Sustainable Criteria in Supplier Evaluation of the Food Industry

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Abstract. Sustainability is an important issue lately. In the current era of globalization, competition between companies is getting tighter. Supplier selection has been identified as one of the most important issues in a sustainable supply chain. Caused by environmental and social problems with suppliers, many companies have used sustainability criteria in the evaluation and selection of their supplier. This study aims to develop the most important and applicable criteria and sub-criteria suitable for sustainable supplier selection through literature review, and how alternative strategies for sustainable suppliers in supply chain management from the food industry. This research has contributed to the research on sustainable supply chain management, especially in the selection of sustainable supplier selection by developing a list of criteria and sub-criteria for sustainability and how the company can apply the criteria with three aspects, namely economic, environmental and social in supplier evaluation. So, alternative strategies for a sustainable supplier in supply chain management can be explained.

1. Introduction

Companies are not only responsible for their internal practices, but also for their supplier behavior [1]. Sustainability is an important issue lately. In the current era of globalization, competition between companies is getting tighter. Consumers no longer only want quality products, but also demand good and timely service. In global supply chains, environmental and social issues are reported almost daily by news outlets and the media [2]. Due to legal and regulatory demands, consumer demand, and stakeholder responses, sustainability are increasingly being considered by companies, and some companies have applied supplier ratings to environmental and social criteria [3].

Efficient Supply Chain Management (SCM) benefits the company by increasing competitive advantage, reducing production risk, reducing supply chain risk, optimized inventory levels, increasing revenue, increasing customer service, and increasing customer satisfaction and profitability [4]. Applying three aspects of sustainability, those are economic, environmental and social in sustainable supply chain activities are very essential for the company. But, if companies in the supply chain misbehave related to sustainability, there will be consequences for the entire supply chain system. In China [5], fast food companies such as McDonald and Kentucky Fried Chicken, have been criticized for using expired materials from their suppliers, overuse of antibiotics, poor employee salaries, and poor working conditions. In Chicago[6], McDonald's low-wage workers protested, asking for salary increases against McDonald's management. These employees also regret the attitude of management who is
considering for raising the salary of company executives. In India [7], fast food restaurants McDonald's plans to close 169 outlets spread across northern and eastern India. This step was taken because of a dispute with its local partners and has the potential to cause thousands of workers to become unemployed.

Many companies have begun to implement sustainable supply chain management (SSCM) and choose suppliers that are environmentally and socially responsible for competitive new market conditions. Governments, non-governmental organizations, industry groups, and other social organizations show awareness and care that continues to increase for how all companies in the supply chain handle environmental, health and workers' rights issues, and other social issues [8]. In the food industry, consumers are increasingly aware of choosing healthier ones and at reasonable prices. In addition, the government and the public hope that food companies will control emissions and pollution of transportation fuels and improve working conditions and the welfare of workers' rights. To meet the expectations and requirements of consumers, investors, shareholders and the government, many companies attach great importance to environmental and social aspects in the supplier evaluation and selection process. Implementing SSCM and turning it into an environmentally and socially responsible organization are important strategic decisions for food companies [9].

Supplier selection has been identified as one of the most important issues in a sustainable supply chain [10]. Caused by environmental and social problems with suppliers, many companies have used sustainability criteria in the evaluation and selection of their suppliers. Based on research [11] states that the right supplier selection is a difficult problem in supply chain management because it includes criteria and decision-making methods that are characterized by uncertainty and complexity. This study aims to develop the most important and applicable criteria and sub-criteria suitable for sustainable supplier selection through literature review, and how alternative strategies for sustainable suppliers in supply chain management from the food industry.

2. Research Method

In this research, we use study literature to collect data and evaluation of sustainable criteria in supplier selection for food industry supply chain. Criteria and sub-criteria are taken according to aspects such as economic, social and environmental. Data analysis and creating sustainable criteria in selecting suppliers with case studies of food industry applications in Indonesia. The literature study was conducted on five methodological steps [12], as illustrated on figure 1.

![Figure 1. Research Method](image)

The collecting data process was started with semi-structured interview, browsing documents/articles in Scopus database, information from the homepages, and published sustainability reports through the search field of title, abstract, and keyword which discussed about SSCM. The collecting data process was continued by reading the abstract of the every article. Then from those articles, it could be done the dimensional analysis of three aspects sustainability, those are economic, environmental and social that related to developing the most important and applicable criteria and sub-criteria suitable for sustainable supplier selection.

3. Result and Discussion

This section consists of discussion on sustainable criteria in supplier selection with case study food industry supply chain, data analysis and making alternative strategies in implementing sustainability programs to improve the quality and productivity of environmentally friendly food or Agri-food production.

3.1. Review of Sustainable Supply Chain
About the definition of S-SCM, Seuring and Mueller [4] defines s-SCM as "material management, information and capital flows, as well as cooperation between companies in the entire supply chain, coincide with taking the objectives of the three aspects of sustainable development, namely, economic, environmental and social, into the account derived from the needs of consumers and stakeholders". According to comparative research [13], sustainable supply chain management is the development of green supply chain management and combining environmental and social aspects of sustainability. According to [14] states that the goal of a sustainable supply chain is to combine economic, environmental and social goals into the organization through regular coordination of key business processes to improve business and profitability. Figure 2 shows the causes of sustainable supply chain management.

![Figure 2. Causes of Sustainable Supply Chain Management.](image)

In the beginning was pressure and additions from external parties set by various groups. While stakeholders form the broadest possible description, two groups have special relevance. On the other hand, consumers are very important, because the supply chain is only justified if the products and services can be accepted by customers. Besides, all government regulations, whether from the local city government, national or multi-national government, have great relevance. Based on these factors, various strategies can be identified, namely how companies deal with existing issues. Based on this, two strategies are "supplier management for risk and performance" and "supply chain management for sustainable products".

3.2. Data Analysis
One of the main problems in the supplier selection evaluation process is choosing the right criteria and sub-criteria. Criteria for sustainable supplier selection are determined based on three aspects, namely economic, environmental and social. According to research [15] suggested that the most widely used criteria for supplier selection were price, quality, delivery, service, technology, manufacturing capability, management, research and development, finance, flexibility, reputation, communication, risk, and individual safety. In the environmental aspect [16], a literature review was conducted and showed that the environmental management system is a criterion that is widely used in terms of the environment, followed by a green image, design for the environment, environmental performance, environmental improvement costs, green competence, ISO 1400, green products etc. For the social aspect, the criteria that can be summarized are discriminatory, workers' rights, working hours, information disclosure, health and safety, stakeholder rights, work practices [17][18][19].

Empirical research [20], explains that quality, price, and reliability are three important elements in SSCM's performance. To evaluate the performance of potential suppliers, several criteria can be measured and adopted in supplier selection based on procuring on reference supply chain operations. Competitive prices and cost control that effectively represent the financial health of the company. Reliable quality, efficient delivery system, and technological capacity, including purchasing, R & D, manufacturing and distribution processes [16]. Improved green image and socially responsible behavior state the company's environmental and social benefits [21]. In addition to traditional evaluation criteria such as cost, quality, delivery, and technology, companies must pay attention to the following criteria
that we included in this study as contributing factors in the selection criteria for environmentally and socially responsible suppliers. Table 1 summarizes the criteria and subcategories and related studies.

Table 1. Criteria and Sub criteria in Sustainable Supplier Selection

| Category          | Criteria                        | Sub Criteria                                                                 | Indicator                                                                                     |
|-------------------|---------------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| Economy           | Purchasing cost                | Price of goods                                                              | The price of goods considers the quality of the material and services offered by the supplier. |
|                   | [22][23][24]                   | Logisitics costs                                                            | The supplier's ability to provide prices that are in line with the logistics costs of raw materials. |
|                   |                                 | Terms of payment                                                            | Suppliers can make it easy for payment terms.                                                |
| Quality           | ISO quality identification     | Maintenance and rejection rate                                              | Quality is the most important factor in choosing the right supplier for the company to increase customer satisfaction, improve reputation, and gain consumer trust. |
|                   | [22][24][26][27]               | Total quality management (TQM)                                              | The ability of suppliers to be able to produce raw materials with defects that are minimal to zero. The ability of suppliers to overcome and minimize the occurrence of defects in products to the hands of consumers. |
| Delivery          | On-time delivery rate          | Accuracy of delivery                                                        | The ability of the supplier to be able to send raw materials in a timely manner with a schedule determined by both parties. Delivery accuracy is an important factor and very significant influence on supplier selection, the company will choose suppliers that deliver goods with faster delivery times and better accuracy. |
|                   | [22][30][31]                   | After sales service                                                         | Services provided by suppliers after the company purchases raw materials.                    |
|                   |                                 | Lead time flexibility                                                       | The ability of the supplier to be able to send the right raw materials with the time of ordering and shipping of goods that have been determined by both parties. Supplier performance indicators can be seen from the percentage of the fulfilment of requests for changes in raw material delivery time. |
|                   |                                 | Time to solve the complaint                                                | This sub-criterion assesses how fast and good the service from suppliers is to complaints from the company. The supplier has good ability in responding to complaints, changing delivery times, changing order quantities, and being able to provide solutions if problems are found. The supplier can give a price discount to the company when ordering large quantities of raw materials._supplier flexibility in changing the delivery time requested by the company, suppliers still fulfil the ability to deliver on time according to the agreement with the company. |
| Flexibility       | Flexibility in discount        | The flexibility of delivery time                                            | The supplier must provide good service if one day the company changes the order amount.     |
|                   | [33][34]                       | Flexibility in ordering                                                    |                                                                                              |
| Environmental     | ISO-14001 certification         | Environmental Performance Evaluation                                        | This sub-criteria discusses environmental management systems, has environmental certifications such as ISO-14001, sustainable control, environmental policy, environmentally friendly process planning, and organizational control processes. The ability of suppliers to always evaluate good environmental performance measurements in order to reduce the environmental impacts that arise in the future. Check from the aspect of suppliers using eco-labels for their products or not. This attribute encourages suppliers to have good environmental performance. |
| Management System | [35]                           | Eco-Labelling                                                              | ISO-14001 certification                                                                      |
| Environment | Green products [39] | Environmental Performance Evaluation [40] |
|-------------|---------------------|----------------------------------------|
|             | Pollution [39][44][45] | Quantity control and effort on the impact of harmful emissions, such as SO2, NH3, CO and HCl. |
|             | Wastewater [44][45] | Efforts to control the quantity and treatment of wastewater. |
|             | Hazardous waste [45] | Management of hazardous waste in accordance with procedures and rules, minimizing pollution related to hazardous waste. |
|             | Inventory of non-hazardous substances [46] | The supplier has good inventory management so that it can meet the demand, type and quantity of goods desired by the company. |
|             | Inventory of substitute material [47] | The level of warehouse management can prevent material mixing and maintain product quality. |
|             | Warehouse management [47] | Suppliers must use an eco-efficient transportation fleet to reduce pollution caused by product transportation. |
| Environment | Green warehousing [46] | Suppliers must use environmentally friendly fuels with low sulfur content to reduce pollution caused by product transportation. |
|             | Using a modern eco-efficient transportation fleet [42] | This sub-criteria explain the use of materials in components that have a lower impact on natural resources. |
|             | Using Green fuels [42] | Suppliers must respect religious and cultural issues at work such as the time to pray for workers. |
| Environment | Green transportation [46] | R & D capability of suppliers to meet current and future needs and help improve product quality for the company. |
|             | Materials used in the supplied components that reduce the impact on natural resources [39] | The ability of the supplier to cooperate with research institutions. |
|             | R&D capacity [36][39] | The supplier must have a clear contract with the worker. This attribute is a supportive action for workers, which has an impact on increasing worker satisfaction. |
|             | Cooperation with research institutions [27][39][48] | Suppliers must provide employment insurance for workers. Employment insurance increases employee satisfaction. |
| Social      | Workers’ rights [49][50] | Suppliers must be responsible for their workers. This is a supporting activity that encourages workers with higher work efficiency. |
|             | Contract [49][51][52][53] | Standard working hours are normal and regular working hours for workers. This is a supporting activity that encourages workers to work with higher work efficiency. |
|             | Employment insurance [49][50][51] | Suppliers must pay workers’ salaries for overtime, which works beyond standard working hours. |
|             | Employment compensation [49][50][51] | Suppliers must cover the cost of health insurance for workers in the workplace. This attribute is a supportive action for workers that increase employee satisfaction. |
|             | Standard working hours [49][50][51] | To prevent and reduce accidents and protect the health of workers, they must be trained in the workplace. This attribute increases the level of security at work. |
|             | Overtime pay [49][50][51] | The availability of safety management in a company is not enough to support the work safety, so this needs to be supported by providing equipment facilities and a safe workplace for workers. |
|             | Health insurance [49][50][51] | There is no difference between male and female workers for growth in the workplace. The more discrimination, the more dissatisfied workers. Works must be paid according to labor laws. Paying according to statutory regulations causes workers to feel satisfied. So, their performance increases at work. |
| Social      | Health and safety at work [49][50][51] | Suppliers must respect religious and cultural issues at work such as the time to pray for workers. |
|             | Training for safety at work [49][50][51] | Workers must be paid according to labor laws. Paying according to statutory regulations causes workers to feel satisfied. So, their performance increases at work. |
| Social      | Supportive activities | Suppliers must respect religious and cultural issues at work such as the time to pray for workers. |
|             | Providing appropriate equipment at work [49][50][51] | Suppliers must respect religious and cultural issues at work such as the time to pray for workers. |
|             | Discrimination [49][50][51] | Suppliers must respect religious and cultural issues at work such as the time to pray for workers. |
|             | Wages [49][50][51] | Suppliers must respect religious and cultural issues at work such as the time to pray for workers. |
3.3. Alternative Strategies for Sustainable Supplier in Supply Chain Management

In this case, the selection of suppliers globally is strategically important (in terms of supply chain and organizational performance) but is a problem of complex decision making [55]. This research supports companies and recommends evaluating suppliers by using economic, environmental and social criteria.

Food companies or agrifoods, in particular, can use sustainable supply chain criteria and indicators that can improve their suppliers' evaluation efforts. Companies must use environmental and social criteria in the supplier evaluation process to ensure legal and regulatory demands, responses to stakeholders and customer demands. Furthermore, companies can use sustainability criteria to achieve competitive market excellence by reporting the results of good supplier evaluations to the public. The results show that the resources available in the company play an important role in determining the level of sustainable supplier evaluation. Therefore, companies must incorporate aspects of sustainability into company objectives and provide appropriate resources for environmental and social supplier evaluations.

Based on the issues emerging in this field, can be planned for alternative strategies for a sustainable supplier in food or agrifoods supply chain management.

![Figure 3. Supplier Management for Risks and Performance of Supply Chain.](image3)

![Figure 4. Supply Chain Management for “Sustainable” Products.](image4)

This study has looked extensively at sustainable supply chain management, especially in evaluating supplier selection. This offers conceptualization (seen in figures 2–4) based on a literature review. Often, the cause of the external aspect is prioritized which is placed on the company by regulating agents, customers, and stakeholders. Such pressure can lead to actions that will be carried out by the company.

To develop sustainable product, we need two strategies. The first is 'supplier management for risk and performance'. One of the main problems in the company that follows this strategy is the loss of the company's reputation if a related problem arises. Therefore, environmental and social criteria are used to complete supplier evaluations based on conventional criteria. Environmental and social standards play an important role in sustainable supply chains. The second strategy is 'supply chain management for sustainable products'. This requires a definition of the product lifecycle-based standards for environmental and social performance, which is then implemented throughout the supply chain.
The criteria and sub-criteria that can be seen in Table 1 can be used for implementation in supplier evaluations to assess compliance with the requirements. Furthermore, criteria and sub-criteria can be used, for example, in assessments to evaluate the environmental and social performance of suppliers. Furthermore, companies can use the results of supplier evaluations in measuring sustainability performance and in sustainability reports to their stakeholders.

### 4. Conclusion

This research has contributed to the research on sustainable supply chain management, especially in the sustainable supplier selection by developing a list of 12 criteria and 42 sub-criteria for sustainability and how the company can apply the criteria with three aspects, namely economic, environmental and social in supplier evaluation. Alternative strategies for sustainable suppliers in supply chain management can be explained, the first is 'supplier management for risk and performance', the second strategy is 'supply chain management for sustainable products'. Furthermore, companies can use the results of supplier evaluations in measuring sustainability performance and in sustainability reports to their stakeholders.

### References

[1] Koplin J, Seuring S, Mesterharm 2007 M. J Clean Prod. 151053-1062.
[2] Freise M, Seuring S. 2010 Logistics Research 8 1-12.
[3] Seuring S, Müller M J 2008 Clean Prod 16 1699-1710.
[4] Chang B, Chang C W, Wu C H 2011 Expert Syst Appl 381850–1858.
[5] Financial Times 2014 [internet] Available from: ft.com.
[6] Liptutan 6 2014 [internet] Available from: liputan6.com.
[7] Liptutan 6 2014 [internet] Available from: liputan6.com.
[8] Banaeian N, Mobli H, Fahimnia B, Nielsen IE, Ormid M 2018 Comput Oper Res. 89 337–347.
[9] Chkanikova O, Mont O. 2015 Corp Soc Resp Env Ma 22 65–82.
[10] Sarkis J, Dhavale D G 2015 Int J Prod Econ. 166177–191.
[11] Tseng ML, Chiang J H, Lan LW.2009 Comput Ind Eng. 57 330–340.
[12] Tranfield D, Denyer D, Smart P. 2003 Brit J Manage. 14 207-222.
[13] Ahi P, Searcy C. 2013 J Clean Prod. 52 329–341.
[14] Gracia MD, Quezada L E. 2016 Economic Research and Electronic Networking 17 3–27.
[15] Ho W, Xu X, Dey P K. 2010 European Journal of Operational Research 202 16–24.
[16] Govindan K, Rajendran S, Sarkis J, Murugesan P 2015 J Clean Prod 98 66–83.
[17] Azadi M, Jafarian M, Saen R F , Mirhedyatian S M. 2015 Comput Oper Res 54 274–285.
[18] Ghadimi P, Heavey C. 2014 Journals Procedia CIRP 15 165–170.
[19] Mani V, Agarwal R, Sharma V. 2014 Int. Strategic Management Review 2 98–112.
[20] Ageron B, Gunasekaran A, Spalanzani A 2012 Int J Prod Econ. 140 168–182.
[21] Sreekumar V, Rajmohan M 2018 Sustain Dev 27 1-11.
[22] Weber CA, Current J R, Benton W C 1991 Eur J Oper Res. 50 2–18.
[23] Lee K H, Kim J W. 2011 Bus Strateg Environ. 20 27–538.
[24] Fallahpour A, Olugu E U, Musa S N, Khezrimotlagh D, Wong K Y 2016 J Neural Computing and Applications 27 707–725.
[25] Sutopo W, Bahagia S N, Cakravastia A and Arisamadhi TMA. 2012 ITB Journal of Engineering. 44128-147.
[26] Ronen B, Trietsch D. 1988 J Operations Research. 36 882–890.
[27] Chen H M W, Chou S Y, Dat L Q, Yu T H K 2016. J Math Probl Eng 61–10.
[28] Feyzioglu O, Bıyıközkän G 2008 MCDM Lecture notes in economics and mathematical systems 63145–154.
[29] Grisi R M, Guerra L, Naviglio G. 2010 Business Performance Measurement and Management 149–163.
[30] Muralidharan C, Anantharaman N, Deshmukh S G. 2001 Int. J. Oper. Prod. Manag 21305–1326.
[31] Govindan K, Sivakumar R. 2016 Ann. Oper. Res. 238 243–276.
[32] Yan G. International Conference on Signal Processing Systems. IEEE.2009:615-619.
[33] Yang Y Z, Wu L Y. 2008. Int. Conf on Wireless Communications, Networking and Mobile Computing (China/IEEE) pp 1-4.
[34] Yang Y Z, Wu L Y. 2007 Int. Conf on Wireless Communications, Networking and Mobile Computing (China/IEEE) pp 4682-4685.
[35] Tseng M L. 2011 Appl Soft Comput 11 4894–4903.
[36] Chen C C, Tseng M L, Lin Y H, Lin Z S. 2010 Int Conf on Industrial Engineering and Management (Management) (China/IEEE) pp 260-264.
[37] Chiu C Y, Hsu C W, Hwang W Y. 2008 Int Conf on Industrial Engineering and Engineering Management (Singapore/IEEE) 1909-1914.
[38] Humphreys P, McCloskey A, McIvor R, Glackin C. 2006 Int J Prod Res. 44 2379–2419.
[39] Lee A H, Kang HY, Hsu C F, Hung H C. 2009 Exp Syst Appl 36 7917–7927.
[40] Thongchattu C, Siripokapirom S. 2010 Int Conf on Mechanical and Electronics Engineering (IEEE) p 313.
[41] Mahmood W H W, Rahman M NA, Deros B M, Jusoff K. 2013 World Applied Sciences Journal. 21 76–84.
[42] Awasthi A, Chauhan S S, Goyal S. 2010 Int Prod Econ. 126 370–378.
[43] Bıyıközkän G, Çifçi G. 2011 Comput Ind 62 164–174.
[44] Humphreys P, McIvor R, Chan F. 2003 Exp Syst Appl 25 141–153.
[45] Humphreys P K, Wong Y K, Chan F T S. 2003 J Mater Process Tech 138 349–356.
[46] Rostamzadeh R, Govindan K, Esmaeili A, Sabaghi M. 2014 Ecol Indic. 49 188–203.
[47] Hsu C W, Hu A H. 2007 Int Conf on Application of Analytic Network Process on Supplier Selection to Hazardous Substance Management in Green Supply Chain Management (Singapore/ IEEE) pp 1352-8
[48] Andersen M, Skjoett-Larsen T. 2009 Int. J. Supply Chain Manag. 14 75–86.
[49] Cowpersmith A, Grosbois D D. 2011 J Sustain Tour. 19 59–77.
[50] Bohdanowicz P, Zientara P. Scandinavian Journal of Hospitality and Tourism . 2008;8:271–293.
[51] Fallahpour A, Olugu E U, Musa S N, Wong K Y, and Noori S. 2017 Comput Ind Eng 105 391–410.
[52] Wahyuadin R S, Sutopo W, Hisjam M, Yuniaristanto, and Kurniawan B. 2015 Lect Notes Eng Comp. 2 877-882.
[53] Sutopo W, Hisjam M, Yuniaristanto, Kurniawan B. 2013 World Congress on Engineering (London/IAENG) I pp. 732-736.
[54] Tseng ML., Chiang J H and Lan LW. 2009 Comput Ind Eng. 57 330–340.
[55] Chan F T S, Kumar N, Tiwari M K, Lau H C W, Choy KL. 2008. Int J Prod Res.46 3825-3857.