sustainable supply chain management, especially being in line with the lean and green SCM concepts. The lean concept aims to reduce costs and to increase the effectiveness of the supply chain. While the green concept tries to ensure that the ongoing process keeps bringing good effect on the environment. In designing the performance measurement of the sustainable supply chain through the lean & green supply chain management approach, this study includes a formulation for Key Performance Indicators (KPI) and grouping of the lean and green indicators which are integrated with the balanced scorecard (BSC) perspectives. It obtained 28 KPIs which consists of 15 lean supply chain KPIs and 13 green supply chain KPIs. Based on overall weighting, the highest priority KPI is the company's total revenue and total operating costs, followed by the total cost of the supply chain (all of them are from a financial perspective). The weights of three KPIs are 0.103, 0.078 and 0.072 respectively.

Keywords: sustainable, palm oil, lean, green, SCM, BSC

1. Introduction

Indonesia is the world biggest producer of CPO (Crude Palm Oil). The production of Indonesia's CPO controls 48% share of the world's CPO production, with a total production had predicted to be increased from 38.5 million tons to 40.5 million tons in 2018/2019 [1]. The total production, exports, and stocks are also estimated will increase rapidly until 2050 which is dominated by plantations in Sumatra, Kalimantan and Papua [2]. Thus, one of the important aspects in developing the sustainable palm oil agriculture-industry is the supply chain management, which has an important role to ensures that the production, distribution and marketing systems will operate effectively and efficiently [2-4]. Thus, effective supply chain management could become one of the company's competitive advantages.
The concepts of supply chain management are required for activities selection in increasing the added value, fulfilling the customer needs and delivering the products to the customers as end-users [4, 5].

One of today's developing issues in the supply chain is the environmental concern. This issue has caused the consumers of various industries, including the CPO's industry, requires companies to produce and distribute environmentally friendly products throughout its various stages of their production and marketing [6, 7]. The trading of certified CPO and kernel over 2018 is significantly increased to USD 12.70 million. It becomes an indicator for increasing awareness of the CPO consumers on the environmentally friendly issue. Compared to other Asian countries producer (India, China, and Bangladesh), Indonesia's exports proportion towards various countries in Europe (Italy, Netherlands, and Germany) tend to be lower. This is due to the demands of European consumers for higher quality of the crude palm oil and guarantees for the product are produced through a series of environmentally friendly processes.

Some policies could constrain the export of CPO from Indonesia, such as since 2008, the European Union market have made requirements that any CPO products exported to the region should possess a sustainable certificate [6]. In other words, the European Union have applied many requirements related to environmental issues, such as the requirement for planting at a certain depth, not planting in infiltration basin areas, and not planting with immolating the forests and animals within. Various environmental issues related to environmental management has required the companies to manage their supply chains to be in line with the concept of Value Supply Chain and being sustainable towards the economic, social and environmental factors [8].

Several issues related to environmental management has required the companies to manage their supply chains to be in line with the concept of Green Supply Chain Management (GSCM). This concept is based on the perspective of how to reduce waste and the impact on the environment caused by the supply chain activities of the industrial companies. In addition, a concept that should be considered for supply chain performance is the Lean Supply Chain Management (LSCM). This concept aims to stream-lined the supply chain costs and reducing overall supply chain process time to increase the effectiveness towards a sustainable system [9-10]. The focus of LSCM is on optimizing the processes of all supply chains, seeking simplification, reducing waste and reducing activities that do not provide added value [11, 12].

Based on the background, integrating the performance measurement of Lean and Green Supply Chain Management will assists the company in improving its competitive advantage and to increase the productivity and effectiveness of various activities within the company [13, 14]. The model produced by this study will be very useful for companies in developing and implementing the supply chain performance measurement systems which based on the Green & Lean supply chain management (GLSCM). As a stakeholder and regulator, the government could monitor that all activities of the company's supply chain constantly provide the sustainability for the company and to ensure that the activities remain attentive to the community and the environment condition [15, 16].

The lean approach in the supply chain is one of the competitive advantage strategies for achieving sustainability in company activities. Lean is a continuous effort to eliminate waste and to increase the added value of products (goods/services) to provide value to customers [15, 16]. The focus of LSCM is to optimize the processes of all supply chains, seeking simplification, reducing waste and reducing activities that do not provide added value. The characteristics of LSCM are the supplier feedback, Just in Time (JIT) delivery by suppliers, supplier development, customer involvement, pull system, continuous flow, reduced set up time, total productive maintenance, statistical process control, and employee involvement. Thus, implementing this concept will minimize the no added value activities and enable to reduce the production costs so that productivity can be increased while keeping maintaining the product quality.

GSCM could be an innovation in implementing supply chain strategies. GSCM concept is based on an environmental context which includes activities such as reduction, recycle, and reuse and material substitution. The GSCM concept is integrating the environmental perspectives into supply chain management including product design, sorting and selecting the raw material sources, manufacturing
processes, delivering the final products to the consumers and management of expired products. Some operational functions and activities in GSCM are Green Procurement [17], Green Manufacturing, Green Distribution and Reverse Logistic [18, 19].

Thus, it is necessary to have integrated management to control the activities of the industrial supply chain in the form of performance measurement models. Likewise, in the palm oil industry, the supply chain management system is to assure and meet the customer demands including the producers, suppliers, transporters, warehouses, retailers and consumers. In this case, the producers, suppliers, transporters, warehouses, and retailers working together and coordinating in a series of activities that aimed to deliver the product to the end-users to meet their needs. It also explains that the supply chain management concept is needed by companies or organizations in selecting activities that increase the added value and meet the customer needs and delivering the products to customers as the end-users.

2. Research Method
This study is observational research in exploring various important indicators to determine the performance measurement based on Lean and Green SCM. The study was conducted on companies engaged in the CPO industry in Indonesia. Data collection was obtained through the stages of observation, interviews and expert verification. Data from observation and interviews were taken to find out the company's real condition, data of the business process of the supply chain, data of the products produced, the raw materials used and the suppliers' area of the raw material used, production processes, transportation and the marketing of the CPO. Data about the expert verification were collected to determine the weights for each indicator to obtain the KPI's priority. Then the KPIs of each LSCM and GSCM was formulated.

Furthermore, the KPI coverage was evaluated in four BSC perspectives [20]. The expert verification is needed so that the formulated KPI could be applied for performance measurements of the company's supply chain. Weighting is performed by applying a pair-wise comparison technique. Verification will continue with the validation of the performance measurements design. This study uses the Analytical Hierarchy Process (AHP) for data analysis [21]. AHP is used in weighting each KPI to determine which KPI was the higher. The KPIs with a higher weighted is a KPI who was more important than other KPIs.

3. Results and Discussion
3.1 The Supply Chain System of CPO Industry
A generic description of the CPO's supply chain system is shown in Figure 1. It shows direct involvements of several entities or parties. These parties include suppliers, manufacturers, transporters, and consumers. To make sure that all stages of production and distribution run smoothly, special supervision is needed. The objective is that each entity in the supply chain system obtains the best output. The business processes and information flow in the CPO industry can be seen in Figure 2.
3.2 Identification of Stakeholder’s Interests and Contribution

This stage tries to identify the interests and contributions of stakeholders which could be described by the stakeholders’ interests and contributions (consumers, employees, investors, regulators and the public). The stakeholder contributions can be described as follows:

a) Consumers (Profit, Growth, Opinion, Trust)

b) Employees (Hands, Hearts, Minds, Voice)

c) Investors (Capital, Credit, Risk, Support)

d) Supplier (Fast, Right, Cheap, Easy)

e) Regulators (Rules, Reason, Clarity, Advise)

f) The Public, in the form of maintaining security around the company neighborhood by promoting corporate social responsibility.

4. Identification of Key Performance Indicators (KPI)

Furthermore, the key performance indicators (KPIs) of the lean and green supply chains were identified on-demand for measuring the performance of the supply chain of CPO companies, as according to the needs of all stakeholders. Indicators related to performance measurement of the lean and green supply chain could be seen in Table 1.

5. Formulation of the Key Performance Indicator (KPI)

The KPIs as obtained on the data collection stage will be verified by the company spokesperson and the experts to determine the suitability of these indicators with the actual supply chain system. Based on the results of the experts' verification, there were 28 KPIs consists of 15 lean supply chain KPIs and 13 green supply chain KPIs. Then the verified KPI will be grouped into the balanced scorecard perspective. The KPI grouping which based on lean and green concepts can be seen in Table 2.
Table 1. Relationship between stakeholder requirements and the verified KPI

| Stakeholder Requirement and Contribution | Consumer | Employee | Investor | Supplier | Regulator | Society | KPI LGSCM-BSC |
|-----------------------------------------|----------|----------|----------|----------|----------|---------|---------------|
| Efficiency and effectiveness            |          | ✓        |          | ✓        | ✓        |         | IBL1          |
|                                        |          |          | ✓        |          |          |         | IBL5          |
|                                        |          |          |          | ✓        |          |         | IBL2          |
|                                        |          |          |          |          |          |         | IBL3          |
|                                        |          |          |          |          |          |         | IBL4          |
|                                        |          |          | ✓        |          | ✓        |         | FL1           |
|                                        |          |          |          |          |          | ✓        | FL2           |
|                                        |          |          | ✓        |          |          | ✓        | FL3           |
| Sustainability, Improvement and Innovation |          |          | ✓        |          |          |         | IBL6          |
| Quality                                |          | ✓        | ✓        |          |          |         | LGL1          |
|                                        |          |          | ✓        |          |          | ✓        | LGL2          |
| Occupational Health and Safety         |          |          |          |          | ✓        | ✓        | IBG1          |
| Environmentally friendly               |          |          |          |          |          |          | IBG2          |
| Data Safety and Reliability            |          |          |          |          |          | ✓        | IBG3          |
| Legal                                  |          |          |          |          |          |          | IBG4          |
| Corporate Social Responsibility (CSR)  | ✓        |          |          |          |          | ✓        | IBG5          |
|                                        |          |          |          |          |          |          | IBG6          |
|                                        |          |          |          |          |          |          | CG1           |
|                                        |          |          |          |          |          |          | LGL1          |
|                                        |          |          |          |          |          |          | LGL2          |
|                                        |          |          |          |          |          |          | LGG4          |
|                                        |          |          |          |          |          |          | LGG5          |
|                                        |          |          |          |          |          |          | FG1           |

Table 2. Results of Verification

| No | KPI of Lean Supply Chain | No | KPI of Green Supply Chain |
|----|--------------------------|----|---------------------------|
| 1  | Product Quality (CL1) [2][22][19] | 1  | Level of the customer interest for environmentally friendly products (CG1) [4][5][14][15] |
| 2  | Level of Customer Satisfaction (CL2) [5][19][8][13] | 2  | Consumed Energy (IBG1) [22][9][10][12] |
| 3  | Utilization of Processing Capacity (IBL1) [22] | 3  | Produced Liquid Waste (IBG2) [22][9][12] |
| 4  | Accuracy of Delivery (IBL2) [22][13] | 4  | Produced Solid Waste (IBG3) [22][9][19] |
| 5  | Total Time for Supply Chain Cycle (IBL3) | 5  | Produced Air emissions (IBG4) [22][9][19] |
| 6  | Duration of Transportation (IBL4) [22] | 6  | Use of hazardous substances (IBG5) [12] |
| 7  | The lead time of order (IBL5) [22][18] | 7  | Waste Disposition (IBG6) [22][5][9] |
| 8  | Transparency in the Business transaction (IBL6) [5][13][14] | 8  | Environmental Cost (FG1) [22][4][9][10][15] |
| 9  | Company's Total revenue (FL1) [22][18][19] | 9  | Mitigation for risk of Environmental incident (LGG1) [22][12][15] |
| 10 | Total Cost for Supply Chain (FL2) [22][18] | 10 | Availability of SOP (LG2) [12][13] |
| 11 | Total Operational Cost (FL3) [22][14] | 11 | Performed activity comply with the Laws and regulations (LGG3) [5][12][14][19] |
| 12 | Accuracy of pass documents from the supplier (LGL1) [22][14] | 12 | Relationship between the company and the surrounding neighborhood (LGG4) [4][5][14] |
| 13 | Accuracy of pass documents from the plant (LGL2) [22][14] | 13 |                              |
| 14 | Employee’s Training and Developments (LGL3) [14] | 14 |                              |
| 15 | Cost for Employee’s Training, seminar and company’s Developments (FL4) [4][5][15] | 15 |                              |
Based on the results, the grouping is performed as based on four perspectives of the Balanced Scorecard, namely financial, customer, internal business process and learning and growth perspectives. The use of the BSC method facilitates weighting and pair-wise comparisons. Furthermore, the input stage for the AHP application was a validation model (can be seen in Table 3).

All indicators for the financial perspective were the highest priority compared to the KPIs of other perspectives. The priorities of obtained KPI indicated that the performance improvements of the company's supply chain begin with increasing the company's total revenue and reducing total costs, including total operating costs and total supply chain costs. This concept required that there should be an excellent synchronization and integration with the financial aspect, which is the main concern of the company so that the company would be able continuously improving their quality and green concept. The company efforts are including increase the budget allocation for the environmental expense, to reduce the environmental impacts due to the company activities. This effort will be more integrated if performs with continuous improvements through allocating budgets for employee training and development, which are expected to improve the employee performance and productivity to enhance the quality and quantity of palm oil production.

In the perspective of internal business green (IBG), the priority is how the company could manage and maintains the produced waste that applied to the company's pounding system, were not harming
the environment or the company's neighbourhood and the business keep preserving the environment. Instead, the solid waste, liquid waste, and air emissions were expected could bring the added value to the company. Wastes from the palm oil processing industry are also generated in the form of liquid. The liquid wastes are in the form of Palm Oil Mill Effluent (POME), condensate wastewater (8-12%) and treatment residual water (13-23%). Through the engineering process, the liquid waste of palm oil could be produced into biogas, through locating the waste in a special place called a bioreactor. Besides, liquid waste can also be used for animal feed, materials for making soap and biodiesel, and the remains could be used for irrigation if it has met the quality of environmental standards.

In terms of Lean IBL concept, the KPIs that become priorities are capacity utilization and transportation time which is starting from the fresh fruit bunches harvest to the ending time of processing. Increasing the utilization of processing capacity aims to increase production quantity and resource utilization. Improving capacity utilization aims to reduce the spending expense per ton of produced palm oil. The duration for transportation from harvest to processing is tried to be less as possible, to maintain the quality of fresh fruit bunches and the quality of produced CPO. Good coordination between the plantation manager, transporter and the factory, will make the transportation activities carried out quickly, allowing for minimizing costs and maintaining quality.

In the consumer perspective, the priority indicator is the quality of crude palm oil, which requires companies to improve and maintain the quality of produced crude palm oil. Logically, good quality of crude palm oil will bring a positive impact to the company, including the increased customer satisfaction and improvements in total revenue. The level of interest of the customer in the environmentally friendly products is used as the KPI that represents the green side of the customer's perspective. This KPI is measured by finding out the percentage of consumers who are willing to pay more for environmentally friendly products and the consumer's tolerance limits to pay more for the environmentally friendly palm oil.

Based on the overall weight of each KPI, then the KPI priorities are determined from the highest weight to the lowest weight. KPI priorities can be seen in Table 4.

| KPI Code | Definition                                      | Total Weight |
|----------|-------------------------------------------------|--------------|
| FL1      | Company's Total Revenue                         | 0.103        |
| FL3      | Total Operational Cost                          | 0.078        |
| FL2      | Total Cost of Supply Chain                      | 0.072        |
| LGG2     | Activities are legal and compliance to Law and Regulations | 0.063 |
| FG1      | Environmental Cost                              | 0.059        |
| LGG1     | Mitigation of risk for Environmental incident   | 0.058        |

KPI in the highest priority is a critical KPI, which means that the KPI has a major contribution to the performance of the entire supply chain. Based on this, the company can determine the right policies to achieve the effectiveness and efficiency of its supply chain. In this study, the perspectives of financial and learning & growth are found to be priorities. It was shown by the evidence that the three KPIs in the highest weight are the total company revenue, total operating costs, and total supply chain costs. It was found that the important aspect which becomes the company's priority is achieving the target for higher profits by fulfilling the customer needs, by offering the best quality of CPO products with the best service to consumers, to minimize the costs for achieving the expected revenue. In terms of the green, the company also prioritizes to conduct the environmentally friendly processes and activities by allocating budget for environmental expense, so they will be able to treat the waste properly, to reduce the risk of environmental damage and incidents, and to reduce the risk of occupational accidents within the company.
6. Conclusions
This study has generated a set of KPIs for measuring the performance of the supply chain of the CPO with the LGSCM approach in the sustainability model. There are 28 KPIs which were the result of the LGSCM formulation, consists of 15 Lean supply chain KPIs and 13 Green supply chain KPIs. This KPI is an important indicator to measure the fulfilment of the needs of all stakeholders involved in the CPO supply chain. The indicator is based on the aspects of cost reduction and environmental impact. Grouping the KPIs into four BSC perspectives have resulting 5 KPIs for the financial perspective, 3 KPIs for the customer perspective, 13 KPIs for the internal business process perspective and 6 KPIs for the learning and growth perspective. The highest weighting KPI's is for the financial perspective as the company's total revenue (FL1) with a weight of 0.103. Thus, CPO companies are expected to be able to implement these acquired KPIs and be integrated in their business processes. The sub-indicators determination for each KPI needs to be developed, especially for determining the scale of good, bad or moderate or using a performance scale.

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