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Supply Chain Sustainability Risk Decision Support Model Using Integrated Preference Selection Index (PSI) Method and Prospect Theory

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Purpose

The goal of this paper is to introduce the integrated model of the Preference selection index (PSI) and the prospect theory as new means to appraise the impact of supply chain sustainability risks based on five pillars of sustainability. Research has shown that sustainability risk assessment has a strong positive impact on improving the performance of enterprises.

Design/Methodology/Approach

This study adopts a new decision support model for assessing supply chain sustainability risk based on additional supply chain risk reprioritization parameters and its integration with Preference Selection Index (PSI) methodology and Prospect Theory. A case example of the supply chain SME producing Moslem fashion has been used in this study.

Findings

The result of our study reveals some critical supply chain sustainability risks affecting the sustainability of enterprises under study.

Research limitations/implications

The use of a limited sample is often associated as a limitation in the research studies and this study is based on findings from SMEs in the fashion retail supply chain. This preliminary study provides academics and practitioners with an exemplar of supply chain sustainability risk assessment in the context of the SME in a developing country

Practical implications
The result of this study is beneficial for practitioners, particularly owner-managers of SMEs who can use this study as guidance on how to consider risk behaviour to identify and select the critical sustainability risks and plan mitigating strategies accordingly.

Originality/value
Scientific studies on using the Preference Selection Index (PSI) and its integration with Prospect Theory as means to assess the criticality of supply chain sustainability risks are very rare. This is the first paper that presents integrated the PSI and Prospect Theory to rank supply chain sustainability risks based on five pillars of sustainability.

Keywords: Small and Medium Enterprise (SME), Supply Chain Sustainability Risk, Preference Selection Index (PSI), Prospect Theory, Risk Priority Number.

1. Introduction

Despite its significant contribution to the GDP of the global economy (Obi *et al.*, 2018) and serving the role as a sector absorbing workforce (Ghergina *et al*., 2020), Small and Medium Enterprises (SMEs) owing to its various limitations such as limited human resources, financial and technological know-how (Smith and Wakinson, 2012; Wosche *et al*., 2017), are vulnerable to the impact of business crisis (Grondys *et al*., 2020). In line with the vulnerability of the Small and Medium Enterprises (SMEs) operation against the impact of business risks (Verano and Venturini, 2013 and Vladic, 2015), creating an improved risk evaluation methodology suitable for the SMEs is believed to increase their business sustainability. Properly managing the impact of business risks has a positive relationship with improved enterprises' financial performance and sustainability (Singh and Hong, 2020; Shahin *et al*., 2019, and Shahin *et al*., 2020). Similar to big enterprises, SMEs are nowadays also under pressure to implement approaches considering sustainability in running their business operation (Fetter, 2019). Within supply chain management, assessing the impact of business risks will enable decision-makers to take appropriate counter measures to prevent business losses, which in turn will improve business performance (Dias *et al*., 2020).

Among research streams in supply chain management, investigative effort to improve understanding of better managing sustainability risks is one of the growing research areas (Fagundes *et al*., 2020). Nevertheless, studies discussing the advancement of supply chain risk management as reported by Ceryno *et al*., (2013), Almaida *et al*., (2015), Ho *et al*., (2015), Fan and Stevenson (2018), Bak (2018), and Nakano and Lau (2020) are silent on reporting empirical studies on accessing supply chain sustainability risks of SMEs. On the other side, among studies reporting on the progress of advancement of supply chain risk assessment tools as reported in the work of Tran *et al*., (2018) and Vishnu *et al*., (2019) are also overlooking research attention to SMEs despite their admittance on the importance of managing supply chain risks in their context. Our perusal of the aforementioned supply chain risk assessment studies indicates some limitations as follows:

- Attention to the risk decision-making process is largely devoted to the large enterprises and the typical risks evaluated tend to focus on operational type risks. Research efforts intended to evaluate risks having an impact on the environmental and social implications in the SME environment has far been given little attention.
- In undertaking risk evaluation, occurrence, detection and severity are mostly used as criteria to determine risk priority ranking. Although having serious influence in quantifying criticality of supply chain risk, other supply chain risk evaluation criteria such as supply chain sensitivity against the impact of a certain risk variable (Lahmar *et al*., 2018) and supply chain resiliency from the impact of a certain risk element (Behzadi *et al*., 2018)are not taken into consideration in the establishment of a decision support model for ranking supply chain risk.
- Pairwise comparison among risk re-prioritization using the Analytical Hierarchy Process (AHP) and Best Worst Method (BMW) is becoming the most widely used decision-making tools to rank critical risk variables despite consistency checking required by these methods may lead to tedious works (Zhou *et al*., 20021).
- Despite affecting priority in risk reprioritization, decision-maker risk behaviour is important criteria in risk reprioritization decision making (Zhu *et al*., 2021). However, this has been still overlooked in previous supply chain risk decision-making studies. Ignoring the inclusion of risk preference of the decision-makers make the result of supply chain risk assessment inappropriate yielding to resource wastage in allocating resources to risk alleviation.

The above situation demands the need to improve methodology to select critical supply chain sustainability risk method for SMEs to gauge risk elements with consideration on the risk behaviour of SME decision-maker. Emerging as one of simple MCDM decision-making tool, the Preference Selection Index (PSI) is presented to aid decision-maker that has been applied to many application areas. Among those are concerning on selecting best plant layout as reported by (Sharma and Singal, 2016), determining the best parameters of solar in the work of Nadda *et al*. (2018), manufacturing process optimization decision making by Parizi *et al*., (2017), ranking best composition of composite material as exemplified by Kumar and Kumar (2020), selecting mining contractor by Borujeni and Gitinayard (2017) and ranking of flexibility in Flexible Manufacturing System (FMS) by Jain *et al.*, (2021). Despite its simplicity which is potentially beneficial to SME practitioners, empirical studies in adopting it for supply chain sustainability risk assessment in SME environment are missing in the past references.

Motivated by this research scarcity and in compliment with inclusion to consider decision-makers risk behaviour, this paper intends to integrate the PSI and The Prospect Theory to accommodate the decision behaviour of SME decision-makers. Next, to consider the importance of supply chain attributes such as sensitivity against the impact of particular risk (Lahmar *et al*., 2018) and speed capability to recover from the impact of certain risk (Behzadi *et al*., 2018 and Rehman and Ali, 2021), sensitivity and recoverability level of the supply chain is added as additional risk criteria in compliment to the previous three risk reprioritization criteria.

Presenting the application of integrated PSI and Prospect Theory as a new approach to evaluating the impact of sustainability risks within the supply chain framework, contributions of this study are as follows. At first, this study offers the empirical study on using the exclusion of pairwise comparison-based risk reprioritization approach by using the PSI method which to the best of our knowledge has not been presented in earlier supply chain risk assessment studies and neither has been integrated with the prospect theory to consider the impact of decision-makers risk behaviour. Secondly, this study reports the inclusion of risk vulnerability and resilience attributes which have also never been addressed in previous supply chain risk reprioritization studies. The inclusion of supply chain risk vulnerability and resilience attributes into the PSI method and Prospect theory is the new contribution of the PSI application in supply chain risk assessment.

The following part of the paper presents a literature review of supply chain risk assessment and the status of studies dealing with the prioritization of sustainable supply chain risks in general and the progress of supply chain risk assessment in the context of SMEs in developing countries. Next, an overview of the PSI method and the Prospect Theory are presented along with the progress in their application area and followed with the establishment of a framework of integrating the PSI and Prospect Theory. Next, the decision support framework building on the integration of the PSI method and Prospect Theory is tested empirically in evaluating the sustainability risk of the SME business focusing on the Moslem retail fashion supply chain in Indonesia. Merits and limitations of implementing the new decision support model are discussed. Conclusions and recommendations for further inquiries are then presented at the end.

2. Supply chain sustainability risks- literature review

2.1.Supply chain sustainability risk assessment methods

In undertaking business at a global stake, SMEs are now confronted by the increasing impact of negative uncertainties from externals and internal factors affecting their business operability. In this regard, attention to managing the adverse impact of those uncertainties is increasingly bringing research direction to the stream of sustainability supply chain risks as one of the emerging research areas in the supply chain management discipline (Fahimnia *et al*., 2015; Fagundes *et al*., 2020). Similar to operational type supply chain, sustainability supply chain risk assessment is an activity intended to identify, evaluate and select critical sustainability risks within the supply chain framework and finding suitable action to alleviate them (Ganguli, 2019). Despite no universally accepted definition of what sustainability risk is, it is a typical risk characterized by long term negative impact affecting the existential of enterprises' business and usually linked not merely to economic and financial issues, but also to the social and environmental impact. This latter characteristic is distinctively different from operational type risk which is usually having an impact to cost, quality and delivery (Shafiq *et al*., 2017). In assisting to a better understanding of supply chain risk typologies, several taxonomies of supply chain risks have been earlier reported by Hudnukar *et al.*, (2017), Rangel *et al*., (2014), Shahbaz *et al*.,(2019) and Mbiri *et al.,* (2021). Meanwhile, considering the categorization of sustainability supply chain risks, a classification model of sustainability risk taxonomy can be referred to in the work of Choirun *et al*., (2020). Considering its growing importance in affecting enterprise business continuity and increasing complexities of supply chain structure, by adopting multi-criteria risk decision-making tools classification model presented in the work of Gugaliya *et al*., (2019) and supply chain risk decision-making model of Anilkumar and Sridharan (2019), scientific studies devoted to improving methodologies in evaluating sustainability risks in the supply chain area are growing as represented in Table 1.

Table 1 Compilations on studies on techniques and methodological approaches in evaluating the criticality of sustainability risks in supply chain discipline (Adopted from Gugaliya *et al.*, 2019 and Anilkumar and Sridharan, 2019)

No		Techniques	Methodological approach	Reference(s)
1	Analytical	Simulation	System Dynamics	Sajid (2021)
			Neural networks	Jianying *et al*, (2021)
2	Empirical	Brainstorming	None	Serrano *et al*., (2020), Hashim *et al.* (2021), Valinejad and Rahmani (2018)
			Space and Materiality Analysis	Xu *et al*., (2019)
		Subjective Multi Criteria Decision Making	Compromise Ranking (e.g. VIKOR	Nazam *et al*. (2020)
			Pairwise Comparison (AHP, BWM	Ganguly and Chatterje (2018) , Rostamzadeh *et al.*, (2019), Majumdar *et al*.,(2021), Moktadir *et al*.,(2021)
			DEMATEL	Benabdallah *et al*., (2020), Song *et al*., (2017)
			Interpretive Structural Model (ISM)	Chen *et al*., (2020)
2		Hybrid MCDM	Fuzzy SWARA-COPRAS	Ansari *et al*., (2020)
			Neutrosopic, AHP and ANP	Junaid *et al*., (2020)
			Fuzzy VIKOR	Nazam *et al*.,(2020)
			Fuzzy TOPSIS and CRITIC	Basset and Mohammed (2020)

			AHP and TOPSIS	Silva *et al.*, (2021)
			Rough Set Theory and DEMATEL	Song *et al*., (2017)
3		Mixed-Method	Neural Network and Gray Relational Analysis	Zou *et al*., (2021)
			Social Network Analysis and TOPSIS	Liu *et al*., (2020)

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Table 1 shows progress on the development and application of varying methodologies to assist the supply chain sustainability risk reprioritization approach. However, despite various models that have been presented both in the form of analytical, empirical and mixed methods for ranking sustainability risk, promoting the use of the PSI method is apparently vacant in the supply chain risk assessment area.

2.2.Supply chain sustainability risk assessment in the context of sme

Considering the SMEs role as a business growth driver in both of developing and developed countries (Hanggraeni *et al*., 2019), scientific endeavours to improve risk assessment method for the SME practitioners is very beneficial to boost global economic growth. However, in terms of its publication quantity, investigative efforts dealing with supply chain risk assessment of the SME is very limited in references. Table 1 presents studies dealing with accessing SME supply chain risk from various references.

Table 2. SMEs supply chain risk assessment studies

No	Author(s)	Risk reprioritization methodology	Risk reprioritization Criteria	Supply chain commodity type	Country of origin
1	Rohmah *et al*., (20I5)	Fuzzy Logic	Occurrence, Severity and Detection	Rice	Indonesia
2	Muchfirodin *et al*., (2014)	Fuzzy logic	Occurrence, Severity and Detection	Tobacco	Indonesia
	Slamet *et al*., (2017)	Analytical Network Priority (ANP)	Occurrence, Severity and Detection	Papaya	Indonesia

3	Anin *et al*., (2015)	None	Occurrence, Severity and Detection	Pineapple	Ghana
4	Zhang and Chen (2015)	Neural Network	None	Finance	China
5	Wahyuni *et al.* (2018)	None	Occurrence and Severity	Food	Indonesia
6	Ernita *et al*. 2019	Analytical Network Priority (ANP)	None	Cocoa	Indonesia
7	Raihan *et al*., (2019)	Analytical Hierarchy Process (AHP)	None	Leather	Bangladesh
8	Nurmianto *et al*., (2019)	None	Occurrence, Detection and Severity	Clams and seaweed	Indonesia
9	Rivas *et al.* (2019)	None	O-S-D	Furniture	Mexico
10	Babu *et al*., (2020)	Sum-Rank Weight-based ISM	None	Manufacturing goods	India
11	Sanny *et al.*(2020)	None	Occurrence, Detection and Severity	Interior Design	Indonesia
12	Alora and Barua (2020)	Fuzzy AHP-TOPSIS	None	Miscellaneous	India
13	Ornaez and Moreno (2021)	AHP	None	Bakery	Spain
14	Anwar *et al.*, (2021)	Bayesian Network	None	Sago starch	Indonesia

As represented in Table 2, scientific studies dealing with supply chain risk assessment in the context of SMEs can be divided into several categories. In the first category, scholars reported the use of conventional Failure Mode and Effect Analysis for ranking supply chain risk are exemplified by the works of Anin *et al*., (2015), Wahyuni *et al*., (2018), Nurmianto *et al*., (2019), Rivas *et al*., (2019) and Sanny *et al*., (2020). In the second category, to deal with the fuzziness of risk reprioritization criteria, fuzzy logic stand-alone-based risk reprioritization ranking approaches are presented by Rohmah *et al*.,(2015) and Muhfirodin *et al.,* (2014) and its integration with pairwise based risk reprioritization criteria based on the AHP and TOPSIS are reported by Alora and Barua (2020). Considering the influence of the weight of risk reprioritization criteria, Slamet *et al*., (2017) and Raihan *et al*., (2019) demonstrated the use of the AHP. Ornaez *et al*., (2020) presented the use of the ANP method to consider interrelationships among supply chain risk variables. Babu *et al.*, (2020) showed the use of the sum-rank weight-based Interpretive Structural Model (ISM) to evaluate the criticality of supply chain risks. Zhang and Chen (2015) promoted the use of artificial intelligence tools to evaluate the criticality of the financial supply chain of SMEs. And at last, Anwar *et al.,* (2021) reported the use of the Bayesian Networks to deal with determining the most impacting supply chain risks to the performance of the SMEs.

In terms of the supply chain risk criteria being used as a basis for risk ranking, the occurrence, detection and severity of supply chain risks are the three most used criteria and evidently no previous efforts have considered supply chain sensitivity and resilience attributes in quantifying the impact of supply chain risks. Based on these findings as represented in Table 1 and Table 2, it indicates scarcity on supply chain sustainability risk evaluation model which considers risk behaviour of SME decision-makers and inclusion of additional risk reprioritization criteria reflecting the sensitivity and resiliency of a supply chain against the impact of a risk element.

3. Integrating the Preference Selection Index (PSI) Methodology and Prospect Theory – The Model

3.1. Preference selection index (PSI) method

Determining the weight of risk reprioritization parameters is an important issue in the risk assessment area. Usually, decision-makers are faced with realities that conflicting attributes demanding prioritization exist. In such a situation, using a less complicated alternative way to estimate the weight of risk attributes is preferable (Jain, 2018). The PSI is a kind of Multi-Criteria Decision Making (MCD) method which exclude the use of pairwise comparison among attributes and decision-makers in assigning priority score in decision-making process. Instead, it relies on the statical computation of risk variables and criteria to obtain the priority ranking. The advantage of using the PSI to solve multi-criteria decision-making problem over the usage of the AHP and BMW is that it enables to improve the efficiency of the decision-making process since decision makers do not take necessary to take pairwise comparison and consistency checking of decision-makers criteria's option in determining priority ranking.

In principle, the general implementing steps of the PSI method and the decision-making process considering its input, process and output is given as in the following.

Step 1. Determination of the score of normalized decision matrix related to the risk variables and attributes.

Step 2. Determination of the decision-maker preference scores and their deviation with normalized risk variables data obtained in step (1).

Step 3. Checking the overall preference score

Step 4. Selecting the best alternative based on the largest preference score.

Table 3. Table presenting the input, process and output model of the PSI methodology

Input	Process	Output
Risk Variables	1. Determination and Normalization of Decision Matrix	Preference Selection Index of each risk variables
Risk Reprioritization Criteria	2. Calculation of the Mean Normalized decision criteria	
	3. Calculation of the Deviation Preference Value and Overall Preference score of each risk reprioritization criteria	

Extending on studies applying the PSI method in section 1, past researches presenting the application of the PSI method as decision-making tools are presented in Table 4.

Table 4. Studies applying the PSI method in the various application area

No	Application area	Author(s)
1	Manufacturing System lifecycle management	Attri and Grover (2015)
2	Selecting priority ranking in mechanical design specification	Chauhan *et al*., (2016)
3	Manufacturing parameter process selection	Patel *et al*., (2018)
4	Mining contractor selection	Borujeni and Gitinavard (2017)
5	Material selection	Singh *et al*., (2015)
6	Cutting fluid selection	Attri *et al*., (2014)
7	Process scheduling	Joseph and Sridhar (2011)
8	Warehouse location selection	Ulutas *et al.* (2021)

Based on Table 4, it is evident that the application of the PSI method in the supply chain risk assessment area is missing.

3.2.Prospect Theory

Introduced by Kahneman and Tversky (1979), the prospect theory is intended to represent decision-makers behaviour under risk and uncertainty. In representing the above behaviour, the prospect theory uses a value function in measuring the level of gains and losses. In this decision-making model, two categories of the situation called gain and loss are existing. A gain situation occurs when the value counted is above the reference points and in reverse, a loss situation is when the value counted is below the reference point. In the prospect theory, two kinds of value functions are introduced, the increasing and decreasing value functions which are counted based on equations 1 and equation 2.

For increasing value function

$$w_{ij} = \begin{cases} (r_{ij} - \varphi_j)^{\alpha} \; if \; r_{ij} > \varphi_j \\ -\pi(\varphi_j - r_{ij})^{\alpha} \; otherwise \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

For decreasing value function

$$w_{ij} = \begin{cases} (\varphi_{ij} - r_{ij})^{\alpha} \; if \; r_{ij} < \varphi_j \\ -\pi(r_{ij} - \varphi_{ij})^{\alpha} \; otherwise \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Based on the experimental result reported by Kahneman and Tversky (1992), the attenuation factor π of the loss varies between 2 and 2.5 and the score of α which represent the diminishing sensitivity parameters is set at 0.88 (Kumar *et al*., 2016). Now let W_{ij} represents the score of value function of every risk element *i* for risk reprioritization criteria *j*. Considering capability to articulate decision-maker risk behaviour, prospect theory has been applied in various areas as reported by (Zhang and Cheng, 2021). When linked to the risk reprioritization decision-making process, recently scientific works reporting the application of the Prospect Theory as a tool for risk priority ranking is given in Table 5.

Table 5. Application of the Prospect Theory in risk priority ranking application area

No	Application area	Authors
1	Project management	Farooq *et al*., (2018)
2	Healthcare	Liu *et al*., (2018)
3	Emergency response	Li and Chao (2019)
4	Energy contracting project	Wang *et al.*, (2019)
5	Aircraft operation	Wang *et al.*, (2018)
6	Steel manufacturing	Sagnak *et al*., (2019) and Gugaliya *et al*., (2019)
7	Renewable energy investment	Ilbahar *et al*., (2022)

As can be seen in Table 5, despite the growing application of the Prospect Theory to aid risk priority ranking to exist, no previous works present its application in the supply chain risk management decision-making process.

3.3 Risk Reprioritization Ranking Using PSI and The Prospect Theory- The Model

In estimating the magnitude of the supply chain risk impact using the integration of the PSI and the Prospect Theory, risk priority number (RPN) as the product of risk preference score and value function score of every risk element is introduced. Mathematically, it is counted using equation (3).

$$RPN_i = \sum_{j=1}^{m} \left| RV_{ij} \psi_j W_{ij} \right| \quad \ldots\ldots (3)$$

Priority of the risk variables to alleviate is started by the risk variable which has the largest risk priority number descending to the risk variable which has the least risk priority score.

The steps to implement the integrated PSI and Prospect Theory model into Supply Chain sustainability risk evaluation is presented in the following.

Step 1. Identifying supply chain risk variables RV_i (i=1, 2, 3, …..m) and risk reprioritization criteria RC_j (j=1, 2, 3, … n).

Step 2. Constructing a risk decision matrix by arranging its column as risk reprioritization attributes and its rows as risk variable alternatives as shown in Table 6.

Table 6. A typical supply chain risk decision matrix

	RC1	RC2	RC3	………	RCn
RV_1	P_{11}	P_{12}	P_{13}	………	P_{1n}
RV_2	P_{21}	P_{22}	P_{23}	………	P_{2n}
RV_3	P_{31}	P_{32}	P_{33}	………	P_{3n}
………	………	………	………	………	………
RV_m	P_{m1}	P_{m2}	P_{m3}	………	P_{mn}

Step 3. Normalizing decision matrix. For non-beneficial attributes, normalization of risk alternatives following equation 4.

$$RV_{ij} = \frac{P_{ij}}{P_{j,max}} \; ; \; \forall i, j, \quad \ldots\ldots (4)$$

Meanwhile, for the beneficial type risk reprioritization attribute, normalize the decision matrix using equation 5.

$$RV_{ij}=\frac{P_{j,min}}{P_{ij}}\ ;\ \forall i,j, \qquad (5)$$

Step 4. Computing mean value of normalized data for risk attribute j $\overline{R_j}$. This step is accomplished by using equation 6.

$$\overline{R}_j=\frac{1}{m}\sum_{i=1}^{m} RV_{ij}\ \ \forall i,j \qquad (6)$$

Step 5. Computing preference variation value for each risk attribute j for every risk element R_{ij}. Computation of the preference variation value is accomplished by using equation 7.

$$PV_j=\frac{1}{m}\sum_{i=1}^{n}\left[R_{ij}-\overline{R}j\right]^2 \qquad (7)$$

Step 6. Determining deviation preference value of each risk criteria *j* using equation 8.

$$\boldsymbol{\phi}_j = |1-PV_j\ | \qquad (8)$$

Step 7. Calculating the overall preference value of risk criteria $\boldsymbol{\psi}_j$ by using equation 9.

$$\boldsymbol{\psi}_j = \frac{\phi j}{\sum_{j=1}^{m}\phi j} \qquad (9)$$

Step 8. Calculate preference selection index of each risk variable RV_{ij} using equation 10.

$$PSI_i = RV_{ij}\psi_j \qquad (10)$$

The result of this step is the preference score of each risk reprioritization attributes as a surrogate of the risk priority number of every risk variable.

Step 9. Determining reference points for each risk attribute using equation 10.

$$\varphi_j = \frac{\mu_j}{\sum_{i=1}^{m} d_{ij}} \qquad (10)$$

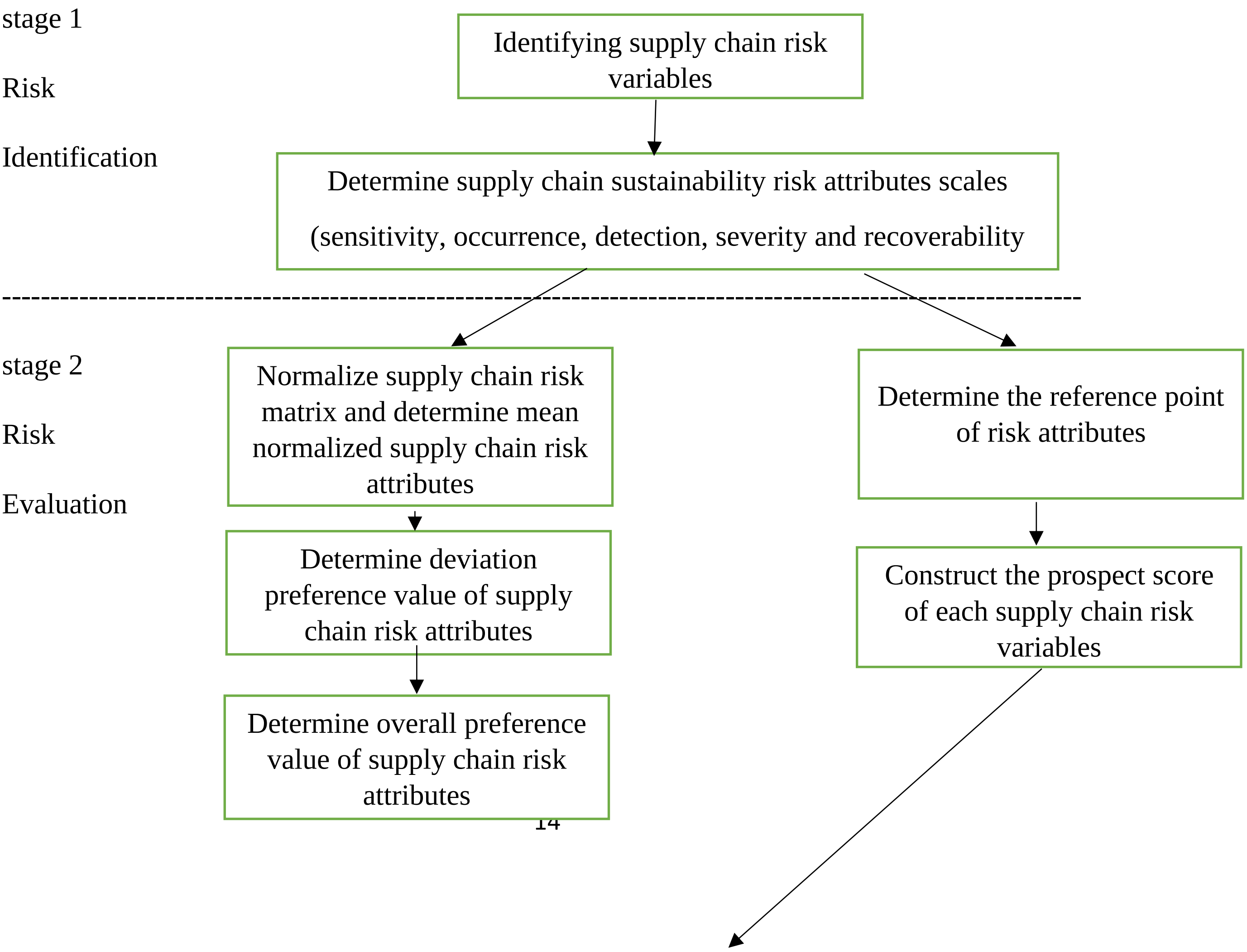
Step 10. Determining the score of prospect value score w_{ij} of each risk variable using equations (1) and (2) depending on the data type. For increasing function value, use equation 1, in reverse, for decreasing function value, equation 2 is used.

Step 11. Determining the risk priority number of each risk variable based on the value RPN_i using equation 11.

$$RPN_i= \sum_{j=1}^{m}\left|RV_{ij}\psi_j w_{ij}\right| \qquad (11)$$

Selecting the priority ranking of each supply chain risk variable based on the RPN_i scores. The supply chain risk variable which has the largest risk priority score is chosen as the first priority.

A flowchart depicting the integration of the PSI and Prospect Theory is then presented in Figure 1.



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Stage 3

Supply Chain

Risk Ranking

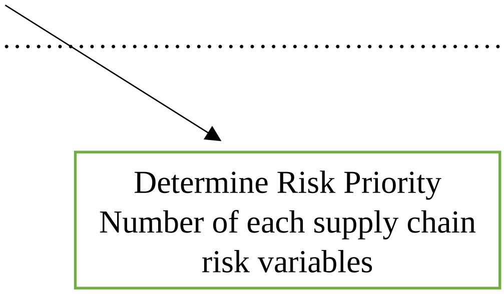

Figure 1. The flowchart of the proposed supply chain risk assessment model.

4. Methodology

A model representing the integration of the PSI and Prospect theory is validated using a case example (Yin, 2014). The SMEs sector chosen for the study is coming from the Moslem fashion industry which represents one of the key SMEs sectors in Indonesia. Moslem fashion industry is chosen as representative sector in the case study considering its significant economic impact. According to Dewi *et al*. (2015) the contribution of the Moslem fashion industry in Indonesia is more than 44% of the Indonesian Gross Domestic Brutto. As reported by Isfianadewi *et al*. (2015), it is also contributing to more than 50% of the national revenue from the creative industry. The data collection process is accomplished in two stages. In the first stage, an extensive literature review is undertaken to obtain the sustainability risks model and later those are confirmed by the experts. Next, a structured questionnaire is used to verify the score of the sustainability risk reprioritization criteria using a Likert 1 to 5 scale. The reference point of risk reprioritization criteria is sent to the experts to determine the score of the risk reprioritization criteria. The categorization of operational risk variables is derived from theoretical variables followed by validation from the SMEs practitioners is then presented in Table 7.

Table 7. Categorization of Supply chain sustainability risk variables from case example

Supply chain risk dimension	Supply chain risk category	Reference	Supply chain risk element validated from the experts
Economical Risk	Competition risk	Schulte and Hallstadt (2017)	Price Competition against imported product
			The entrance of new competitors
	Market risk	Dewi *et al*., (2015) Puniyamoorthy *et al*. (2013)	The change of customers Preference
	Product brand risk	Schulte and Hallstadt (2017)	Less known product brand
Environmental Risk	Production process waste risk	Gianakis and Papadopoulos (2016), Oliviera et al., (2019)	By product waste
	Natural disaster	Gianakis and Papadopoulos (2016)	Earthquake, hurricane, flood
		Gianakis and Papadopoulos (2016)	Disease
Social Risk	Labor practice risk	Cunha *et al*., (2021)	Uncomfortable production facility condition
			Unavailability of insurance for workers
Institutional Risk	Governmental risk	Hadiguna (2012)	Inflexible governmental policy
	Regulatory compliant risk		Noncompliance to governmental standard/regulation
Operational Risk	Supplier risk	Ebrahimi *et al*., (2019)	Unreliable suppliers
	Production Facility risk	Hudnurkar *et al*., (2021), Shahbaz *et al*., (2019)	Production machine failure

	Demand risk	Shahbaz *et al,*. (2019)	Error in determining customer demand
	Quality risk	Ghadge *et al*., (2017)	Low quality of raw material and process quality control
	Knowledge risk	Durst and Zieba (2020)	Insufficiency on risk management know how
			Lack of innovation capability
	Behavioral risk	Ragunath and Devi (2018)	Reactively in preventing risk occurrence
			Ignoring the importance of product intellectual property
	Human resource risk	Hudnurkar *et al*., (2017), Cunha *et al*., (2019)	Employee turn over
			Scarcity of talent

In the second stage, a comparative study between using conventional supply chain FMEA, standalone PSI method, and integrated method of the PSI and the Prospect Theory is used to demonstrate the applicability of the model in practical situations.

4.1. Determination of the supply chain risk reprioritization criteria and risk reference point of a case example.

In this paper, five supply chain sustainability risk reprioritization criteria are used. The scale and linguistic interpretation of these five risk reprioritization parameters are presented in Table 8. Meanwhile demanded trends of the supply chain risk reprioritization parameters are then presented in Table 9. And reference point as a basis for risk evaluation is given in Table 10.

Table 8. Risk Reprioritization Parameters

Score	Linguistic Interpretation	Supply chain risk Sensitivity level	Supply chain risk occurrence level	Supply chain risk detectability level	Supply chain risk severity level	supply chain recoverability capability level
1	Almost impossible/ Remote	the level of supply chain sensitivity is very low	possibility of risk event occurrence is very almost impossible	The occurrence of risk variables is directly observable by no means of a detection tool	The level of supply chain risk impact is negligible	The speed of the supply chain to recover is very fast
2	Very small	The sensitivity level of the supply chain against the impact of risk is very small	Possibility of risk event occurrence is very small	the level of supply chain risk detectability is very small	The effect of risk event occurrence is annoying customers	the speed of the supply chain to recover is fast
3	Medium	The sensitivity level of the supply chain against the impact of risk is medium	Possibility of risk event occurrence is medium	the level of supply chain risk detectability is medium	The effect of a risk event is moderately annoying customers	the speed of supply chain to recovery is medium
4	High	The sensitivity level of the supply chain against the impact of risk is high	Possibility of risk event occurrence is medium	the level of supply chain risk detectability is high	The effect of a risk event is violating regulations	the speed of the supply chain to recovery is low
5	Very high	The sensitivity level of the supply chain against risk events is very high	Possibility of risk event occurrence is almost certain	the level of supply chain risk detectability is easily detected with certainty	The effect of a risk event is threatening human lives and the environment	Recoverability of the supply chain is very late and demanding intervention from organizations outside of the company

Table 9. Description of risk reprioritization parameter and their implication

Risk Reprioritization Parameter	**Description**	**Implications**	**Demanded trends**
Risk occurrence (O)	The number of a particular risk event that occurs	The higher the risk event occurrence, the higher the rating	Smaller the better
Risk detectability (D)	Possibility of a risk event can be detected	The higher the detectability the lower the rating	Larger the better
Risk sensitivity (SN)	The level of ease of being affected by a risk factor	The easier being affected the higher is the rating	Smaller the better
Risk severity (S)	The level of impact caused by a risk factor	The more serious the impact of the risk effect, the higher is the rating	Smaller the better
Risk recoverability (R)	The speed of a supply chain recovers from disruption caused by a risk factor	The higher the speed of recoverability, the smaller is the rating	Larger the better

Among five risk reprioritization parameters, risk detectability and risk recoverability are categorized into larger the better target, while other parameters, risk occurrence, severity and sensitivity are classified as lower the better category.

The reference point of the case example is presented in Table 10.

Table 10. Reference points of each risk criterion

No	Supply Chain Risk Sensitivity level	Supply Chain risk occurrence level	Supply Chain risk detectability level	Supply Chain Risk severity level	supply chain recoverability capability level
1	1	1	1	1	2

The score of every supply chain risk reprioritization in each column is obtained from the mean rating scale provided by the experts.

Table 11. Supply chain risk reprioritization scale of case example

Supply chain risk dimension	Supply chain risk category	Supply chain sustainability risk factors	Supply chain risk Sensitivity level	Supply chain risk occurrence level	Supply chain risk detectability level	Supply chain risk severity level	supply chain recoverability capability level
Economic risk	Competition risk	Price competition against	2,6	3,8	2	2	1,8

		imported product					
		The entrance of new competitors	3,2	3,4	2,2	3	2
	Market risk	The change of customers Preference	3,2	2,6	2,2	2,8	1,4
	Product brand Risk	Less known product brand	3	1	2	2	2
Environmental risk	Process waste risk	By product waste	2	2	1,8	3	1,8
	Disaster risk	Earthquake, hurricane and flood	2,2	1,4	2	2,6	1,6
		Pandemic	3	1,4	2	2,6	1,6
Social risk	Facility risk	Uncomfortable production facility	2,6	1,4	1,2	2,4	1,4
	Worker insurability risk	Unavailability of insurance for workers	2,2	1,2	1,2	2,2	2,2
Institutional risk	Governmental risk	Inflexible governmental policy	2,2	2,4	2	2,2	1,8
	Compliance Risk	Compliance issue to governmental regulations	1,8	2,4	2,4	1,8	1,6
Operational risk	Supplier risk	Unreliable suppliers	2,2	2	3	2,8	1,6
	Production facility risk	Production facility failure	2,4	2	1,4	1,8	1,8
	Demand risk	Error in determining customer demand	2,6	2	1,4	1,8	1,8
	Behavioral risk	Reactively in preventing risk occurrence	1,8	1,6	1,4	2,4	1,8
		Ignoring the importance	2,2	1,6	1,8	3	1,6

		of product intellectual property					
	Human resource risk	Employee turn over	3,2	2	1,6	2,8	1,4
		Scarcity of talents	2	2,2	3	3	1,8
	Knowledge Risk	Insufficiency on risk management know how	2,8	1,6	1,6	3	1,4
		Lack of innovation capability	3,2	1,6	1,8	3	2
	Quality risk	Low quality of raw material and process quality control	4,1	1	1,2	2,2	2
		Mean	64,5	40.6	39,4	50,6	36,4

Number of Risk factors N = 21 risks.

4.2.Determination of overall risk preference score and value function of each risk element of case example.

Overall preference score of risk reprioritization attribute is representing the relative importance of supply chain risk reprioritization criteria. It is obtainable by undertaking calculation from risk decision matrix from Table 3 by using equation 3 until equation 9. The score of overall preference score of risk attributes of the case example is presented in Table 12.

Table 12. Calculation of overall preference score of risk attributes.

Supply Chain Risk Sensitivity level	Supply Chain risk occurrence level	Supply Chain risk detectability level	Supply Chain Risk severity level	Supply chain recoverability level
0.2795	0.0858	0.2899	0.2975	0.0473

Next, based on equation 10, the priority score of every risk element of the case example is then presented in Table 13.

Table 13. Supply chain Risk Priority of case example using the PSI approach

Supply chain risk dimension	Supply chain risk category	Supply chain sustainability risk factors	Risk priority score
Economic risk	Competition risk	Price competition against imported product	1.714
		The entrance of new competitors	5.441
	Market risk	The change of customers Preference	4.662
	Product brand risk	Less known product brand	2.963
Environmental risk	Process waste Risk	By product waste	3.774
	Disaster risk	Earthquake, hurricane and flood	3.245
		Pandemic	3.468
Social risk	Facility risk	Uncomfortable production facility	3.055
	Worker insurability risk	Unavailability of insurance for workers	2.749
Institutional risk	Governmental risk	Inflexible governmental policy	3.984
	Compliance risk	Compliance issue to governmental regulations	3.869
Operational risk	Supplier risk	Unreliable suppliers	4.109
	Production facility risk	Production facility failure	3.413
	Demand risk	Error in determining customer demand	3.469
	Behavioural risk	Reactively in preventing risk occurrence	3.080
		Ignoring the importance of product intellectual property	3.447
	Human resource risk	Employee turn over	3.973
		Scarcity of talents	4.233
	Knowledge risk	Insufficiency in risk management know-how	3.577
		Lack of innovation capability	3.830
	Quality risk	Low quality of raw material and process quality control	3.100

The score of prospect value of each risk variable is counted by normalizing risk criteria reference point using equation 11 and followed by using equation 12. Then, the result of counting the score of prospect value of every risk variable from the case example is presented in Table 14.

Table 14. The score of prospect value of each risk variable from case example

			Decreasing value			**Increasing Value**		
Supply chain risk dimension	**Supply chain risk category**	**Supply chain sustainability Risk factor**	Occurence	Severity	Sensitivity	Detectability	Recoverability	Value Function Score
Economic risk	Competition risk	Price competition against imported product	0.099	0.006	-0.713	0.058	0.001	-0.555
		The entrance of new competitors	0.109	0.144	-0.152	0.058	0.0450	0.204
	Market risk	The change of customers Preference	0.102	0.142	0.289	0.046	0.0218	0.555
	Product brand risk	Less known product brand	0.285	0.044	0.122	0.322	0.045	0.818
Environmental risk	Process waste risk	By product waste	0.091	0.145	0.264	0.322	0.009	0.831
	Disaster risk	Earthquake hurricane and flood	0.283	0.077	0.144	0.039	0.0298	0.572
		Pandemic	0.137	0.072	0.281	0.039	0.029	0.056
Social Risk	Facility risk	Uncomfortable production facility	0.134	0.071	0.279	0.009	0.029	0.522
	Worker insurability risk	Unavailability of insurance for workers	0.061	0.013	0.271	0.009	0.029	0.383

Institutional risk	Governmental risk	Inflexible governmental policy	0.099	0.128	0.271	0.058	0.001	0.556
	Compliance Risk	Compliance issue to governmental regulations	0.114	0.099	0.258	0.058	0.023	0.494
Operational risk	Supplier risk	Unreliable suppliers	0.099	0.142	0.271	0.072	0.037	0.532
	Production Facility Risk	Production facility failure	0.091	0.115	0.276	0.0175	0.037	0.534
	Demand risk	Error in determining customer demand	0.091	0.223	0.301	0.017	0.023	0.655
	Behavioral risk	Reactively in preventing risk occurrence	0.0134	0.091	0.258	0.0175	0.028	0.407
		Ignoring the importance of product intellectual property	0.144	0.081	0.271	0.032	0.037	0.565
	Human resource risk	Employee turn over	0.142	0.040	0.289	0.072	0.021	0.564
		Scarcity of talents	0.010	0.096	0.264	0.072	0.037	0.479
	Knowledge risk	Insufficiency on risk management know how	0.077	0.077	0.283	0.046	0.021	0.504
		Lack of innovation capability	0.144	0.079	-0.303	0.0322	0.003	-0.075
	Quality risk	Low quality of raw material	0.128	0.044	0.297	0.099	0.045	0.613

		and process quality control						

Next, to investigate the impact of different risk reprioritization approach using conventional supply chain FMEA, using the PSI stand-alone method and integrated the PSI and Prospect Theory is accomplished and the results are presented in Table 15.

4.3.Comparison on risk priority ranking using Conventional FMEA, the PSI alone and The Model

Table 15. Comparison of supply chain risk ranking among conventional supply chain FMEA, The PSI and Integrating the Prospect Theory into the PSI

Supply chain risk dimension	Supply chain risk category	Supply chain sustainability risk factors	Risk priority number Using conventional FMEA	Priority rank	The psi alone	Priority rank	The model (The psi and prospect theory)	Priority rank
Economic risk	Competition risk	Price competition against imported product	15.20	2	1.71	4	0.64	4
		The entrance of new competitors	14.96	3	5.44	1	1.08	3
	Market risk	The change of customers Preference	16.01	1	4.66	2	2.56	1
	Product Brand Risk	Less known product brand	4.0	4	2.96	3	2.42	2
Environmental risk	Process waste risk	By product waste	10.8	1	3.77	1	3.13	1
	Disaster risk	Earthquake, hurricane and flood	7.28	2	3.24	3	3.10	2
		Pandemic	7.28	2	3.46	2	0.19	3
Social risk	Facility risk	Uncomfortable production facility	3.45	1	3.05	1	1.59	1
	Worker insurability risk	Unavailability of insurance for workers	3.16	2	2.75	2	1.32	2
Institutional risk	Governmental risk	Inflexible governmental policy	10.56	1	3.98	1	2.22	1

	Compliance risk	Compliance issue to governmental regulations	10.36	2	3.87	2	1.93	2
Operational Risk	Supplier risk	Unreliable suppliers	16.80	1	4.10	2	2.17	3
	Production facility risk	Production facility failure	5.04	7	3.41	8	1.80	7
	Demand risk	Error in determining customer demand	5,37	6	3.46	7	2.25	2
	Behavioral risk	Reactively in preventing risk occurrence	5.37	6	3.08	10	1.25	9
		Ignoring the importance of product intellectual property	8.64	4	3.48	4	1.94	5
	Human resource risk	Employee turn over	8.96	3	3.97	3	2.22	1
		Scarcity of talents	13.2	2	4.23	1	1.99	4
	Knowledge risk	Insufficiency on risk management know-how	7.68	5	3.56	6	1.78	8
		Lack of innovation capability	8.64	4	3.83	5	0.27	10
	Quality risk	Low quality of raw material and process quality control	2.64	8	3.10	9	1.90	6

Comparing the result of applying the conventional supply chain FMEA model to the Preference Selection Index (PSI), except for three risk variables “By-product waste”, “Uncomfortable production process facility” and ‘Inflexible government policy” the priority ranking of case example is showing different priorities to almost all other risk elements. This indicates that the inclusion of additional risk reprioritization criteria, the sensitivity and recoverability of the supply chain against the impact of a certain risk element are affecting the priority of risk and those two criteria should be taken into consideration in taking risk assessment effort.

Similarly, by taking comparison on using the PSI method solely and inclusion of decision-makers behavior which manifested by the prospect value score of every risk element of case example, except for the two risk elements, “Uncomfortable production facility” and ‘Inflexible governmental policy’, the priority ranking of risks of all other risk elements from case example are showing different priority score. When using the conventional FMEA as a risk assessment approach, the most critical risk is “Unreliable suppliers” as a top priority. However, when using the PSI method and considering sensitivity and recoverability of the supply chain, the most important risk is “The entrance of new competitors”. If decision-makers risk behavior is considered “By-product process waste “is assigned as the top priority ranking.

The above comparative study is also showing different risk priority scores among all risk variables compared. The difference in risk priority assignment is reasonable as the methodological approaches used by the three methods are different. In conventional supply chain, FMEA using three risk reprioritization criteria, relative importance or relative weight of risk reprioritization criteria is ignored. Meanwhile, in the PSI method, determination of risk priority ranking is based on the relative weight of risk reprioritization criteria and considered the impact of two other risk reprioritization criteria, sensitivity and recoverability of supply chain against the influence of a particular risk. When considering the influence of decision-makers in determining the risk priority, the prospect value score of every risk element is taken into consideration.

When using the conventional FMEA as a risk assessment approach, the most critical risk is ‘Unreliable suppliers” as a top priority. But when using the PSI method and considering sensitivity and recoverability of the supply chain, the most important risk is “The entrance of new competitors”. If decision-makers risk behavior is considered and integrated into the PSI, “By-product process waste “is assigned as the top priority ranking.

In the economic risk dimension, the risk that has the highest RPN score is the risk in the form of "Changes in customer preference". This finding is also in line with the results of a study from (Fitrani and Christi, 2018) that for the fashion industry, typical market risk in the form of "Changes in customer preference" is one of the most influential types of risk in the fashion industry.

In environmental risk, production process waste is the perceived risk that has the most impact on the company. Garbage resulting from the fashion production process is a typical environmental risk is which is perceived as more impacting influence because of the frequency of the byproduct waste occurrence from the production process compared to other environmental risk modes since natural disasters and disease (pandemic) which have a very small frequency of occurrence and are difficult to detect when it will occur.

From the governmental risk perspective, out of two confirmed risks, the impact of governmental risk is significant for the sustainability of SMEs operation in particular when it is linked to the flexibility of providing business credits compared to the second institutional type risk type.

Of the two social risks, facility risk is the risk that mostly affects worker productivity and comfort working place. Therefore, it is considered more influential than the risk of not having health insurance for workers because usually the recruitment of employees in SMEs is based on family relationships that do not require a formal employment contract that requires the provision of insurance health.

For operational risk, the risk element that is most significant is “Demand risk”. This happens because the fashion industry is an industry that is classified as demand-driven industry. Thus, uncertainty and error in determining consumer needs will greatly affect business continuity. This confirms the findings of Sumarliah (2021), McMaster *et al*. (2020), Martino *et al.* (2017) and Dash and Nalam (2009) who declared that demand risk is very critical in the fashion industry.

4.4.Comparison on Cumulative Impact among Conventional Supply Chain FMEA, The PSI stand-alone and The Model

The relative impact of sustainability risk dimensions of the case example is compared and presented in Table 16.

Table 16. Comparative studies on the impact of supply chain sustainability risk dimensions using three risk reprioritization approaches.

Supply chain risk dimension	**Supply chain risk category**	**Supply chain risk element validated from the experts**	**Risk priority number**		
			Conventional supply chain FMEA	**PSI Method**	**The proposed model**
Economical risk	Competition risk	Price competition against imported product	15.20	1.71	0.64
		The entrance of new competitors	14.96	5.44	1.08
	Market risk	The change of customers Preference	16.01	4.66	2.56
	Product brand risk	Less known product brand	4	2.96	2.42
		Sum	50.17	14.77	6.7
Environmental risk	Production process waste risk	By product waste	10.8	3.77	3.13
	Natural disaster	Earthquake, hurricane, flood	7.28	3.24	3.10
		Pandemic	7.28	3.46	0.19
		Sum	25.36	10.47	6.42
Social risk	Labour practice risks	Uncomfortable production facility condition	3.45	3.05	1.59
		Unavailability of insurance for workers	3.16	2.75	1.32
		Sum	6.61	5.80	2.91
Institutional risk	Governmental risk	Inflexible governmental policy	10.56	3.98	2.22
	Compliance risk	Noncompliance issue to governmental standard/regulation	10.36	3.87	1.93
		Sum	20.92	7.85	4.15

Operational risk	Supplier Risk	Unreliable suppliers	16.80	4.10	2.71
	Production Facility Risk	Production machine failure	5.04	3.41	1.80
	Demand Risk	Error in determining customer demand	5.37	3.46	2.25
	Quality Risk	Low quality of raw material and process quality control	2.64	3.10	1.90
	Knowledge risk	Insufficiency on risk management know-how	7.68	3.56	1.78
		Lack of innovation capability	8.64	3.83	0.27
	Behavioral risk	Reactively in preventing risk occurrence	5.37	3.08	1.25
		Ignoring the importance of product intellectual property	8.64	3.48	1.94
	Human resource risk	Employee turn over	8.96	3.97	2.22
		Scarcity of talent	13.2	4.23	1.99
		Sum	82.34	36.22	18.11

Table 16 shows comparative studies on the impact of supply chain sustainability risk dimensions when using three risk reprioritization approaches. Using the conventional supply chain FMEA model, the most impacting sustainability risk is “Operational risk” followed by ‘Economical risk”, “Environmental risk”, “Governmental risk” and “Social risk” as the last risk dimension. Following the result of estimating the impact of sustainability risk dimension using the PSI method, the first priority of sustainability dimension is occupied by “Operational risk” as the first rank, “Economical risk” as the second rank, “Environmental risk” as the third rank and “Governmental risk” and “Social risk” as the fourth and fifth risk rank respectively. Taking the proposed model shows no difference in risk dimension ranking as first, second and third risk dimensions are still occupied by ‘Operational risk”, ‘Economical risk” and “Environmental risk”. The fourth and fifth rank is assigned to “Governmental risk” and “Social risk”. Accordingly, the priority risk of dimension is the same as all risk dimensions of the case example. This result indicates that operational risks are still perceived as the most impacting risks affecting the sustainability of enterprises. In reverse, social risks are still perceived as the least risky risks.

5. Results and Discussions

Motivated by limitation of empirical studies on supply chain sustainability risk assessment in the small and medium enterprise environments in a developing country, scarcity of scientific effort in adopting the PSI as a multi-criteria decision-making tool and the limited number of studies in using the Prospect Theory in supply chain risk assessment, this study attempts to offer an integrated model of the PSI method and Prospect Theory as new decision support model to appraise the impact of sustainability risks in a developing country. Referring to our survey on the use of the PSI method in the supply chain sustainability risk assessment area, it is evident that such effort has not been reported in past research studies. The result of this study confirms the importance of considering decision-makers risk behavior which affect the risk priority decision making and choose the most appropriate risk alleviation strategy. Our study shows that the operational risk dimension is still perceived as the most impacting risk in the context of developing country and social risk is still perceived as the least important risk to consider.

5.1 Contribution to the supply chain risk management theory

Past studies showed that supply chain risk assessment in the context of small and medium enterprises in a developing country is mostly using the traditional supply chain risk FMEA. This rely on the use of the RPN as a risk metric based on the three risk criteria and pairwise comparison among risk criteria is mostly becoming the basis to determine risk priority ranking. Furthermore decision-makers risk behavior and vulnerability and resiliency of supply chain as influential risk prioritization criteria are almost overlooked in taking risk decision making. Evidently, as this study found, no previous scientific attempt is presented on the promotion of the PSI as a decision-making tool in supply chain risk evaluation despite its simplicity for use. In filling these gaps, a new decision support model of supply chain sustainability risk based on the PSI method considering vulnerability, resiliency and decision-makers risk preference is presented and empirically tested using a case example. The study offers an alternative risk assessment model instead of reliance on pairwise and consistency checking by using the AHP/ANP and or the BWM methods.

The proposed study provides a new offering on how to consider vulnerability and resilience as additional risk attributes and also risk behavior of decision-makers in an integrated manner embedded in the PSI which never been presented by previous scholars. Although previous studies have already used prospect theory in risk management, our study shows that the use of the Prospect theory in supply chain risk assessment is missing.

Moreover, this study applies such a model in the context of sustainability of SMEs in a developing country which has never been reported in previous works. The proposed model offering an improved approach to accessing sustainability of the supply chain in relation to which most critical supply chain risks should be monitored and alleviated considering decision-makers risk behavior.

5.2 Contribution to the supply chain risk managerial practice

Presenting the application of the integrated PSI and the Prospect Theory in evaluating supply chain sustainability risks, several offerings to the risk management practices are as follows. At first, this study offers an exemplar of how to consider the sensitivity and recovery capability of their supply chain against the impact of adverse events and how to consider their risk preference in making risk priority decision making which enables to make a more realistic decision making. Secondly, this study attempts to offer a categorization of supply chain risks whose impact is potentially affecting the continuity of their business operation within sustainability pillars. Thirdly, this study guides SMEs decision-makers to identify which risk variables are mostly impacting their business whether those risks are coming from internal or external enterprise organizations.

5.3. Limitations

Similar to the other type of scientific works, considering that application of the model is limited only to a few SMEs. The validity and relevancy of the supply chain risk ranking approach is limited to the SMEs in the fashion supply chain only and demanding replication to other sectors and additional case examples. Secondly, limitations related to the possibility of other types of risks are not considered in this study. Thirdly, risk elements presented in this study is based on the views of the SME owners and managers and are not considering other stakeholders like governmental offices and customers. Fourthly, the risk reprioritization model presented is based on consideration of independence among risk variables and risk reprioritization criteria which is contrary in a practical setting. Furthermore, reliance on the assumption of consensus to reach reference points in group-based risk assessment is hard to found in industrial practices and determination on the score of α is accomplish subjectively. This study excludes Information Technology as a risk dimension that shall be taken into consideration.   Regzdeh and Shoukohyar (2020) advised further supply chain sustainability risk evaluation in a more comprehensive way. At last, the relative importance of every risk dimension among the five pillars of sustainability and the age of decision makers working experience are not considered in making risk appraisal.

6. Conclusions and New Research Paths

This paper presents the application of integrating the PSI method and the Prospect Theory to select critical supply chain sustainability risks in the context of SMEs in a developing country. The PSI method is intended to determine the weight of the risk reprioritization criteria instead of the AHP and the entropy approach. Meanwhile, prospect theory is included to accommodate decision-makers preferences in assigning risk preference scores. Next, considering the influence of supply chain vulnerability and resiliency, additional risk reprioritization criteria are included in the supply chain risk appraisal model. A case example related to the evaluation of the SME supply chain sustainability risk in the retail fashion supply chain is presented to demonstrate its applicability in the practical situation. A comparative study confirms for not ignoring the influence of additional risk criteria and decision-makers risk preference. The result of applying the model shows critical risk elements in every risk category and concluded that in view of the SME decision-makers in the case study, operational risks are still perceived as the most impacting risks for their business operation and leaving social risks as the least risky dimension. Promoting the application of the PSI method in the supply chain sustainability risk area, several potential research directions are recommended to dig in future studies. At first, deleting the assumption independence on risk variables and supply chain risk reprioritization criteria demands deeper study. Next, deleting consensus to reach reference points in group-based risk assessment and determination of the score of α in a more objective way is vacant in supply chain risk assessment studies. Secondly, considering the uncertainty of the boundary of the risk ranking scale, integrating the use of the Grey Relational Analysis (GRA) method into the proposed model is worth investigating. As this study only considers sensitivity and recovery time from the impact of a risk element, comparing the performance of the proposed model with the inclusion of additional vulnerability and resilience attributes using other multicriteria decision-making tools is another research direction worth pursuing.

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