Design of Key Performance Indicators for Supplier in Sustainable Organic Farming Supply Chain

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Abstract

Suppliers have an important role in the flow of goods and services in supply chain. The demand for a sustainable supply chain encourages companies to choose suppliers who have sustainable criteria, namely economic, social and environmental. This study aims to design sustainability criteria that are important for the performance of seed suppliers for companies engaged in organic agriculture. The design of sustainable key performance indicators (KPI) begins with a literature study and is followed by interviews and validation from experts to formulate KPIs. Valid indicators are then weighted using the Analytical Hierarchy Process (AHP) to determine the level of importance of these indicators. This study found 27 indicators of sustainability, consisting of 16 economic indicators, 5 social indicators and 6 environmental indicators. The most important indicator is economy with weight (0.724), followed by social (0.193) and environment (0.083). This key performance indicator can be used as a reference for seed suppliers to manage their performance.
Keywords: Sustainable Supply Chain, Organic Farming, Key Performance Indicators (KPI), Analytical Hierarchy Process (AHP).

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1. Introduction

Sustainable Supply Chain is the management of a supply chain considering economic, social, and environmental factors, which are well managed for goods or services (Harnanda 2016). The Sustainable Supply Chain is developed by functional roles, which affect fulfillment of customer satisfaction or business interests seen from economic, social, and environmental aspects (Haghighi et al. 2016, R. Ghasemi 2016). The performance of the Supply Chain depends on the performance of its suppliers. According to (Luthra et al. 2016, Garg 2016), collaboration between suppliers and producers is required to increase the productivity of the supply chain. Measuring supplier performance is an important activity in a sustainable supply chain (Tripathi and Gupta 2019). Suppliers have an important role in improving the performance and competitive advantage of a business (Piotrowicz and Cuthbertson 2015). As reported by several researchers, the role of suppliers, especially in Sustainable Supply Chains, is still inefficient and requires to be better managed (Chen and Kitsis, 2017) (Haghighi et al. 2016, R. Ghasemi 2016).

In order to manage supplier performance, important indicators are required to be managed. Several studies regarding supplier performance indicators in the agricultural sector are not much focused on supplier performance in sustainable organic agriculture. This research identified the key performance indicators of suppliers in organic agriculture used as a reference in managing suppliers. A case study was conducted on a seed supplier of organic agriculture in Yogyakarta Province, Indonesia. Identification of key performance indicators began with literature studies and interviews with seed suppliers, and then the indicators were validated by the experts and followed by weighting the KPIs using the AHP method. This paper was prepared

as follows: first, the literature review was described, followed by the research methodology, then it was continued with the presentation of the results and discussion as well as conclusions and managerial implications.

2. Literature Review

2.1. Sustainable Supply Chain

In Sustainable Supply Chain management, resources of material, information, capital are managed and coordinated among supply chain members (Najmi et al. 2018, Mukhtar 2018), to achieve the goals of the three categories in sustainable development (economic, environmental, and social) (Ghadimi and Heavey 2014). The company realizes that carrying out sustainable practices can make the company more economical, can generate new revenue, and increase the satisfaction of employees and customers. The sustainable supply chain is defined as a form of managing operations, resources, information, and supply chain financing to maximize the productivity of the supply chain focusing on the impacts of environmental, which are fundamental to maximize social welfare and supply chain behavior between workers, clients, and communities (Leksono et al. 2018, Vanany 2018). Sustainable Supply Chain refers to a series of technical actions that can help companies achieve more sustainable economic, environmental and social perspectives (Awasthi et al. 2018, Gold 2018). An inseparable part of sustainable supply chain management is the selection of sustainable suppliers and the evaluation of their performance. Currently, many companies have considered economic and environmental performances in the process of selecting their suppliers, likewise from the social perspectives such as things related to child labor, human rights violations, and anti-corruption ethics (Bag et al. 2020, Kayikci 2020). The selection of suppliers has a very important role in achieving maximum profit. The management for selecting supplier criteria and its implementation is essential in supporting the image and legitimacy of the company if seen from the industrial perspective (Kamble et al. 2020, Gawankar 2020).

2.2. Key Performance Indicator in the Management of Sustainable Supply Chain

Key performance indicators for suppliers in a sustainable supply chain consist of 3 indicators, economy, social, and environment. The economic category consists of indicators that have a role in improving the financial and marketing performance of suppliers. The economic category focuses on the main objective of the organization, which is to increase profits as in the traditional supply chain. This can be achieved by reducing costs in several different areas or by saving time. On social category, the company has increased awareness of this category so that the company began to concentrate on issues such as security, working conditions, operations, salary, child labor, human rights, and poverty. Pressure from management and stakeholders forces the company to be socially responsible. The social category consists of indicators carried out by suppliers to participate in social activities in order to improve the welfare of employees and the surrounding community. In the environmental category, awareness of environmental damage encourages manufacturing companies and customers to be more focused on environmental protection. This encourages stakeholders in the company to ensure safe practices such as pollution control, recycling, and recovery that will have a positive impact on improving business, company image, customer attraction, and quality improvement (Chen et al. 2020, Chan 2020). The environmental category consists of indicators carried out by suppliers in promoting the reduction of environmental pollution and threats caused by waste from the environment. Based on the literature review, there are 30 indicators consisting of 17 economic indicators, 7 social indicators, and 6 environmental indicators, which are presented in Table 1.

Table 1. Key Performance Indicators for Sustainable Supply Chain

Categories and Indicators	Descriptions	Formula	References
Economy			
Delivery cost	Costs used in the shipping process	The total cost of goods/shipping costs	Haghighi et al. (2016); Tajbakhsh & Hassini (2015); Hsu et al. (2017); Wibowo et al (2017); Ahmed et al. (2016); Khan et al. (2018); Piotrowicz & Cuthbertson (2015)
Quality	Giving rate product that is free from error production and suitable to the specification required	Percentage of quality to defects	Narimissa et al. (2019); Wang et al. (2019); Tripathi & Gupta (2019); Khan et al. (2018); Piotrowicz & Cuthbertson (2015); Ghadimi & Heavey (2014);

Categories and Indicators	Descriptions	Formula	References
			Sufiyan et al. (2019); Chen et al. (2020); Pinna et al. (2018); Baba et al. (2019)
Reliability of service	Consistently providing services according to the tasks determined to satisfy those who receive services.	Percentage of services	Khan et al. (2019); Bag et al. (2020); Sufiyan et al. (2019); Tripathi & Gupta (2019); Hsu et al. (2017); Wong et al. (2018); Piotrowicz & Cuthbertson (2015); Varsei & Soosay (2014)
Capacity	Results of production or processing volumes or the number of units that can be handled, received, stored, or produced by facilities within a certain period of time.	Percentage of capacity to be achieved	Khan et al. (2018); Piotrowicz & Cuthbertson (2015); Leksono et al. (2018); Ahmed et al. (2016); Tajbakhsh & Hassini (2015)
Flexibility	Variability in product volume	The calculation with demand variance and the volume of maximum and minimum profit output over a certain period of time	Narimissa et al. (2019); Tripathi & Gupta (2019); Leksono et al. (2018); Wong et al. (2018); Khan et al. (2019); Chen et al. (2020); Sufiyan et al. (2019); Wong et al. (2018); Haghighi et al. (2016); Khan et al. (2018)
Efficiency of price	Cost savings by not reducing the costs of raw material	Percentage of price reduction to cost of goods	Tajbakhsh & Hassini (2015); Kamble et al. (2020); Chen et al. (2020); Leksosno et al (2018);Hsu et al. (2017); Elhuni & Ahmad (2017)
Warranty and return processing cost	Costs used in the product warranty	The ratio of Warranty time	Tajbakhsh & Hassini (2015); Narimissa et al. (2019)
Total response time of supply chain	The amount of time between the order made and the corresponding shipment	The difference of time between the order made and the corresponding delivery	Tajbakhsh & Hassini (2015); Bag et al. (2020); Narimissa et al. (2019)
Total time of cash	The total settlement of time in cash flow	Time ratio in cash flow	Tajbakhsh & Hassini (2015)
Cycle time of cash-to-cash	The amount of time required/investment to flow back to the company after being spent on raw materials	Number of days stock + number of unpaid sales days - the number of outstanding debts	Tajbakhsh & Hassini (2015); Wibowo et al. (2017)
Information accuracy	The level of closeness between the information value with the actual value	Amount of information accuracy	Tajbakhsh & Hassini (2015); Narimissa et al. (2019); Trimathi (2019); Harnanda et al. (2016)

Categories and Indicators	Descriptions	Formula	References
Information availability	Amount of available information obtained	Frequency of information availability	Tajbakhsh & Hassini (2015); Leksono et al (2018)
Economic value added	The number of profits generated by the company is greater than the capital invested to generate profits.	Percentage of revenue exceeds profit	Giannakis et al. (2020)
Procedures of document control	Controlling documents in conducting transaction activities	Controlling frequency	Ghadimi & Heavey (2014)
Handling the customer complaint	Complaints from customers about products or services	Total number of complaints registered	Ghadimi & Heavey (2014); Bag et al. (2020); Wong et al. (2018); Tajbakhsh & Hassini (2015)
Surveillance of Post-market	Supervision of the product before marketed	Ratio of supervision	Ghadimi & Heavey (2014)
Diversity index	Providing a variety of seeds adapted to the agricultural season	Number of seed varieties	Harnanda (2016)
Social			
Sustainability training and education for suppliers	Providing training to suppliers regarding the selection of good seeds and maintenance.	Number of training provided	Narimissa (2019); Kusrini (2018); Bravo (2017); Elhuni (2017); Wong (2018); Harnanda (2016); Ahmed (2016)
Ensuring the rights of stakeholders using smart perception technology	Organizational policies using smart technology	The percentage for the use of smart technology	Zhihua Chen (2020); Leksono (2018); Wong (2018); Ahmed (2016)
Not employing child labor	Employing child labor	Number of errors	Grover (2016)
Customer/community complaints	Complaints from customers about the product or service	Percentage of complaints to customers	Giannakis (2020); Sufiyan (2019) ; Narimissa (2019); Wong (2018)
Establishing new employment	Provide job opportunities to new employees and new partnerships towards buyers	Number of job opportunities	Narimissa(2019); Ahmed (2016)

Categories and Indicators	Descriptions	Formula	References
opportunities;			
Number of business partnerships;	Number of business partners carried out by the supplier	Number of business partnership	Narimissa (2019); Baba (2019)
Local markets	Number of products distributed to the local market	Number of markets supplied	Kamble (2020)
Environment			
Frequency of environmental violations;	Number of environmental violations committed in the process	Percentage of environmental violations	Tajbakhsh & Hassini (2015); Kusrini & Primadasa (2017)
Weather forecast accuracy	Determination of weather accuracy in agricultural activities	Percentage of weather accuracy	Harnanda (2016)
Recycling of materials	Using products collected from plants, packaging, etc., which are disassembled, separated, and processed into recycled products, components, and/or materials or reused, distributed, or sold as used without additional process.	Percentage of material recycled/reused	Grover et al. (2016); Leksono et al. (2018); Hsu et al. (2017); Wong et al. (2018); Ahmed et al. (2016); Khan et al. (2018); Tajbakhsh & Hassini (2015); Zhang & Awasthi (2014); Miranda et al. (2019)
Green and smart logistic	Number of environmentally friendly logistic environments and using smart technology	The percentage for the use of green and smart logistic	Chen et al. (2020); Wong et al. (2018); Ahmed et al. (2016)
Environmental management system	A management system that plans, schedules, implements, and monitors activities in order to environmental performance.	Percentage of environmental performance	Khan et al. (2018); Narimissa et al. (2019); Wong et al. (2018)
The use of environmentally friendly materials	The number of materials used that do not cause environmental damage or pollution	Percentage of environmentally friendly materials	Khan et al. (2018); Leksono et al. (2018); Haghighi et al. (2016); Zhang & Awasthi (2014); Ghadimi & Heavey (2014); Miranda et al. (2019)

2.3. Analytical Hierarchy Process (AHP)

In complex decision-making systems, where there are many variants of factors in terms of quantity and quality, the Multiple Criteria Decision Making (MCDM) method will be used to support the decision-making process. One method that can be used is the Analytic Hierarchy Process (AHP) method (Wolnowskaa and Konicki 2019). This method is successfully applied to problems related to technical and economic aspects. This method can be applied for selecting various suppliers,

investment projects, certain equipment to be purchased for a project, and the distribution of financial resources based on a certain budget (Aşchilean et al., 2017).

3. Methods

Design of Key Performance Indicators (KPI) was conducted in the following steps: First, a literature study was conducted to obtain the initial KPI, then interviews were conducted with 3 experts from seed and fertilizer suppliers to validate the initial KPI obtained from the literature review. Validation was performed by giving a Likert scale rating of 1-5 with 1 = strongly disagree, 5 = strongly agree to the KPI. KPIs with an average value of less than 3 were deleted. KPIs that have been validated were then weighted using the AHP method to determine the level of important indicators to supplier performance. AHP is a weighting method in decision-making that has been used by several researchers to measure supply chain performance.

4. Result and Discussion

This research focuses on the supply chain of organic agriculture, which is a grower in organic vegetable farming. In this supply chain, the company requires suppliers to supply seeds for organic vegetables. Suppliers provide seeds for the organic agriculture company. Design of performance measurement in this study can be used by suppliers to improve their performance. When the performance of suppliers increases, then consumers will be more satisfied with the performance of the suppliers, and then the sales will also increase.

In this research, the indicators were compiled from various literature focusing on sustainable supply chains. Therefore, these indicators were divided into three categories, economic, social, and environmental. The economic category consisted of indicators that have a role in improving the financial and marketing performance of suppliers. Meanwhile, the social category consisted of indicators to participate in social activities to improve the welfare of employees and the surrounding community. The environmental category consisted of indicators in promoting the reduction of environmental pollution and threats caused by waste from the environment. Based on literature study, the initial indicators obtained were 17 economic indicators, 7 social indicators, and 6 environmental indicators.

In order to proposed valid indicators, then a questionnaires consist of the proposed indicators was distributed to supplier and expert to be validated. Validation was performed by giving a likert scale rating of 1-5 with 1 = strongly disagree, 5 = strongly agree to the indicators. Indicators with an average value of less than 3 are removed from the indicator because they are considered unimportant indicators. The result of validated indicators is presented in Figure 1 which consist of 16 economic indicators, 5 social indicators, and 6 environmental indicators. After obtaining validated indicators, then these indicators are analyzed using the AHP method to determine the level of important to supplier performance. Suppliers and experts were given a questionnaire containing pairwise comparisons for AHP analysis and the results were given in Table 2.

Figure 1. The validated conceptual framework of KPIs for supplier

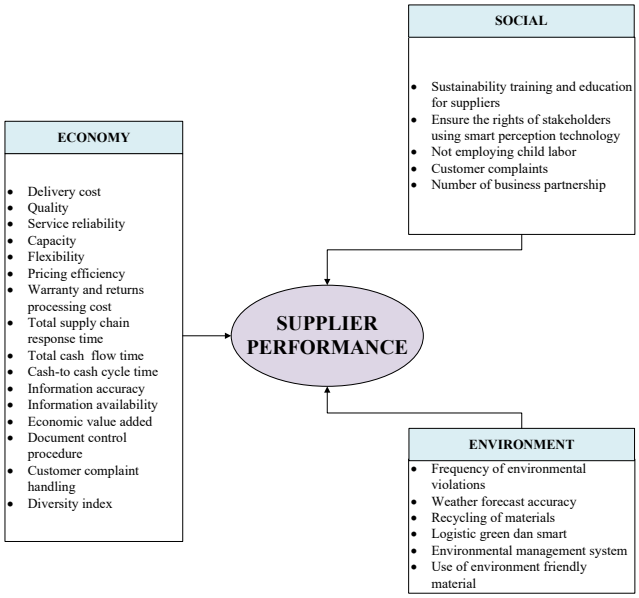

Table 2. The important weight of sustainable sub- criteria

Sub criteria ECONOMY (0,724)	Weight	Sub criteria SOCIAL (0,193)	Weight	Sub criteria ENVIRONMENT (0,083)	Weight
Quality	0.176	Customer/community complaints	0.359	Frequency of environmental violations	0.232
Cycle time of Cash-to cash	0.139	Not employing Child labor	0.322	Recycling of materials	0.232
Reliability of Service	0.107	Number of business partnerships	0.188	Environmental Management System	0.232
Pricing efficiency	0.093	Sustainability training and education for suppliers	0.094	The use of environmentally friendly materials	0.232
Procedures of Document Control	0.086	Ensuring the rights of stakeholders using smart perception technology	0.037	Weather forecast accuracy	0.044
Capacity	0.08	Total	1.000	Green and smart logistic	0.029
Warranty and returns processing cost	0.07			Total	1.000
Flexibility	0.061				
Total response time of supply chain	0.045				
Handling Customer Complaints	0.034				
Price information	0.03				
Information availability	0.02				
Information accuracy	0.019				

Delivery cost	0.016				
Diversity index	0.013				
Economic value added	0.011				
Total	1.000	Total	1.000	Total	1.000

Based on the importance weight, it shows that the sustainable supply chain category with the highest importance weighting is the economy (0.724), followed by social (0.193), and environment (0.083). This is in line with the results of research conducted by (Kusrini and Primadasa 2018), which explained that in the palm oil industry, the most important criteria in sustainable supply chains is economy, followed by social and environmental criteria.

4.1. Economy

Indicators with the high importance weights in economy criteria are quality (0.176), cash to cash cycle time (0.139), service reliability (0.107). Product quality has the most important weight because it has significant influence to consumers. Products with good quality will be able to increase company reputation, which will have an effect on the number of product sales as well as increased profits. The results of research conducted by (Narimissa et al. 2019) explained that the economy is the most important criteria in measuring performance in an oil and gas company in Iran. Meanwhile, base on research conducted by (Khan et al. 2018), there were three indicators contribute to improving supplier performance,i,e, quality, delivery, and flexibility. This research in line with study conducted by (Wang et al. 2019) that quality is important in determining suppliers for fresh agricultural products. Moreover, (Piotrowicz and Cuthbertson 2015) explained that quality indicators are important to be considered in a supply chain. Based on the studies, it can be concluded that quality becomes the important indicator to be considered on economic criteria in various types of industries.

4.2. Social

Indicators with the high importance weights in social criteria are customer complaints indicators (0.359), not employing child labor (0.322), number of business partnerships (0.188), sustainability training, and education for suppliers (0.094) and ensuring the rights of stakeholders using smart perception technology (0.037). These indicators are in line with other study conducted by previous researchers. The research conducted by (Narimissa et al. 2019) explained that social criteria are the important factor to be considered in measuring performance in an oil and gas company in Iran. Furthermore, research conducted by (Giannakis et al. 2020) explained that indicators on social criteria that affect supplier performance with the highest weight are health and safety incident rate, customer/community complaints, and social investment in the community. Research conducted by (Wong et al. 2017) showed that customer complaints are one of the indicators that affect supplier performance on social criteria in the health care industry. Those studies indicate that the customer complaint indicator has a very important impact on the measurement of supplier performance.

4.3. Environment

Indicators with the high importance weights in social criteria are frequency of environmental violations (0.232), recycling materials (0.232), environmental management system (0.232), and the use of environmentally friendly materials (0.232). Environmental criteria are the important things in the measurement of performance in an oil and gas company in Iran (Narimissa et al. 2019). In contrast, the research conducted by (Kusrini and Primadasa 2018) explained that in environmental criteria, the influential indicators are the use of energy and water. The research conducted by (Khan et al. 2018) showed that the indicator of the use of environment-friendly materials for environmental criteria in a car assembly company is the most important indicator. Base on the research conducted by other researcher, it can be concluded that indicators in this study are in line with previous study.

5. Conclusion

This study was conducted by designing indicators for supplier in organic farming. The conceptual framework was developed by integrating sustainable supply chain aspects, economic, social, and environment. The results of the indicators can be used to evaluate the performance of suppliers, especially seed suppliers for organic farming. This study shows that a sustainable supply chain can produce an appropriate indicators as a basis for measuring and evaluating supplier performance. Indicator quality is the most important in economy, while customer complaint and frequency of environmental violations are indicator need to be considered the most in Social and Environment. Even though this research was conducted in organic farming, the results can be generalized to other suppliers in agriculture and other fields.

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