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Sustainable and resilient supplier selection: the case of an Indonesian coffee supply chain

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Abstract – Supplier selection has become one of the core elements of supply chain management because suppliers affect a company's bottom line and supply chain performance directly. Supplier selection is a complex decision-making process that includes multiple criteria and a set of supplier alternatives. This study integrates the dimensions of sustainability and resilience into the supplier selection process. The aim is to propose a systematic supplier selection framework to help companies categorize suppliers based on their sustainability and resilience performance and select the ones that perform well on those two dimensions. We use a novel multi-criteria decision-making method (MCDM), the Best-Worst Method (BWM), to solve the complex decision-making process of coffee supplier selection in a local roastery in Indonesia. The data was collected from two groups: experts regarding the coffee supply chain in Indonesia and a decision-maker at a coffee roastery in Indonesia. The result shows that the economic criteria for sustainability performance and risk reduction criteria for resilience performance are the most important supplier selection criteria for both groups. There are no significant differences between the importance evaluations of criteria by both group of experts, which indicates that the supplier selection process of the company aligns with the expert perspective.

Keywords: Supplier Selection; Sustainable Supplier; Resilient Supplier; Multi-criteria Decision- Making Method; Best-Worst Method; Coffee Roastery; Indonesia Coffee Supply Chain.

1. Introduction

Since Dickson's study on vendor selection criteria in 1966 (Cheraghi et al. 2004), there has been ample academic attention to the concept and process of supplier selection. Integration with the right supplier has been a key factor in supply chain optimization, to reduce lead time, production cycle time, and inventory costs (Chen and Paulraj 2004, Cheraghi et al. 2004, Lambert and Cooper 2000). In addition, suppliers can directly impact a company’s profitability, with raw materials or components possibly costing more than 50% of a company’s revenues (Cheraghi et al. 2004, Weber et al. 1991). That means supplier selection is a strategic decision in supply chain management (Bai and Sarkis 2010, Rashidi et al. 2020).

Multiple objectives, supplier selection criteria, and methods have been proposed to support supplier selection decisions (Wetzstein et al. 2016). While most research has focused on the economic performance of suppliers, recent trends have shown a growing interest in their performance involving sustainability and resilience (Rajesh 2021, Rajesh and Ravi 2015, Rashidi et al. 2020, Wetzstein et al. 2016). Governments, NGOs, and consumers pressure companies to develop a more sustainable supply chain that extends their responsibility to their supplier operations (Rajesh 2021, Rashidi et al. 2020, Seuring and Müller 2008). Additionally, since disruption in a supplier’s operations can have a catastrophic effect on their business operations, companies need to select resilient suppliers to reduce their vulnerability to supplier-related risks (Rajesh and Ravi 2015, Torabi et al. 2015).

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Combining the performance regarding sustainability and resilience in supplier selection is complex, since there may be a trade-off between the two (Fahimnia and Jabbarzadeh 2016, Ivanov 2018). Sustainable suppliers offer some advantages, such as increasing a company's sustainability-related performance (Rashidi et al. 2020), increasing compliance with stakeholders and reducing government pressure (Seuring and Müller 2008b). However, it may also make companies more vulnerable to supplier-related risks, since they invest in and rely more on a few selected suppliers (Werff et al. 2018).

A highly resilient supplier with operational flexibility, on the other hand, may allow companies to adjust their operation quickly state when disruption occurs because of unexpected risk (Rajesh 2021). In addition, companies might increase their acceleration to recovery when they have a resilient supplier (Torabi et al. 2015). However, highly resilient suppliers may lean toward economic performance, trading off social and environmental performance. They may also be more costly and less efficient due to buffer-related redundant operations, e.g., inventory, factory, suppliers. To select a sustainable and resilient supplier, companies need to set their supply chain objectives and align their supplier selection criteria accordingly. Therefore, a systematic supplier selection framework is needed to consider multiple criteria and solve the complexity in the supplier selection problem. Earlier studies used Multiple Criteria Decision-Making (MCDM) method to solve complex decision-making processes in the supplier selection process (Lajimi et al. 2021, De Boer et al. 2001, Schramm et al. 2020). The heuristic structure in MCDM simplifies the supplier selection process when the decision-maker is faced with multiple supplier alternatives and considers compensatory factors (Zhan et al. 2021).

Although there has been extensive research into supplier selection using the MCDM method, research into sustainable and resilient supplier selection requires more attention. Firstly, many earlier studies only incorporate two aspects of sustainability: the environmental and social aspect (Jabbarzadeh et al. 2018, Luthra et al. 2017, Rashidi et al. 2020, Wetzstein et al. 2016). At the same time, sustainable supply chain management (SSCM) framework suggests that sustainability should use a triple bottom line approach, which incorporates environmental, social, and economic aspects (Carter and Rogers 2008, Seuring and Müller 2008b). Secondly, incorporating sustainability and resilience performance simultaneously in supplier selection is still in its infancy, since the relationship between the two factors is as yet inconclusive (Kaur and Singh 2019, Rajesh and Ravi 2015, Zavala-Alcívar et al. 2020). As such, this study contributes to supplier selection research by developing a supplier selection framework to select suppliers based on their performance in the areas of sustainability and resilience. We used a novel MCDM, Best-Worst Method (BWM), to solve the complexity in the supplier selection decision-making process.

This research applies the proposed framework in the real case of a local roastery in the Indonesian coffee supply chain, which allows us to present managerial implications as well, while most studies in this area use theoretical examples (Rashidi et al. 2020). In some studies, real case examples have been used, in the automotive, electronics, textile (Banaeian et al. 2015, Rashidi et al. 2020), and agri-food industries (Banaeian et al. 2015, 2018, Rezaei et al. 2016, Wang et al. 2021). However, studies examining the coffee sector are rare and those that did, did not incorporate sustainability and resilience performance, focusing instead on economic factors (Saputra and Novita 2021, Siregar 2019).

Having said that, Indonesia’s domestic coffee market is substantial globally and has grown remarkably in the past five years (Normala 2018, Nurhayati-Wolff 2021). The local roastery we discuss in this study is at the heart of this growing market, since it provides freshly roasted coffee to the domestic market. Selecting sustainable and resilient suppliers has become increasingly important, since the company needs a competitive supply chain to keep up with the increasing domestic coffee demand.

The remainder of this article is organized as follows. A literature review regarding sustainability and resilience performance in supplier selection is presented in Section 2. The proposed supplier selection framework and methodology are explained in Section 3. In Section 4, the proposed supplier selection framework is applied to Indonesia Coffee supply chain. In this section, data is collected from a sample of experts and a decision maker at case company to finally analyze them using the Best-Worst Method (BWM). The conclusions of the paper are presented in Section 5.

2. Literature Review

There has been a shift from a bid-and-buy approach to a more collaborative approach with the selected supplier (Cheraghi et al. 2004, Ho et al. 2010, Lambert and Cooper 2000). Integration with selected suppliers is key to a successful supply chain management (Chen and Paulraj 2004, Lambert and Cooper 2000, Mentzer et al. 2001). This integration allows companies and suppliers to improve their inventory planning and make their logistics more efficient. It has been suggested that integration allows for supply chain visibility, and thus creates supply chain resilience (Christopher and Peck 2004). As such, supplier selection is critical strategic decision in supply chain management which can protect the overall supply chain performance and competitive position of a company.

There has been a substantial research into supplier selection (Govindan et al. 2015, Rashidi et al. 2020, Wetzstein et al. 2016). Several studies have focused on assessing and determining which methods are commonly applied and suitable to solve supplier selection problems (De Boer et al. 2001, Konys 2019, Schramm et al. 2020). In a longitudinal review, Wetzstein et al. (2016) found that approaches/methodologies that use mathematical models to solve supplier selection problem make up the dominant research stream. Meanwhile, the question as to which factors need to be considered with regard to supplier performance has been studied extensively since selection criteria have different intrinsic meanings in different company or industry contexts. A considerable number of supplier selection criteria have been established based on seminal work conducted by Dickson in 1966 (Abdolshah 2013, Cheraghi et al. 2004, Weber et al. 1991). Taken together, these studies have shown that several criteria remain substantially important regardless of the company/industry context, for example, Price and Quality. Nevertheless, the final supplier selection criteria have evolved and varied in multiple recent studies (Banaeian et al. 2015, Genovese et al. 2013, Luthra et al. 2017, Rajesh and Ravi 2015, Rezaei et al. 2016).

Despite the prominent use of traditional supplier selection criteria that only focus on economic factors, the factors involving sustainability in supplier selection have emerged as a potential and growing area of research (Wetzstein et al. 2016). Some studies have explained how a company can select green (Banaeian et al. 2018, Genovese et al. 2013, Rezaei et al. 2016), social (Ehrgott et al. 2011, Sancha et al. 2016) or sustainable suppliers, accommodating a triple bottom line approach (Luthra et al. 2017). In addition, the resilience factor has become more important since companies look for a resilient supplier to overcome the supply chain risk of disruption (Hosseini and Barker 2016, Rajesh and Ravi 2015, Torabi et al. 2015). Some resilient supplier selection criteria are based on supply chain resilience factors developed by prominent studies of Christopher and Peck 2004, Pettit et al. 2010, Sheffi and Rice 2005. Before reviewing the literature focusing on sustainable and resilient performance for suppler selection, we aim to emphasize the importance of selecting criteria in MCDM methods.

2.1. Importance of selecting criteria in MCDM methods

MCDM methods help decision-makers select the best alternative based on selected criteria (Schramm et al. 2020). Numerous MCDM methods have been applied to solve supplier selection problems (Govindan et al. 2015, Ho et al. 2010, Schramm et al. 2020). MCDM methods like Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Analytic Network Process (ANP), and Best-Worst Method (BWM) have been frequently applied to select the optimal supplier (Schramm et al. 2020).

Many MCDM methods focus on obtaining weights for the criteria selection (Rezaei et al. 2016), based on which, a set of alternatives can be evaluated against the criteria, allowing decision-makers to select or rank the alternative according to the criteria in question. MCDM methods are applied after the criteria have been obtained and selected, and criteria formulation is an important step in supplier selection problems (De Boer et al. 2001). Decision-makers need to determine which criteria are relevant for the context of their problem. Despite the extensive criteria selection in earlier studies into supplier selection, only a handful of criteria appeared twice or more in existing literature (Rashidi et al. 2020) since several criteria may not have a practical or strategic use for the companies involved. Selecting irrelevant criteria will reduce the validity and reliability of the supplier selection method (Rashidi et al. 2020). To increase the relevancy of the criteria, prior to the use of MCDM methods, many researchers used experts judgment to select the relevant criteria in their research context, in addition to suggestions from literature findings (see, for example, Banaeian et al. 2018, Genovese et al. 2013, Luthra et al. 2017, Rezaei et al. 2016). In this study, we also used expert opinions to finalize the criteria that were extracted from literature.

2.2. Sustainable Supplier Selection Criteria

Supplier selection criteria are related to an industry’s context. Prior research into sustainable supplier selection criteria has integrated TBL criteria as a sustainability measure, instead of using just one or two criteria. Although the number of studies including all three aspects of TBL is limited, the criteria categorization and hierarchy vary from study to study. (Rashidi et al. 2020). In practice, multi-national coffee companies have applied the TBL approach in their sustainable purchasing program. For example, in 2015, Starbucks accomplished 99% of their sourcing based on CAFE practices which verify and monitor supplier sustainability performance encompassing social, economic, and environmental performance (Conservation International 2018).

Economic criteria are sustainability-related criteria that are used in many traditional supplier selection problems. Economic criteria that focus on the supplier's economic performance have been initially formulated in Dickson's 23 criteria for vendor selection (Cheraghi et al. 2004, Weber et al. 1991). Several traditional criteria, including Net Price, Delivery, Quality, were still heavily used in most studies 15 years after the publication of the Dickson study (Weber et al. 1991), while in more current studies, Cheraghi et al. (2004) and Ho et al. (2010) found that the traditional criteria are still relevant. These three criteria are the most commonly used in supplier selection research (Rashidi et al. 2020). Although Price is widely used as a supplier selection criterion, it can no longer be used as the only important factor to select suppliers, because companies want to build integration with more qualified suppliers. Significant changes in global competition have affected the importance of several traditional criteria and put the focus on more non-traditional economic criteria, e.g., communication and process innovation, while issues surrounding sustainability in the supply chain have motivated more companies to consider environmental and social factors in their supplier selection process.

Large manufacturing companies have come under pressure to develop more environmentally friendly business processes, and they usually extend this responsibility to their supplier base (Seuring and Müller 2008), which means they look for environmentally friendly or green suppliers to improve their environmental performance. Several systematic reviews found environmental criteria in green or sustainable supplier selection is growingly important (Govindan et al. 2015, Luthra et al. 2017, Rashidi et al. 2020, Wetzstein et al. 2016). Rashidi et al. (2020) conducted a meta-review including 4.882 papers from 1990 to 2018 and found that green supplier selection criteria and the integration of environmental criteria with other criteria dominate most research clusters in supplier selection. Some of the most widely used environmental criteria are the Environmental Management System, Recycling, Pollution Control, Eco-design, Energy Consumption, and Air Emission (Govindan et al. 2015, Rashidi et al. 2020). While these criteria are based in large part on automotive and electronics manufacturing, some studies also proposed a number of environmental criteria that are more relevant to the industry examined in this study, like Forest Protection, Pesticides and Inorganic Fertilizer Usage, and Diversity Protection (Starbucks 2020, UTZ 2015, Wahyudi and Misnawi 2012).

In order to align with a sustainable supply chain management framework (Carter and Rogers 2008), companies need to assess their suppliers based on their internal and external social impacts. On the premise of supply chain integration, social misconduct by suppliers can damage the reputation of their client companies and increase the risk of litigation, for example in the infamous Rana Plaza case (Sancha et al. 2016). Ehrgott et al. (2011) define socially sustainable supplier as "We conceptualize socially sustainable supplier selection as the degree to which firms' supplier selection processes ensure that supplier organizations do not violate the social standards common in Western countries (e.g., exploitive and unsafe working conditions)". Nevertheless, social criteria has received the least amount of attention in existing research, because it is difficult to quantify social impact (Rashidi et al. 2020, Sancha et al. 2016). Some prominent social criteria that have been used to measure the social performance of suppliers are Health and Safety System, Employment Practice, Stakeholder Management, and Social Influence to Surroundings (Ghadimi et al. 2016, Govindan et al. 2013, Luthra et al. 2017, Rashidi et al. 2020, Sancha et al. 2016). Table A in the Appendix provides a summary of prominent sustainable supplier criteria from literature.

2.3. Resilient Supplier Selection Criteria

There have been multiple perspectives on the area of resilience from multiple disciplines. Ponomarov and Holcomb (2009) explored various definitions from multiple disciplines and synthesized the concept of resilience within the supply chain context. Similarly, Pettit et al. (2010) developed a supply chain resilience framework by incorporating multiple definitions of resilience from engineering, ecological science and risk management. Overall, it is widely accepted that resilience within a supply chain represents the extent to which a supply chain is able to prepare for, respond to and recover from disruption (Christopher and Peck 2004, Sheffi and Rice 2005).

The importance of resilience is rooted in the interdependent nature of actors in a supply chain. Companies are vulnerable to supply chain risks like environmental turbulence (e.g., natural disaster), deliberate threats, external pressure, resource scarcity and supplier disruption (Pettit et al. 2010). The ripple effect of disruption in one supplier can affect the operations of an entire supply chain. Ivanov (2018) explained that, when a disruption cannot be localized, disruption can cascade through the supply chain and damage its entire performance. For example, a natural disaster in one of the supplier locations may halt a company's operations due to material scarcity. Therefore, a resilient supplier is arguably important in terms of supply chain management when it comes to maintaining a company's performance.

Despite the early development of a resilient supply chain framework, research into resilient supplier criteria formulation is relatively new and limited. Rajesh and Ravi (2015) selected two dimensions of a resilient supply chain: supplier responsiveness and supplier risk reduction ability. Pramanik et al. (2017) used five resilience criteria: buffer capacity, critical nodes, responsiveness, re-engineering, and adaptive capability, while Hosseini and Barker (2016) used three resilience criteria (absorptive capacity, adaptive capacity and restorative capacity) in their supplier evaluation model. Finally, in their review involving resilient supplier selection models in agri-food, Zavala-Alcívar et al. (2020) identified responsiveness/velocity, redundancy and rerouting, which indicates more a reactive response than a preventive ability as being the most widely used supplier evaluation criterion. Table B in the Appendix contains a summary of prominent resilient supplier criteria from literature.

3. Proposed Supplier Selection Framework

The proposed framework in this research has two main phases:

A. Pre-Selection of Qualified Suppliers Based on Non-Compensatory Rules

Evaluating supplier performance based on sustainability and resilience will require the decision-maker to have supplier information. Nevertheless, companies may have fixed requirements for their suppliers to fill before evaluating their potential suppliers in further. This process is used to include only qualified suppliers for further supplier selection, which is why the pre-selection phase is typically conducted by applying non-compensatory rules (Rezaei et al. 2016). Non-compensatory rules are decision-making rules that assume there is no trade-off or compensation among different criteria/alternatives (Citeman 2010).

Decision-makers can use different types of non-compensatory rules to pre-select suppliers. There are at least three basic non-compensatory rules: the conjunctive, disjunctive and lexicographical approaches (Citeman 2010, Rezaei et al. 2016). The conjunctive approach is used when the supplier should meet a certain threshold for each criterion in the pre-selection stage. The disjunctive approach is used when suppliers should fulfil at least one criterion in the pre-selection stage. And lexicographical rank is used when suppliers should fulfil the most important criterion to pass to the next selection stage. When suppliers have passed this pre-selection stage, decisionmakers can further evaluate the supplier in the supplier selection process. (see, for example, Rezaei et al. (2016)).

B. Selection of Suppliers Based on A Set of Criteria

In the supplier selection process, suppliers are selected based on a set of criteria. In this study, we focus on sustainability and resilience as a set of criteria to select suitable and resilient supplier. Once criteria have been formulated based on earlier studies, expert interviews are conducted to ensure the criteria are relevant to this study. One way to do that is via a semi-structured interview. This Expert input is important to finalize the criteria and ensure that they are relevant to the practical purpose of the company and to the industry context (see, for instance, Banaeian et al. 2015, 2018 and Rezaei et al. 2016).

As explained earlier, the supplier selection problem is a multi-criteria decision-making problem, and a novel version of MCDM methods, which was developed by Rezaei (2015) and called the Best-Worst Method (BWM), is used in this study. Criteria selection is the first and one of the main steps in all MCDM methods, including BWM, and will be explained below.

The Best-Worst Method

BWM solves a problem with a sub-set of criteria to evaluate multiple alternatives (Rezaei et al. 2015). Compared to AHP, BWM has several advantages (see Rezaei 2015): Firstly, BWM requires fewer pair-comparison than AHP. In BWM, the number of comparisons is formulated as 2n-3. Meanwhile, for AHP, the number of comparisons is formulated as follows n(n-1)/2 with n as criteria. If there are eight criteria, BWM will require 13 comparisons; meanwhile, AHP will need 23 comparisons. It is significantly less with BWM; thus, it reduces the data collection time and creates a more efficient process. Secondly, the consistency ratio for BWM is better than AHP, which means even with fewer comparisons, BWM can deliver a highly reliable output. The detailed procedure of BWM is described in Appendix A.

BWM consists of five steps, as explained by Rezaei (2015):

Step 1. Determine a Set of Criteria
Several criteria considered relevant for decision-making or evaluating alternatives need to be listed as follow:

$$\{c_1, c_2, c_3, \ldots, c_n\} \quad (1)$$

Step 2. Define the most important (Best) and the least important (Worst) criteria

The best and the worst criteria need to be defined at this stage. The best criterion is the most important criterion. In contrast, the worst criterion is the least important criterion within a set of criteria.

Step 3. Compare the best criteria over all other criteria (BO Vector)
At this stage, the best criterion is compared to the other criteria using a number between 1 and 9. 1 means "equally important," and 9 means "absolutely more important", which means when the best criteria compare against itself it will obtain a score of "1". The resulting Best-to-Other (BO) Vector is expressed as follows:

$$A_B = (a_{B1}, a_{B2}, \ldots a_{Bn}) \quad (2)$$

where A_{Bj} indicates preference of best criteria B over j criteria. Best criteria B against itself (A_{BB}) obtains a score of 1, as explained earlier.

Step 4. Compare the least important (Worst) criteria to other criteria
Next, other criteria are compared to the worst criterion by assigned a number between 1 and 9. 1 means "equally important," and 9 means "absolutely more important". Therefore, an others-to-worst (OW) vector is developed as follow:

$$A_W = (a_{1W}, a_{2W}, \ldots a_{nW}) \quad (3)$$

where A_{Wj} indicates preference of worst criteria W over j criteria. Worst criteria against itself (A_{WW}) got a score of 1, as explained before.

Step 5. Find the optimal weight
In the linear version of BWM by minimizing the maximum absolute difference of $\{|w_B - a_{Bj}w_j|, |w_j - a_{jW}w_W|\}$ for all j, the optimal weights are calculated. Then this is translated into the following optimization problem:

$$\min_{w} \max_{j} \{|w_B - a_{Bj}w_j|, |w_j - a_{jW}w_W|\} \quad (4)$$

such that

$$\sum_{j=1}^{n} w_j = 1$$

$w_j \geq 0$, for all j

Model (4) is converted into:

$$\begin{aligned} &\min \xi \\ &\text{such that} \\ &|w_B - a_{Bj}w_j| \leq \xi, \text{ for all j} \\ &|w_j - a_{jW}w_W| \leq \xi, \text{ for all j} \\ &\sum_{j=1}^{n} w_j = 1 \\ &w_j \geq 0, \text{ for all j} \end{aligned} \quad (5)$$

$w^* = (w_1^*, w_2^*, \ldots, w_n^*)$ that is the optimal weight of the criteria is the result of Model 2. ξ^*, the optimal value of objective function in Model 2, indicates the consistency rate. To check the acceptability of the consistency of the provided pairwise comparisons, the input-based consistency rations and their associated thresholds provided in Liang et al. (2020) is used.

4. Implementing the proposed framework in the Indonesia Coffee Supply Chain

Case Study Background

A roastery in Indonesia was chosen as a case study, which we will call SKL. SKL was established in 2017 and has served domestic customers with roasted coffee from multiple origins in Indonesia (e.g., Sumatera, Jawa, Bali, Toraja, Sulawesi). It has the ambition to become a market leader by building a sustainable coffee ecosystem. SKL has lab facilities and sorting facilities to evaluate and select coffee from its suppliers (e.g., farmers, processors, cooperatives, traders), and also acts as a trader and sells coffee to another roastery in Indonesia.

Experts of Indonesia Coffee Supply Chain

The experts we consulted in this study are academic and managerial experts with experience in and knowledge of supplier selection for a local roastery in Indonesia. The experts had to have at least four years of working experience to be considered to possess relevant knowledge. In all, we consulted sixteen experts in this study. The list of experts can be found in the Appendix, Table C.

The following Figure shows the different phases to implement the proposed suppler selection framework in SKL.

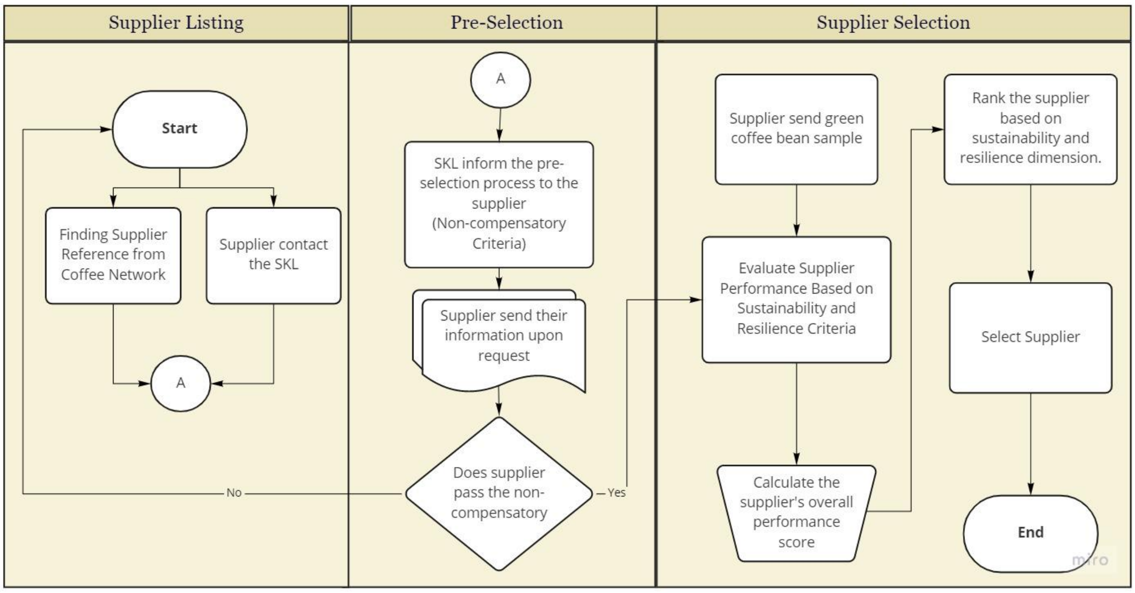

Figure 1. Proposed Supplier Selection Framework in SKL - Different phases (Supplier listing, Pre-selection, Supplier selection) to implement the proposed supplier selection framework in SKL (case company)

Pre-Selection of qualified suppliers based on non-compensatory rules in SKL

A local roastery can set the minimum acceptable performance involving one or more criteria to pre-select the suppliers. The suppliers in this study are coffee suppliers who provide green coffee beans. A supplier can be a Small Holder Farmer (SHF), coffee producer association, cooperative or, trader/exporter/importer selling the coffee directly to the local roastery.

In the SKL case, a decisionmaker determines the non-compensatory criteria in the supplier pre-selection stage, which we learned from interviewing the company's decisionmaker. He proposed six suppliers from the same coffee origin in Indonesia for the pre-selection stage based on two non-compensatory criteria (Supply Capacity to SKL and Capacity to Deliver the Product) (see Table 2). Since the criteria here are non-compensatory, a conjunctive approach is used. Only suppliers who meet the minimum threshold for each criterion are selected for further selection processes marked with "Accepted" for Overall Qualification in Table 2.

Table 2. Supplier Pre-Selection Result

Supplier	Minimum Supply Capacity to SKL	Has Capacity to Deliver the Product	Overall Qualification
S1	Accepted	Accepted	Accepted
S2	Not accepted	Accepted	Not accepted
S3	Accepted	Accepted	Accepted
S4	Accepted	Not accepted	Not accepted
S5	Not accepted	Not accepted	Not accepted
S6	Accepted	Accepted	Accepted

Based on the result from Table 2, only S1, S3 and S6 are included in the actual supplier selection process.

Selection of suppliers based on a set of suitability and resilience criteria in SKL

Initially, 34 of the most widely used and relevant supplier selection criteria from literature were identified (see Table A and B in the Appendix). To determine which criteria were relevant in the context of this study, semi-structured interviews were conducted with three experts in Indonesia coffee supply chain. The experts had at least ten years of working experience in various coffee organizations across the supply chain and occupied different managerial roles to be included in this data collection stage. More information about these three experts can be found in Appendix, Table D.

A semi-structured interview gives the researcher the flexibility to explore the respondent's answer while keeping the interview topic within in the scope of the study (Sreejesh et al. 2014). The experts were asked about the importance of each supplier selection criteria in the context of the Indonesia coffee supply chain and to give a score on a 7-point Likert scale. Criteria considered at least moderately important (5) by at least 60% of the experts were selected for further criteria weight measurement. Based on this process, a final set of sustainable and resilient supplier selection criteria are presented in Table 3.

Table 3. Sustainable and Resilient Supplier Selection Criteria

Dimension	Criteria	Sub-criteria
Sustainability	Economic	Quality
		Price
		Delivery Punctuality
		Product Traceability
		Reputation and Position in Industry
		Product Safety
		Technology Level
	Environmental	Forest Protection
		Pesticides and Inorganic Fertilizer Usage & Record
	Social	Influence on Contractual Stakeholder
		Influence on local community
Resilience	Responsiveness	Streamlined Process
		Respond to Short-Term Changes
	Risk Reduction	Relationship
		Risk Awareness

Determination of the Criteria Weights

To determine the importance of every criterion based on expert perspectives, interviews were conducted with sixteen experts using the BWM approach. The criteria weights were also calculated from the perspective of the decisionmaker (DM) responsible for supplier selection at SKL, the aim being to compare the importance of sustainability and resilience criteria in the supplier selection process between SKL and expert perspectives.

Because supplier selection criteria are inherently affected by company and industry context, the comparison may provide insight into how the concept of sustainability and resilience differs from the two perspectives.

By adopting the linear model of BWM, the importance of every criterion regarding the performance involving sustainability and resilience was calculated. Table 4 shows the relative weights of the sustainability-related criteria and sub-criteria based on the perspectives of the experts and the SKL DM. They all assigned the highest priority to the Economic criterion (0,61;0,65). From both perspectives, Social and Environmental criteria each make up less than 30% of total area weight. Schramm et al. (2020) suggested that the weights of criteria in the supplier selection process shows the importance and the trade-off of supplier performance involving sustainability-related criteria. Thus, the evaluation of criteria by experts and SKL DM showed that a local roastery may compensate the environmental and social performance of the supplier by increased economic performance. The experts indicated that the domestic customer pays more for the taste or quality of the coffee, not for the social and environmental value underlying the product. The concept of sustainability is still in its infancy stage as far as the roastery in Indonesia is concerned. Hence, the experts argued that the company roastery has little motivation to prioritize a supplier's social and environmental performance. As for the least important criteria, the result was different. SKL DM prioritized environmental criteria above social criteria because she argued that environmental performance has a greater impact on product quality.

Opinions on what is the most important sub-criterion varied (see Table 4, Columns 7 and 9). Experts suggested Price (0,17) as the most important criterion, while the SKL DM chose Quality (0,17) and Product Safety (0,17) as the most important criteria. The SKL DM aligns more with Ho et al. (2010) and Rashidi et al. (2020), who found that Price is still considered to be an important criterion, but not viewed as the most important criterion when it comes to selecting a sustainable supplier. SKL DM believed that Product Safety is quite important since it usually correlates with the coffee bean's taste quality. Contaminated green coffee, by mildew, oil, and chemical, might translate to unpleasant flavour coffee traits or be dangerous to consume (Perfect Daily Grind 2020).

Table 4. Relative Weight of Sustainability Criteria and Sub criteria

Dimension	Criteria (Area)	Experts	SKL DM	Sub-Criteria	Experts		SKL DM	
		Area Weight	Area Weight		Local Weight	Global Weight	Local Weight	Global Weight
Sustainability	Economic	0.61	0.65	Quality	0.21	0.13	0.26	0.17
				Price	0.28	0.17	0.15	0.10
				Delivery Punctuality	0.11	0.07	0.08	0.05
				Product Traceability	0.10	0.06	0.15	0.10
				Reputation and Position	0.08	0.05	0.08	0.05
				Product Safety	0.12	0.07	0.26	0.17
				Technology Level	0.10	0.06	0.03	0.02
	Environmental	0.16	0.23	Forest Protection	0.39	0.06	0.67	0.15
				Pesticides and Inorganic Fertilizer Usage & Record	0.61	0.10	0.33	0.08
	Social	0.23	0.13	Influence on Local Community	0.53	0.12	0.33	0.04
				Influence on Contractual Stakeholder	0.47	0.11	0.67	0.08

*The global weight of each sub-criterion is calculated by multiplying the sub-criterion local weight with the area weight to which the sub-criteria belong. For example, Expert: the global weight of "Quality" (0.13) is retrieved from multiplying Area Weight of "Economic" (0.61) by Local Weight of "Quality" (0.22) or: 0.61 x 0.22.

Table 5 shows the weights of the resilience-related criteria and sub-criteria from the perspectives of the experts and the SKL DM. Both the experts and the SKL DM assigned greater weight to Risk Reduction (0,54;0,80). As the roastery faces great uncertainty when dealing with suppliers without a formal agreement, the experts and SKL DM agreed that it is better to adopt a precautionary approach. In Indonesia, most suppliers are SHFs that are not formal business entities. In addition, Relationship (0,36;0,60) was considered the most important sub-criterion. As mentioned by the experts, a good relationship with suppliers can guarantee supply, especially during adverse times such as supply shortage due to disease outbreak, enable flexible shipment arrangement, and many others. This argument aligns with the findings of Werff et al. (2018), that a supplier with a good relationship with an open-communication attitude and mutual trust may improve the success of the procurement.

Table 5. Relative Weight of Resilience Criteria and Sub criteria

Dimension	Criteria (Area)	Experts	SKL DM	Sub-Criteria	Experts		SKL DM	
		Area Weight	Area Weight		Local Weight	Global Weight*	Local Weight	Global Weight*
Resilience	Responsive-ness	0.46	0.20	Streamlined Process	0.56	0.26	0.67	0.13
				Short-Term Response	0.44	0.21	0.33	0.07
	Risk Reduction	0.54	0.80	Relationship	0.67	0.36	0.75	0.60
				Risk Awareness	0.33	0.18	0.25	0.20

*The global weight of each sub-criterion is calculated by multiplying the sub-criterion local weight with the area weight to which the sub-criteria belongs. For example, Expert: the global weight of "Relationship" is retrieved from multiplying Area Weight of "Risk Reduction" (0.54) by Local Weight of "Relationship" (0.67) or: 0.54 x 0.67 = 0.36

An output-based and input-based consistency check was conducted based on Liang et al. (2020). The data shows high consistency.

To determine the significance of the differences between the weights of criteria and sub-criteria from the opinions of experts and SKL DM, Whitney-Mann U test is used (see Table E, F, and G in the Appendix). The results show that the differences are not significant.

Evaluating Supplier Performance

The information about the supplier performance is needed to calculate the overall supplier score. SKL DM evaluated the performance based on selected criteria involving sustainability and resilience. In some qualitative criteria, SKL DM used the Likert scale (1: very low; 5: very high) or a binary choice (0: No; 1: Yes) to measure supplier performance, which means that information from SKL DM does not use the same unit and scale, and the data was normalized using a normalization technique developed by Jahan and Edwards (2015). As a result, the data can be scaled from 0 (lowest) to 1 (highest). The normalized supplier performance data is presented in Table 6.

Table 6. Supplier Performance

	Sustainability Dimension											Resilience Dimension			
	Economic							Environmental		Social		Responsiveness		Risk Awareness	
Supplier \ Sub-Criteria	Quality	Price	Delivery Punctuality	Product Traceability	Reputation and Position in Industry	Product Safety	Technology Level	Forest Protection	Pesticides and Inorganic Fertilizer Usage & Record	Influence on local community	Influence on Contractual Stakeholder	Streamlined Process	Short-Term Response	Relationship	Risk Awareness
S1	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
S3	0.40	0.74	1.00	1.00	0.75	1.00	1.00	1.00	1.00	0.75	1.00	0.75	0.94	1.00	0.00
S6	0.40	0.89	1.00	0.00	0.75	1.00	1.00	1.00	0.00	0.50	1.00	1.00	1.00	0.75	1.00

To determine the overall score for each supplier based on their performance in terms of sustainability and resilience performance from the perspectives of experts and SKL DM, we need to calculate the value of the suppliers (Vi) using the additive value function shown in the following Equation:

$$Vi = \sum_{j=1}^{n} w_j P_{ij} \tag{6}$$

P_{ij} represents the normalized scores of the different suppliers on the criteria.

Tables 7 and 8 contain the scores for each suppler based on their performance regarding sustainability and resilience.

Table 7. Overall Supplier Sustainability Performance Score

Sustainability Criteria	**Sub-criteria**	**Experts**			**SKL DM**		
		S1	**S3**	**S6**	**S1**	**S3**	**S6**
Economic	Quality	0.103	0.051	0.051	0.133	0.066	0.066
	Price	0.168	0.124	0.150	0.100	0.073	0.089
	Delivery Punctuality	0.067	0.067	0.067	0.050	0.050	0.050
	Product Traceability	0.060	0.060	0.000	0.100	0.100	0.000
	Reputation and Position in Industry	0.051	0.038	0.038	0.050	0.037	0.037
	Product Safety	0.072	0.072	0.072	0.166	0.166	0.166
	Technology Level	0.063	0.063	0.063	0.019	0.019	0.019
Environmental	Forest Protection	0.063	0.063	0.063	0.150	0.150	0.150
	Pesticides and Inorganic Fertilizer Usage & Record	0.098	0.098	0.000	0.075	0.075	0.000
Social	Influence on local community	0.122	0.091	0.061	0.042	0.031	0.021
	Influence on Contractual Stakeholder	0.108	0.108	0.108	0.083	0.083	0.083

Table 8. Overall Supplier Resilience Performance Score

Resilience Criteria	**Sub-criteria**	**Experts**			**SKL DM**		
		S1	S3	S6	S1	S3	S6
Responsiveness	Streamlined Process	0.258	0.193	0.258	0.133	0.100	0.133
	Short-Term Response	0.205	0.194	0.205	0.067	0.063	0.067
Risk Reduction	Relationship	0.362	0.362	0.271	0.600	0.600	0.450
	Risk Awareness	0.000	0.000	0.175	0.000	0.000	0.200
Overall Resilience Performance Score		0.825	0.749	0.910	0.800	0.763	0.850

Supplier Selection

Figure 2 is based on the findings in Table 7 and 8. It shows that every supplier is located in the highly sustainable and resilient quadrant. However, S1 is more sustainable in comparison to S6, which in turn is more resilient.

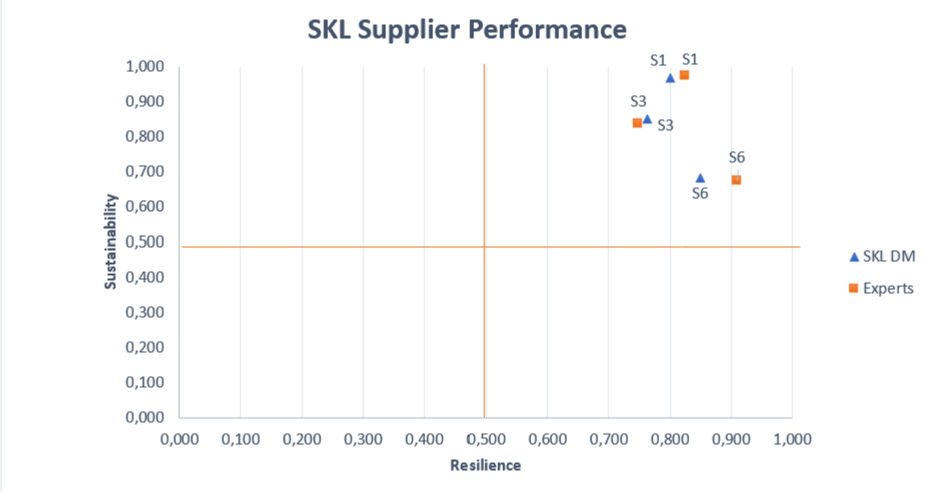

Figure 2. Supplier performance chart - Supplier segmentation based on two dimensions of supplier performance: sustainability and resilience. The segments are high sustainable and high resilient; high sustainable and low resilient; low sustainable and high resilient; low sustainable and low resilient.

Based on Figure 2, the SKL DM can select the supplier that matches the company's needs the most. S1 is considered the most sustainable by both experts and SKL DM, despite the slight difference in their overall sustainability performance scores. Similarly, both the experts and the SKL DM consider S6 to be the least sustainable supplier. Based on the interview with SKL DM, S6 is a trader who purchases the coffee from other smaller producers (e.g., SHFs). SKL DM mentioned that S6 cannot provide information about the specific coffee origin, about the suppliers, farm practices and how they set the price with their suppliers. Thus, S6 has a score of zero on Product Traceability and Pesticides Inorganic Fertilizer Usage and Record. Since the total weight of Product Traceability and Pesticides and Inorganic Fertilizer Usage and Record criteria is above 0.16 (16%) of overall performance score for experts and SKL DM, it is obvious why S6 has a very low sustainability score. Overall, the supplier ranks the same in the sustainability dimension according to the experts and the SKL DM.

In contrast to the results involving sustainability, S6 was ranked as the most resilient supplier according to the experts and the SKL DM. This is in line with Rajesh (2021) regarding the trade-off between sustainable and resilient performance. A supplier with good performance on resilience may have to trade off its sustainability-related performance. Because S6 is a trader, it may have access to more than one supplier. In addition, S6 is a more established trading company compared to the other suppliers. It may also have a better risk management system and greater risk awareness.

SKL DM can select S1 (good on sustainability) or S6 (good on resilience). The final selection depends on the SKL business objective and strategy. If SKL considers sustainability more important, S1 is a promising supplier, being the most sustainable supplier, according to the experts and the SKL DM. On the other hand, when the company requires a more resilient supplier, for instance where there are local droughts, suppliers like S6 can guarantee coffee supply. However, unlike S6, which scores relatively poorly on sustainability, S1 has a good score when it comes to resilience. Having said that, when we look at the sub-criteria, we see that S1's performance on resilience is mostly due to its good score on Relationships, against a zero score on Risk Awareness. Considering the overall score in both dimensions, SKL should select S1 as their supplier, while being cautious of the S1 zero score on Risk Awareness.

5. Conclusion, Limitation and Further Research Direction

Supplier selection is a process that is critical to the success of supply chain management. The interdependent nature of supply chains requires companies to manage and integrate their process with their suppliers. Existing research into sustainable and resilient suppliers in the coffee sector is limited, with most studies focusing on the automotive and electronic industries. Moreover, research into supplier performance on sustainability and resilience is in its infancy. This research contributes to existing knowledge involving supplier selection by conducting a case study at a roastery in Indonesia and developing a systematic supplier selection framework using BWM, to select sustainable and resilient coffee suppliers.

The proposed supplier selection framework allows the company's decision-maker to evaluate its suppliers' performances and thus select the suppliers based on their performance involving sustainability and/or resilience. The coffee sector has the most advanced sustainability program compared to other commodities (Panhuysen, S. and Pierrot 2018). However, certification is expensive and not applicable for most local roasteries in Indonesia, which is a domestic-oriented market (Astuti 2018, Wahyudi and Misnawi 2012). This study offers an alternative by integrating MCDM into the supplier selection process. The decision-maker can improve the sustainability and resilience in the supply chain by selecting suppliers that best meet the relevant criteria.

Additionally, a roastery can use the overall performance score from the proposed supplier selection framework to segment its suppliers based on their performance for further supplier development. There have been studies on the link between supplier segmentation and supplier development (Rezaei et al. 2015). Supplier development is an effort from the company to upgrade their supplier performance to increase the buying company's competitive advantage (Rezaei et al. 2015).

This research has some limitations and provides opportunities for future work. Firstly, the Sustainable Supply Chain Management (SSCM) framework proposes that sustainability can occur at the intersection of economic, environmental, and social goals (Carter and Rogers 2008). Additionally, Schramm et al. (2020) argued that, in SSCM, the company should not trade off low environmental and social performance against good economic performance, and should instead only select the best supplier on all sustainability-related criteria. The author did not set a minimum criteria weight for environmental and social criteria to avoid compensation through economic criteria in the research design. Thus, experts may compensate the sustainability criteria when weighing the criteria and sub-criteria. Nevertheless, the framework is designed in such a way because the author would like to explore the initial stage of sustainability from the perspective of Indonesia coffee experts as there is limited literature in this area. Thus, the result shows that experts tend to favour criteria, and future research may apply a non-compensatory method to select a sustainable supplier in a win-win scenario involving all sustainability-related criteria.

Secondly, given the limited and inconclusive research into the relationship between the performance on sustainability and resilience, this research does not include the relationship between these two dimensions. The supplier is given a separate overall score for sustainability and resilience. There is no aggregation weight between the two dimensions that incorporates the trade-off between the two dimensions. Recent research is still inconclusive on how the sub-criteria of sustainability and resilience are interrelated (Fahimnia and Jabbarzadeh 2016; Rajesh and Ravi 2015). Therefore, future research into the relationship between the performance on sustainability and resilience is needed to obtain a more comprehensive picture of how sustainable and resilient suppliers are selected.

Thirdly, due to our focus on this particular company in this particular market, insight into other factors, like different sizes, market contexts, etc., was not included. As such, it will be interesting to determine the difference in criteria weight based on company size or customer segmentation (e.g., instant coffee/specialty coffee). In the interview, one of the experts mentioned that a smaller roastery might value its supplier's social and environmental performance more, as they are more interested in the relationship aspects. However, other experts mentioned that smaller roastery has no interest in environmental and social performance, because there is a limit to which they can influence their suppliers. As such, future research is needed to explore the variance in roastery level and how different roastery may use different strategies to select their suppliers.

Fourthly, the effect of selected suppliers on the purchasing process and the supply chain performance lies beyond the scope of this study. For example, in this research, Relationship is part of the resilience dimension. The supplier-buyer relationship is important to the success of the procurement process (Werff et al. 2018). However, the research design is exploratory, thus providing no evidence that the selected supplier will increase the success of the procurement. To that end, future explanatory research into the effect of sustainability and resilience supplier selection on the procurement process and overall local roastery supply chain performance is recommended.

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Appendix

Table A. Sustainable Supplier Selection Criteria

Sustainability Criteria	Sub-criteria	Description	Reference
Economic	Quality	Quality is the measure of product compliance to manufacturing requirement (fitness to use) and the defect rate of the product.	Cheraghi et al. 2004, Govindan et al. 2013, Ho et al. 2010, Weber et al. 1991
	Price	Price of the product refers to the net price of the product	Cheraghi et al. 2004, Ho et al. 2010, Luthra et al. 2017, Rashidi et al. 2020, Weber et al. 1991
	Delivery Punctuality	Compliance to finish an order in agreed deadline.	Cheraghi et al. 2004, Genovese et al. 2013, Govindan et al. 2013, Ho et al. 2010
	Production Facilities & Capacities	The fitness of supplier production facilities and capacities with buying companies' requirement.	Cheraghi et al. 2004, Rezaei et al. 2016, Weber et al. 1991
	Technology Level	The level of supplier's technology to meet the buying companies current demand in term of quality and delivery.	Cheraghi et al. 2004, Govindan et al. 2013, Weber et al. 1991
	Involvement in New Product Design	The supplier speed and design capability and participation to produce a new product from development stage for buying companies.	Cheraghi et al. 2004, Genovese et al. 2013, Govindan et al. 2013
	Financial Capabilities	Supplier's financial stability and ongoing concern perspective.	Cheraghi et al. 2004, Luthra et al. 2017
	Economic Transparency	Supplier ability to present document on the invoices for the coffee raw materials (cherry)	Starbucks, 2020, Wahyudi & Misnawi 2012
	Product Traceability	Supplier ability to present the information to trace back the origin of the coffee producer (date, name of seller, unit of measure, quantity and type of coffee).	Starbucks 2020, Wahyudi & Misnawi 2012
	Reputation and Position in Industry	Supplier's years of experience and their market position in the industry	Banaeian et al. 2015, Cheraghi et al. 2004, Weber et al. 1991
	Product Safety	Supplier's product safety and GMO-free	Wahyudi & Misnawi 2012
Environmental	Environmental Management System	Supplier compliance to ISO 14000 certification on environmental management	Banaeian et al. 2018, Govindan et al. 2013, Rezaei et al. 2016
	Coffee Certification	Supplier Certification related to Environmental Performance (e.g., Rainforest Alliance, Organic, Utz, CAFÉ Practices)	Astuti 2018, Kolk 2013, Wahyudi & Misnawi 2012
	Pollution Production	The production creates a minimum waste and pollution (e.g. air pollution, substance discharged into the sewer, solid waste) from origin to buyer's gate	Banaeian et al. 2018, Govindan et al. 2013, Rezaei et al. 2016
	Resources Consumption	The consumption of materials, energy and water is minimum at producing the product from origin to buyer's gate. Supplier has documented measure for efficient usage of energy.	Govindan et al. 2013, Luthra et al. 2017, Starbucks 2020, UTZ 2015
	Waste Management / Pollution Control	Production waste is managed in such a way that maintain at minimum level and not contaminate local environment. Organic waste is recycled whenever possible.	Luthra et al. 2017, Rashidi et al. 2020, Rezaei et al. 2016, Starbucks 2020, Wahyudi & Misnawi 2012
	Green Packing and Labelling	Supplier ability to take environmental consideration for packaging and labelling.	Luthra et al. 2017
	Diversity Protection	Suppliers contribute to protect and enhance habitat and ecosystem by using natives species as canopies/shade tree, and plant multi-species where space allow to increase bio-diversity.	Starbucks 2020, UTZ 2015, Wahyudi & Misnawi 2012
	Forest Protection	Coffee is not grown on converted conservation area/natural forest unless with legal permit	Starbucks 2020, UTZ 2015, Wahyudi & Misnawi 2012
	Land Erosion Management	The farm has buffer zone which allow for seasonal or permanent water body to reduce land erosion.	UTZ 2015, Wahyudi & Misnawi 2012
	Pesticides and Inorganic Fertilizer Usage & Record	Supplier has clear instruction / code of conduct to be applied on the farm to minimize water contamination. The supplier also does not use any pesticides that are banned according to national law. Supplier kept a record of the activity of pesticide and inorganic fertilizer usage.	Starbucks 2020, UTZ 2015, Wahyudi & Misnawi 2012

Sustainability Criteria	Sub-criteria	Description	Reference
Social	Occupational Health & Safety	Comply to H&S Standard to national law	Bai & Sarkis 2010, Ghadimi et al. 2016, Govindan et al. 2013, Luthra et al. 2017, Rashidi et al. 2020
		The level of Supplier H&S Incidents	
		Supplier has code of conduct regarding health & safety practice	
	Employement Practices	Supplier has trained disciplinary and security practice aligned with Human Right	Bai & Sarkis 2010, Ghadimi et al. 2016, Govindan et al. 2013, Luthra et al. 2017, Rashidi et al. 2020, Starbucks 2020
		Supplier has formal contract with their employee	
		Supplier support labor equity in term of age, gender, and minority group.	
		Supplier complies with law of the country on working arrangement (working hours, annual leaves, overtime payment, paid sick leaves)	
		Supplier offer job opportunities within company to keep employee turn over low	
		Supplier complies with law of the country on employment compensation	
		Supplier offer Career Development within company to keep employee turn over low	
		Supplier enforces a policy that prohibits the use of forced, bonded, indentured, convict or trafficked labor (ILO Conventions 29, 97, 105 and 143). Written policy required for large/medium farms, mills, and warehouses with more than 5 employees.	
		Supplier is not engaged with any practice of child labor (employ any person under the legal age), employment of authorized minor is not limiting their access to education.	
	Influence on local community	Supplier has positive influence on local community well being (e.g health, education, infrastructure, economic welfare and growth, community, social cohesion and pathologies), moral rights of society having stakes in the business	Bai & Sarkis 2010, Ghadimi et al. 2016, Govindan et al. 2013, Luthra et al. 2017
	Influence on Contractual Stakeholder	Supplier has procurement standard, screening and standard on partnership, conducted consumer education	Bai & Sarkis 2010, Ghadimi et al. 2016, Govindan et al. 2013, Luthra et al. 2017
	Information Disclosure	Providing information to customers and stakeholder regarding material used, carbon emission, and toxins released during production that might be harmful for environment and society.	Luthra et al. 2017
	Certification on Social Performance	The supplier has certification which includes the measurement of good social performance (e.g. Utz, fairtrade, Café Practice)	Astuti 2018, Kolk 2013, Wahyudi & Misnawi 2012

Table B. Resilient Supplier Selection Criteria

Resilience Dimension	Criteria	Description	Reference
Responsiveness Criteria	Streamlined Process	Supplier with streamlined (standardized) and simplified process in multiple production site can give rapid response when one of the processing site disrupted. Supplier may have redundant production line or multiple capability to enhance production flexibility.	Christopher and Peck 2004, Rajesh and Ravi 2015, Sheffi 2005
	Respond to short-term changes	Supplier can respond rapidly in term of short-term changes in volume and product requirement.	Christopher and Peck 2004, Rajesh and Ravi 2015, Sheffi and Rice 2005
	Control System	Supplier has visibility in supply chain and can identify and response to disruption before it has bullwhip effect through effective and sensitive control system end to end.	Sheffi and Rice 2005
Risk Reduction Criteria	Vulnerability	Degree of supplier vulnerability to unpredictable or intentional disruption. Vulnerability is high when supplier has high likelihood and impact at the event of disruption.	Sheffi and Rice 2005, Rajesh and Ravi 2015
	Relationship	Resilient supply chain requires a high collaboration among actors. Collaboration may improve visibility of supplier to respond on supply chain changes, thus reducing uncertainty.	Christopher and Peck 2004, Rajesh and Ravi 2015 , Parkhaoui 2017
	Risk Awareness	Suppliers should be aware of various risks, such as risks related to assets, process, organizations, and the environment. Risk awareness helps them to act in cases of emergency, thus increasing resilience capability of suppliers.	Christopher and Peck 2004, Rajesh and Ravi 2015
	Risk Management Culture	Supplier has a supply chain management team who actively assess the risk in the supply chain. Risk register is regularly updated. Risk assessment is mandatory for decision making process	Christopher and Peck 2004, Sheffi and Rice 2005, Rajesh and Ravi 2015

Table C. List of Experts for measuring the weights of criteria

No	Role	Expertise	Years of Experience
1	Roaster/Roastery Owner	Managing day-to-day roastery operation activities. Conducting supplier selection by inspecting green bean quality (green bean quality and cup testing).	6
2	Roaster/Roastery Owner	Managing day-to-day roastery operation activities. Conducting supplier selection by inspecting green bean quality (green bean quality and cup testing).	6
3	Coffee Researcher	Researching Indonesia coffee supply chain network include the marketing network.	6
4	Trader	Managing partnership with producers (include micro-trader, smallholders farmers, and processor). Inspecting green bean quality and supplier capability.	4
5	Coffee Researcher	A researcher for seasonal and spice plants for a government institution. He has studied coffee certification's impact on the sustainability of the Indonesia coffee supply chain.	15
6	Coffee Researcher	Researching Indonesia coffee supply chain for a doctoral degree. His works involve study in coffee certification impact for smallholder farmers and the implementation of Indonesia Coffee Standard	10
7	Purchasing/Roastery Owner	Owner of a coffee shop and roasting company. Managing the daily operation of the company including selecting and managing the partnership with the supplier.	11
8	Assistant Project Manager in Coffee Supply Chain Development Project	Consultant for Coffee Supply Unit in a global coffee consulting company. Supporting the company to develop training for coffee supplier, managing and evaluating coffee producer availability and logistics management.	4
9	Roaster/Roastery Owner	Managing day to day roastery operation activities. Conducting supplier selection by inspecting green bean quality (green bean quality and cup testing).	10
10	Head of Roaster	Experienced Roaster. Responsible to the roasting operations activity in the company. Managing and selecting coffee supplier to fit the company needs.	11
11	Roaster/Roastery Owner	Managing day to day roastery operation activities. Conducting supplier selection by inspecting green bean quality (green bean quality and cup testing).	5
12	Coffee Entrepreneur	The respondent is owner of roasting company and a chain of coffee shops in Indonesia. The role includes selecting green bean supplier that align with the needs of the company customer segment.	8
13	Coffee Trainer Coordinator, Coffee Export-Import Association	Working for Indonesia export-import coffee association. Responsible to develop and lead training for the development of coffee supplier. The respondent also owner of home-scale coffee roastery who responsible to roast the coffee and select coffee supplier.	6
14	Green Bean Specialist, Coffee Shop Owner	Coffee entrepreneur who own roasting company, coffee shop and coffee supply chain development project. The role includes inspecting and selecting green bean for the company as green bean specialist.	11
15	Café & Roastery Owner	Home-industry roastery owner. Managing day to day roastery operation activities. Conducting supplier selection by inspecting green bean quality (green bean quality and cup testing).	4
16	Purchasing Manager/ Roastery	Conducting purchasing function in a roasting company in Indonesia. Specializing in specialty coffee. Overseeing purchasing process include selection of green bean supplier and identifying cup quality.	5

Table D. Experts for Criteria Selection

Expert	Organization	Function	Expertise	Year of Working Experience
RT	Domestic Roastery (A)	Purchasing and Product Development Specialist	Coffee class instructor for coffee tasting and barista course, Responsible in green bean coffee quality control and sourcing, Responsible in product development for coffee and other beverages	13 Years
JS	Domestic Roastery (B)	Head of Business, Coffee Subsidiary Business	Currently responsible for managing the overall operation and development of the coffee business, overviewing the procurement process, and coffee quality control. He has experience as operations and marketing manager in multiple industry.	20+ years
IM	National Coffee Association	Executive Director	Academician and coffee practitioner. Previously, an executive director of a coffee association. The association aims to increase Indonesia's specialty coffee volume and value through good quality coffee standards.	20+ Years

Table E. Mann Whitney U Test Result for Criteria Level

	Sustainability Criteria			Resilience Criteria	
	Economic	Environmental	Social	Responsiveness	RiskReduction
Mann-Whitney U	6,000	4,000	6,000	4,000	4,000
Wilcoxon W	7,000	140,000	7,000	5,000	140,000
Standardized Test Statistic	-0,409	-0,819	-0,409	-0,824	-0,824
Asymp. Sig. (2-tailed)	0,683	0,413	0,683	0,410	0,410

Table F. Mann Whitney U Test Result for Sustainability Sub-criteria

	Quality	Price	Delivery Punctuality	Product Traceability	Reputation & Position in Industry	Product Safety	Technology Level	Forest Protection	Pesticides and Inorganic Fertilizer Usage & Record	Influence on local community	Influence on Contractual Stakeholder
Mann-Whitney U	3,000	0,000	5,000	3,000	4,000	0,000	3,000	3,500	3,500	5,500	5,500
Wilcoxon W	139,000	1,000	6,000	139,000	140,000	136,000	4,000	139,500	4,500	6,500	141,500
Standardized Test Statistic	-1,021	-1,633	-0,612	-1,021	-0,816	-1,633	-1,021	-0,923	-0,923	-0,514	-0,514
Asmptotic Sig. (2-tailed)	0,307	0,102	0,540	0,307	0,414	0,102	0,307	0,356	0,356	0,607	0,607

Table G. Mann Whitney U Test Result for Resilience Sub-criteria

	Streamlined Process	Short-Term Response	Relationship	Risk Awareness
Mann-Whitney U	8.000	8.000	8.000	8.000
Wilcoxon W	9.000	9.000	9.000	9.000
Standardized Test Statistic	0.000	0.000	0.000	0.000
Asmptotic Sig. (2-tailed)	1.000	1.000	1.000	1.000

Author statement

Dwi Uli Rahmawati: Conceptualization, Methodology, Formal analysis, Investigation, Resources, Writing –Original Draft
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