Sustainable Production and Consumption 28 (2021) 543–555

Contents lists available at ScienceDirect

Sustainable Production and Consumption

journal homepage: www.elsevier.com/locate/spc

Research article

Prioritising risk mitigation strategies for environmentally sustainable clothing supply chains: Insights from selected organisational theories

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A R T I C L E I N F O

Article history:
Received 12 January 2021
Revised 15 June 2021
Accepted 17 June 2021
Available online 24 June 2021

Editor: Dr. Charbel Jabbour

Keywords:
Clothing supply chain
Environmental sustainability
Fuzzy TOPSIS
Risk mitigation strategies
Resource dependence
Supply chain risks

A B S T R A C T

Recent outbreak of COVID-19 pandemic has provided strong impetus to supply chain resilience research. In a volatile and uncertain business environment, resilience can be incorporated by developing and implementing effective risk mitigation strategies. In this research, risk mitigation strategies for environmentally sustainable clothing supply chain have been prioritised by considering their efficacy to mitigate various risks. Twelve risks and thirteen mitigation strategies, identified through literature review and experts' opinion, are considered as decision criteria and alternatives respectively. Fuzzy Technique for Order Preference by Similarity to Ideal Solutions (fuzzy TOPSIS) is implemented under a group decision making scenario for prioritising the strategies. Developing supply chain agility; multiple green sourcing and flexible capacities; adoption of green practices; building trust, coordination and collaboration; and alignment of economic incentives and revenue sharing are found to be dominant risk mitigation strategies for environmentally sustainable clothing supply chain. These strategies have been viewed through the lens of resource dependence, change management and transaction cost theories. Organisation desirous to build resilience in their supply chain can prioritise the risk mitigation strategies and adopt a portfolio of strategies based on the outcome of this research.

1. Introduction

Sustainable supply chain (SSC) refers to the "proficiency in meeting the current generation's needs without relying on future generation's technologies and requirements" (Mani et al., 2018). SSC integrates three dimensions of sustainability or triple bottom line, namely environmental, social, and economic (Xu et al., 2019; Gardas et al., 2019). The primary responsibilities of firms implementing environmentally SSC revolve around minimising the hazardous impacts on environment that has a positive impact on leanness (Dues et al., 2013). Integration of environmental dimension into the strategic plan and operational practices ensures competitive advantage to the firm (Sarkis, 2003). Besides, environmentally SSC, in general, shows better financial performance, thereby making it economically viable (King and Lenox, 2001; Lo et al., 2012).

Every supply chain is susceptible to risks and disruptions which are defined as unpredictable events affecting the flows, either partially or completely, in supply chain. Risks are classified under demand, supply, process, finance, information, business environment, natural disasters (flood, earthquake, etc.) and pandemics (SARS, COVID-19, etc.) (Samvedi at al., 2013; Ivanov, 2020; Karmaker et al., 2021; Majumdar et al, 2020; Moktadir et al., 2021). In recent years, risk management and resilience in SSC have attracted the attention of researchers (Rostamzadeh et al., 2018; Oliveira et al., 2019; Xu et al., 2019; He et al., 2021; Hsu et al., 2021). Resilience in supply chain implies that the organisations and their network should adjust or maintain essential functions under stressful and unfavourable conditions (Heckmann et al., 2015). Supply chain strategy of an organisation mandates the development and adoption of a risk mitigation portfolio to build resilience. Although several aspects of risk mitigation have been investigated by researchers, most of them have focussed on generic supply chain (Chopra and Sodhi, 2004; Christopher and Peck, 2004; Norrman and Jansson, 2004; Tang, 2006; Faisal et al., 2006; Diabat et al., 2012; Chen at al., 2013; Wang et al., 2017).

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https://doi.org/10.1016/j.spc.2021.06.021
2352-5509/

Clothing supply chain not only employs large workforce, mostly unskilled or semi-skilled, but also uses huge amount of water and other natural resources (Majumdar and Sinha, 2019; Majumdar and Sinha, 2021). Moreover, textile and clothing is the second most polluting supply chain after petrochemicals and accounts for around 20 % of the total industrial water pollution according to an estimate of World Bank (Holkar et al., 2016). Besides, a large number of harmful and carcinogenic chemicals are used in the chemical processing of textiles and clothing. This often creates violation of sustainability norms specially in emerging economies, like India, where the legislations are either lax or the enforcement is not stringent (Caniato et al., 2012; Mathiazhagan et al., 2013). For example, around 750 textile dyeing and printing units in Tirupur, India, were closed in 2010 as these units failed to comply with the zero liquid discharge norm which was made mandatory by the Madras High Court (Valeur, 2013). In spite of these staggering examples, risk management in SSC of clothing industry has not received adequate attention from the researchers (Diabat et al., 2014; Xu et al., 2019). However, the demand for green clothing, manufactured by using natural fibres cultivated organically without any harmful pesticides and then processed without using harmful chemicals and dyes, is increasing among the ethical and caring consumers. As a consequence, the textile and clothing supply chains are facing pressures to embrace SSC practices.

The specific risks related to environmentally sustainable clothing supply chain like unavailability of green materials, demand uncertainty of green products, high investment and low return of green investment, etc. are a bit different from those of other supply chains (Majumdar et al., 2021). Therefore, the generic risk mitigation strategies may not be very apt for environmentally sustainable clothing supply chain. Though risk mitigation is one of the heavily researched areas in supply chain (Sinha et al., 2004; Samvedi at al., 2013; Wijethilake and Lama, 2019), prioritising risk mitigation strategies in environmentally SSC has not received adequate attention. To the best of our knowledge, there is only one published research (Mangla et al., 2015) that has attempted to prioritise risk mitigation strategies for environmentally SSC of plastic industry. From the ongoing discussion, the following research questions are formulated.

RQ1: How to prioritise the risk mitigation strategies for sustainable clothing supply chain?

RQ2: How various strategies mitigate the risks in sustainable clothing supply chain?

RQ3: How the risk mitigation strategies can be viewed through the lens of pertinent organisational theories?

To answer the aforesaid questions, an attempt has been made in this research to prioritise the risk mitigation strategies for environmentally sustainable clothing supply chain. This research makes contributions firstly by presenting a decision making framework combining risks and their mitigation strategies and secondly, by addressing the specific need of risk mitigation strategies for environmentally sustainable clothing supply chain. Besides, this research propounds the significance of transaction cost economics theory and resource dependence theory in the context of supply chain risk mitigation.

Rest of the paper is organised as follows. Section 2 presents a brief literature review focusing on the risk management in supply chain. Section 3 describes the research methodology that includes fuzzy TOPSIS, data collection and implementation of the former. Section 4 presents the results and discussion. Finally, conclusions are presented in section 5.

2. Literature review

The literature review has been divided in two sections. As the present research revolves around the prioritisation of risk mitigation strategies, the review primarily focusses on the application of various quantitative and qualitative methods for risk management in supply chain. The first section presents the review of risk identification and assessment. The second section summarises the research works on risk mitigation strategies.

2.1. Risk identification and assessment

The first two steps of risk management are risk identification and risk assessment. Supply chain risks can be related to demand, supply, operation, finance, business environment and information (Samvedi et al., 2013; Majumdar et al., 2021). Green supplier failure, high cost of green materials and non-availability of green materials are some of the supply related risks whereas lack of demand, uncertainty of demand and key customer failure are some of the demand related risks (Christopher and Peck, 2004; Wang et al., 2012; Aqlan and Lam, 2015). Technology failure and technology change can also impose supply chain risk (Pfohl et al., 2011; Radivojevic and Gajovic, 2014). Lack of funding for green investment and exchange rate fluctuation are financial risks related to SSC (Manuj and Mentzer, 2008; . Natural disaster, pandemic, political instability, legislation etc. are some of the important business environment related risks (Radivojević and Gajović, 2014; Majumdar et al., 2021).

Several authors have used techniques like Analytic Hierarchy Process (AHP), fuzzy AHP, Technique for Order Preference by Similarity to Ideal Solutions (TOPSIS), Decision Making Trial and Evaluation Laboratory (DEMATEL), Interpretive Structural Modelling (ISM), Failure Mode and Effect Analysis (FMEA) and best-worst method (BWM) to assess supply chain risks. AHP and its variants are the most extensively used Multi-Criteria Decision Making (MCDM) tool for the modelling of supply chain risks (Gaudenzi and Borghesi, 2006; Wang et al., 2012; Radivojević and Gajović, 2014; Rostamzadeh et al., 2018; Ding et al., 2020).

Gaudenzi and Borghesi (2006) implemented AHP model to identify supply chain risks with an objective to improve customer satisfaction in dental and medical supply chain. Combined fuzzy AHP and fuzzy TOPSIS was implemented by Samvedi et al. (2013) for the risk analysis in Indian steel industry. This work showed an effective way to develop a risk index for a supply chain. Radivojević and Gajović (2014) also created a risk assessment model in supply chain based on AHP and fuzzy AHP. In a recent work, Moktadir et al. (2021) have used best-worst method to rank various risks in sustainable leather supply chain.

Some of the researchers have worked on the identification of risks in textile and clothing supply chain. Wang et al. (2012) used fuzzy AHP for risk assessment of different green initiatives adopted in the fashion supply chain. In another work on apparel retail chain, using Delphi and ISM, Venkatesh et al. (2015) found that globalisation, behavioural aspects of employees, and security and safety of resources are the driver risks, whereas customer satisfaction and financial risks are the driven risks in Indian context. In a recent research, Majumdar et al. (2021) identified risks related to the green clothing supply chain in context of South-east Asia using fuzzy AHP. The inter-relationship of potential supply chain risks at different levels, namely at first tier suppliers, at 3 PL, at the focal company, and from the external sources was analysed by Pfohl et al. (2011) using ISM. Diabat et al. (2012) also identified different risks in the food industry based on literature review, experts' consultation and ISM model.

2.2. Risk mitigation strategies

In uncertain and turbulent markets, one of the major challenges in supply chain is managing and mitigating risks by building resilience (Christopher and Peck, 2004). Tang (2006) suggested that postponement, strategic stock, flexible supply, flexible transportation, revenue management, dynamic assortment planning, and silent product rollover are the key strategies for supply chain risk mitigation. Besides, trust and collaborative relationships among supply chain partners and information and knowledge sharing, about the risks, are major drivers of supply chain risk mitigation (Faisal et al., 2006). Collaborations in three aspects, namely supplier collaboration, customer collaboration, and internal collaboration can mitigate the respective supply chain risks (Chen at al., 2013; Yoon et al., 2018). Adoption of cartel supply collaboration by upstream firm is profitable in terms of risks mitigation (Dai et al., 2017).

Multi-sourcing option and regionalising of supply chain are also effective strategies to mitigate supply and environmental risks (Kamalahmadi and Meller-Parast, 2016; Santillán-Saldivar et al., 2021). Sourcing intermediaries can augment the stability and reliability of supply chain by absorbing some of the risks (Vedel and Ellegaard, 2013). Brusset and Teller (2017) analysed the resiliency of supply chain and found that both tighter integrations between echelons and high flexibility increase the resiliency. In the same note, Behzadi et al. (2017) observed that the mixed combination of robustness and resiliency are very effective for the mitigation of risks in agriculture supply chain. Sreedevi and Saranga (2017) also reported that appropriate flexibility in the supply chain can mitigate supply, process and delivery risks. The type of firm also influences the supply chain risk management capability as service firms have higher strategic flexibility than manufacturing firms during financial crisis (Blome and Schoenherr, 2011).

In terms of methodologies, many researchers have explored FMEA for the risk mitigation and management. Chung and Chu (2016) studied the risks in aerospace technology industries using FMEA and identified the critical control points for risks. AHP based models were also developed by some researchers (Wang et al., 2012; Phonphoton and Pharino, 2019) for evaluating the risk mitigation strategies, whereas TOPSIS was employed by others (Mangla et al., 2015) In a recent work, best-worst method was used to improve the environmental risk mitigation strategies in chemical plants (Wang et al., 2020). A grounded theory based research conducted by Jayaram and Avittathur (2015) proposed that sustainable strategies like green design, product recovery and reverse logistics are the primary factors for implementation of environmentally SSC. Game theoretic approach has also been used by the researchers to develop risk mitigation strategies (Gao et al., 2018). Recently, Hsu et al. (2021) used quality function deployment (QFD) approach to prioritise resilience enhancing factors considering risk and resilience capabilities in fashion supply chain.

2.3. Organisational theories

There are many organisational theories by which the behaviour of firms and their actors in supply chain can be explained (Fan and Stevenson, 2018). Resource based view (RBV) theory (Akbar and Ahsan, 2019), resource dependence theory (Pfeffer and Salancik, 1978), transaction cost economics (TCE) theory (Meinlschmidt et al., 2018), change management theory, stakeholders' theory (Meixell and Luoma, 2015), institutional theory (Sancha et al., 2015; Koster et al., 2019), social capital theory (Kilubi and Rogers, 2018), dynamic capability theory (Baz and Ruel, 2021) etc. are some of the theories widely used in the context of supply chain management. According to RBV, organisations can achieve sustained competitive advantages by acquiring valuable and non-substitutable physical, human or organisational resources (Barney, 1991). The coordination of all these resources can improve the firms' competitive advantage (Baz and Ruel, 2021). Organisational resource dependence theory (RDT) states that every organisation tries to minimise its dependence on others for scarce resources. RDT also explains how the resources external to the organisations influence the behaviour of the organisations (Pfeffer and Salancik 1978; Xiao et al., 2019). Symbiotic resource dependency is achieved when both the firms help each other to achieve their respective organisational goals. Change management theory explains how individuals, teams and organisations prepare for and execute the changes under the driving forces like technology, consumer demand, competitive pressure, organisational restructuring, etc. TCE theory posits that an organisation's make-or-buy decision is determined by the procurement cost in conjugation with the transaction costs (Grover and Malhotra, 2003). Ex-ante transactions costs are related to information-seeking and negotiation of contractual terms, whereas ex-post costs arise from monitoring and enforcement of contractual agreements. As supply chain network incorporates multiple organisations, these theories can elucidate the behaviour of firms in different scenarios.

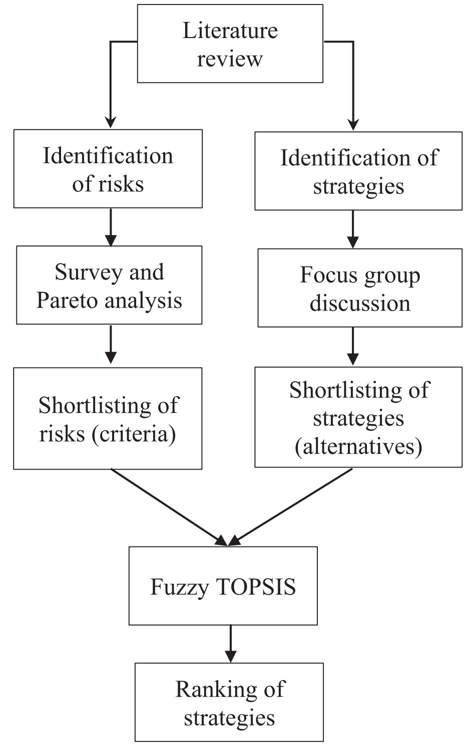

Fig. 1. Flowchart of research methodology.

Our literature review reinforces that though risk identification and assessment have received adequate attention of the research fraternity, risk mitigation strategies for SSC require more rigorous investigation. Textile and clothing supply chain is one of the major users of harmful chemicals and it contributes significantly to industrial water pollution. However, as on today, there is no reported research on the risk mitigation strategies for environmentally sustainable clothing supply chain. As some of the risks related to the environmentally sustainable clothing supply chain are very industry specific, they would require special attention for mitigation. These gaps are attempted to be addressed in this research.

3. Methods

3.1. Questionnaire survey for shortlisting of risks

A pictorial representation of research methodology is presented in Fig. 1. First, 18 risks relevant to environmentally sustainable clothing supply chain, namely sourcing of funds for green investment, change in environmental legislation, exchange rate fluc-

Table 1
Profile of respondents.

Parameters	Details	No. of respondents	Proportion of respondents (%)
Qualification	Graduate	26	65
	Post-graduate	10	25
	Doctorate	4	10
Experience	10-15 years	8	20
	16-20 years	13	32.5
	> 20 years	19	47.5
Position in supply chain	Fabric manufacturer	5	12.5
	Clothing manufacturer	10	25
	Brand	10	25
	Quality/ certification	15	37.5

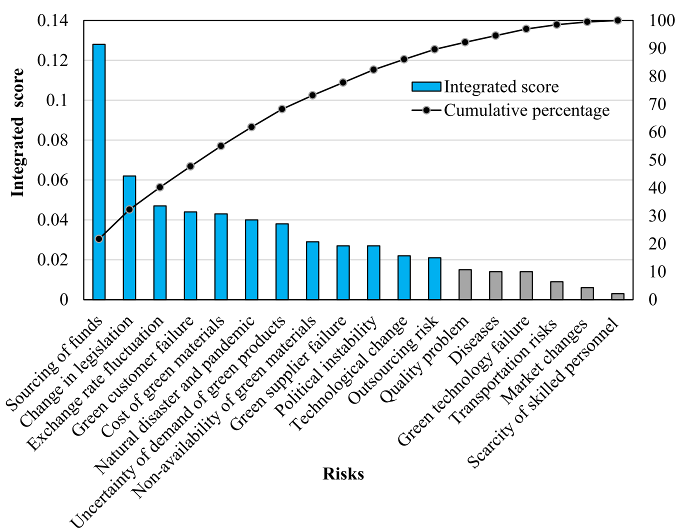

Fig. 2. Pareto chart of sustainable supply chain risks.

tuation, green customer failure, cost of green materials, natural disasters and pandemic, uncertainty of demand of green products, non-availability of green materials, green supplier failure, political instability, technological change, outsourcing risk, quality problem, diseases, green technology failure, transportation risks, market changes and scarcity of skilled personnel were identified from literature (Wang et al., 2012; Radivojević and Gajović, 2014; Rostamzadeh et al., 2018; Ding et al., 2020). Then a questionnaire, given in supplementary information, was sent to 110 supply chain managers of leading clothing companies. Managers having at least 10 years of experience were considered as potential respondents. A questionnaire was sent via email to the experts who were asked to quantify the impact of the identified risks using the five-point Likert scale. For the likelihood or probability of risks, experts were asked to use a scale of 0-1. Forty valid responses were obtained, after two reminders, making the response rate of 36.4%. The profile of respondents is given in Table 1. The integrated score of risks was calculated by multiplying the impact and the probability of occurrence. Pareto analysis was then used to select the 'vital few' risks and to eliminate 'trivial many' (Karmaker et al., 2021). Fig. 2 presents the Pareto chart of risks. It is observed that top 12 risks contribute to 90% of the total integrated score whereas remaining six contribute to only 10%. Therefore, to make the analysis simpler and more reasonable, only these top 12 risks were considered further.

3.2. Focus group discussion for shortlisting of risk mitigation strategies

A list of supply chain risk mitigation strategies identified through literature review is presented in Table 2. For the shortlisting of risk mitigation strategies relevant to clothing supply chain, a focus group discussion was conducted. A team of six supply chain managers of leading textile and clothing organisations operating in India took part in focus group discussion. The team members were selected randomly from the list of respondents who participated in the shortlisting of risks (section 3.1).

The team of experts helped to shortlist relevant strategies and also suggested to include 'hazard management and adoption of safety standards' as a potential strategy which was not existing in literature. Textile and clothing manufacturing processes like spinning, weaving, dyeing, printing and finishing, and apparel manufacturing cause major health and safety threats to the respective workers due to exposure to cotton dust, chemicals, loud noise and several other hazards. Textile dyeing, printing and finishing are the basic operations wherein dyes and chemicals are used. United States Environmental Protection Agencies (USEPA) proclaimed that a large number of textile auxiliaries used for cleaning and finishing of textile fibres are carcinogenic in nature and hence, there is restriction to use these chemicals worldwide (Lacasse and Baumann, 2004).

The team of experts also contributed towards further refinement of mitigation strategies to render them more pertinent to environmentally sustainable clothing supply chain. The make and buy mitigation strategy was renamed as outsourcing of green processes and products. The team felt that the applications of traceability, digitisation and big data, etc. as risk mitigation strategies are still in the nascent stage in textile and clothing industry and therefore, not included for further analysis. Finally, 13 risk mitigation strategies were shortlisted as shown in Table 3.

3.4. Implementation of fuzzy TOPSIS

The perception of experts regarding the risks and their mitigation strategies involves vagueness and subjectivity as there exists no quantifiable data. Therefore, it is prudent to invoke fuzzy logic into the decision making framework as it can effectively handle the sets having overlapping boundaries. AHP is based on pairwise comparison of elements with respect to each of the elements at the next higher level. As the current problem involves 12 risks as decision criteria and 13 mitigation strategies as alternatives, use of AHP or its variants would entail $12 \times 11/2 = 66$ pairwise comparison at the criteria level and $12 \times 78 = 936$ pairwise comparisons at the alternative level. This becomes cumbersome to manage, creating enormous pressure on decision makers that may lead to inconsistency in judgement. In contrast, TOPSIS works with direct rating of alternatives with respect to each criterion, thereby essentially bypassing the tedious pairwise comparison. Therefore, in this research, fuzzy TOPSIS (Chen, 2000) was used to prioritise mitigation strategies with respect to the risks associated with environmentally sustainable clothing supply chain. The methodology has been explained below. The detailed explanation of steps involved in fuzzy TOPSIS is given in Appendix.

Table 2
Supply chain risk mitigation strategies.

Sl. no.	Mitigation strategies	Definition	Sources
1	Risk avoidance	Elimination of difficult and unmanageable risks to keep the supply chain robust. Generally, this is followed for the risks which have high impact as well as high probability.	Manuj and Mentzer (2008).
2	Risk reduction	An effective strategy for the operational risks having high probability but low impact. This strategy can reduce the cost if risks are pooled amongst all partners of supply chain.	Chopra and Sodhi (2004); Tang (2006); Aqlan and Lam (2015).
3	Risk sharing and transfer	Generally followed when the risk has high impact but low probability. In most of the cases, it is handled through insurance or contracts.	Li et al. (2015); Ghadge et al. (2017); Tsao et al., (2021).
4	Risk acceptance	Preferred for the risks having low probability and low impact. The mitigation strategies are costlier than the eventual impact of these risks.	Aqlan and Lam (2015).
5	Postponement	Delaying the product differentiation in supply chain so that demand fluctuation does not affect supply chain performance.	Tang (2006); Manuj and Mentzer (2008); Wang et al. (2017).
6	Surplus inventory and strategic stock	Surplus green inventory can mitigate supply chain disruptions and delays. This surplus inventory may also be seen as strategic stock which refers to stocking of critical inventories in strategic locations.	Finch (2004); Chopra and Sodhi (2004); Tang (2006).
7	Make and buy	A proven strategy that makes a supply chain resilient as some of the products or inventories are made in-house, whereas the rest is procured from external suppliers.	Sinha et al. (2004); Tang (2006); (Wieland and Marcus Wallenburg, 2012)
8	Alignment of economic benefits and revenue sharing	Revenue sharing to keep the green suppliers motivated as well as to attract more of them, is another strategy for managing supply related disruptions.	Cao et al. (2010); Ghadge et al. (2017).
9	Flexible and multimodal transportation	Involves different means of transportation (air, sea, rail, truck, small carriers, etc.), different logistics partners and different routes to manage disruptions in supply chain.	Tang (2006); Zsidisin and Wagner (2010).
10	Risk contingency plan	Risk contingency plans are complementary to risk mitigation plans and the former try to minimise the impact of a disruptive event after its occurrence.	Finch (2004); Norrman and Jansson (2004); Kleindorfer and Saad (2005); Oliveira et al. (2019).
11	Adoption of green practices	Adoption of green practices in design, procurement, manufacturing, warehousing and distribution by all the supply chain partners.	Ghosh and Shah (2012); Jayaram and Avittathur (2015).
12	Developing agility	Agility is defined as the ability to respond quickly to unpredictable changes. The market is characterised by competitiveness, turbulence and uncertainty and therefore, an organisation needs agility in its supply chain to ensure delivery of uninterrupted products and services.	Faisal et al. (2006); Braunscheidel and Suresh (2009); Christopher et al. (2011); Nandi et al., (2021); Bui et al., (2021).
13	Multiple sourcing and flexible capacity	A single-source procurement model, though ensures minimisation of cost, is prone to unpredictable disruptions. Therefore, organisations should develop multiple green suppliers, having flexible production capacity, from different geographic regions.	Sinha et al. (2004); Diabat et al. (2012); Kamalahmadi and Meller-Parast (2016); Wang et al. (2017); Oliveira et al. (2019).
14	Trust, coordination and collaboration	Existence of transparency, mutual understanding and trust within an organisation, between the organisation and its suppliers, and between the organisation and its customers. Trust generates healthy cooperation, coordination, coalition and collaboration.	Braunscheidel and Suresh (2009); Swami and Shah (2013); Chen et al. (2013); Wang et al. (2017); Bui et al., (2021).
15	Strategic risk planning	A systematic approach involving three phases, namely phase 1 (identification, measurement, assessment), phase 2 (evaluation, mitigation and contingency plan) and phase 3 (control and monitoring).	Kleindorfer and Saad (2005); He (2017).
16	Information sharing and visibility	Information about key green operational areas such as inventory, production and logistics should be shared real-time among all the partners of supply chain.	Gunasekaran and Ngai (2004); Tummala and Schoenherr (2011).
17	Relationships	A mutual understanding and sharing of thoughts and knowledge between the focal firm and its partners, suppliers and customers is desirable to mitigate risks.	Faisal et al. (2006); Grötsch et al. (2013)

Table 3
Risk mitigation strategies for clothing supply chain.

Strategy code	Mitigation strategies
S1	Postponement
S2	Surplus green inventory
S3	Outsourcing of green processes and products
S4	Alignment of economic incentives and revenue sharing
S5	Flexible and multimodal transportation
S6	Hazard management and adoption of safety standards
S7	Adoption of green practices
S8	Developing agility
S9	Multiple green sourcing and flexible capacity
S10	Trust, coordination and collaboration
S11	Strategic risk planning for green objectives
S12	Information sharing and visibility
S13	Risk transfer and sharing

Table 4
Fuzzy positive ideal solutions and fuzzy negative ideal solutions.

Risk code	FPIS (A^*)	FNIS (A^-)
R1	0.900	0.056
R2	0.900	0.056
R3	0.500	0.011
R4	0.900	0.033
R5	0.900	0.033
R6	0.500	0.011
R7	0.900	0.033
R8	0.900	0.033
R9	0.700	0.011
R10	0.500	0.014
R11	0.500	0.011
R12	0.700	0.011

3.4.1. Formation of decision matrix

In this step, the opinions of decision makers regarding the weights of 12 risks and performance scores of 13 mitigation strategies were obtained. Three decision makers who participated in focus group volunteered to take part in this step. The first decision maker (DM1) was from textile and clothing manufacturing area with 23 years of experience, second decision maker (DM2) had an experience of 22 years in textile manufacturing and academia, and the third decision maker (DM3) had 10 years of field experience in quality and environmental certification. Linguistic ratings having five levels, namely very low (VL), low (L), medium (M), high (H) and very high (VH), were used by the three decision makers. The linguistic ratings were converted to triangular fuzzy numbers as per the conversion scale given in Table A1 (Chen, 2000; Samvedi et al., 2013).

3.4.2. Calculation of aggregated fuzzy weights of risks

The linguistic ratings given by the three decision makers, corresponding to importance of each risk, are presented in Table A2. Thereafter, these ratings were converted to triangular fuzzy numbers and fuzzy aggregated weights of risks were obtained as given in Table A3.

3.4.3. Fuzzy scores of mitigation strategies

Different strategies are able to mitigate different risks to varying extent. One strategy may be very effective against a particular risk while being ineffective against another risk. The same group of decision makers (DM1, DM2 and DM3) expressed the linguistic ratings of 13 mitigation strategies with respect to each of the 12 risks as listed in Table A4.

3.4.4. Construction of normalised and weighted normalised fuzzy decision matrices

Normalised fuzzy decision matrix was obtained using Eqs. (A4) and A5. All the elements of fuzzy decision matrix were divided by 9 expect for the elements corresponding to the risk R10 (political instability). As the c_j^* for R10 was 7, therefore, all the elements corresponding to this risk were divided by 7. Weighted normalised decision matrix was obtained using equation A6.

3.4.5. Calculation of fuzzy positive and fuzzy negative ideal solutions

Fuzzy positive ideal solution (FPIS, A^*) and fuzzy negative ideal solution (FNIS, A^-) corresponding to each risk were calculated using Eqs. (A7) and (A8), respectively, and are given in Table 4.

3.4.6. Calculation of separation distances

The separation distances d_i^* and d_i^- of each risk mitigation strategy from the fuzzy positive ideal solution and fuzzy negative ideal solution were calculated using Eqs. (A9)-(A11) and are given in Table 5.

3.4.7. Calculation of closeness coefficient and ranking of mitigation strategies

Closeness coefficients ($CC_i{}^*$) of risk mitigation strategies, obtained by using Eq. (A12), are shown in the last column of Table 5. Subsequently, mitigation strategies were ranked in decreasing order of their closeness coefficient, as shown in Table 6.

4. Results

It is observed from Table 6 that developing agility in supply chain; multiple green sourcing and flexible capacity; adoption of green practices; trust, coordination and collaboration; and alignment of economic incentives and revenue sharing are the top five strategies for risk mitigation in environmentally sustainable clothing supply chain. Table 7 shows how the aforesaid strategies mitigate the risks in clothing supply chain. Building agility, a strategic intent of the organisation, has the highest closeness coefficient (0.490) implying that it is the most potent strategy for mitigation of risks in environmentally sustainable clothing supply chain. Table 7 highlights that supply chain agility can mitigate nine out of 12 SSC risks by efficient use of point of sales data, flexibility, responsiveness and virtual integration. Christopher and Peck (2004) argued that the visibility of upstream and downstream sides of supply chain is often very poor as the information exchange happens infrequently and only on limited matters. Therefore, agility of supply chain, having market sensitivity, flexibility, visibility, virtual integration and velocity, significantly reduces the risks associated with financial aspects, demand, supply and government regulations (Wieland and Wallenburg, 2012).

Multiple green sourcing and flexible capacity is the second potent strategy (closeness coefficient of 0.480) that mitigates seven SSC risks. Focal company must use its resources to develop and engage with multiple green suppliers rather than depending on a single supplier (Tang, 2006; Kamalahmadi and Meller-Parast, 2016). This may increase the procurement cost in short term, however, if the cost of risks of supply disruption is considered, this can be an efficient risk mitigation strategy.

Adoption of green practices by the focal firm and its suppliers, which mitigates six SSC risks, acquires the third position in the hierarchy of risk mitigation strategies. Adoption of green practices by supply chain partners can only be achieved with trust building, coordination and collaboration among various supply chain partners, which acquires the 4$^{\text{th}}$ position in ranking of mitigation strategies.

Table 5
Distance measures and closeness coefficients of risk mitigation strategies.

Strategy code	Distance from FPIS (d_i^*)	Distance from FNIS (d_i^-)	Closeness coefficient ($CC_i{}^*$)
S1	6.185	3.885	0.386
S2	5.929	4.586	0.436
S3	5.770	4.765	0.452
S4	5.563	4.869	0.467
S5	6.241	3.883	0.384
S6	5.906	4.488	0.432
S7	5.511	5.047	0.478
S8	5.234	5.027	0.490
S9	5.359	4.941	0.480
S10	5.428	4.953	0.477
S11	5.728	4.670	0.449
S12	5.652	4.548	0.446
S13	5.744	4.307	0.428

Table 6
Ranking of risk mitigation strategies.

Strategy code	Mitigation strategies	Rank
S8	Developing agility	1
S9	Multiple green sourcing and flexible capacity	2
S7	Adoption of green practices	3
S10	Trust, coordination and collaboration	4
S4	Alignment of economic incentives and revenue sharing	5
S3	Outsourcing of green processes and products	6
S11	Strategic risk planning for green objectives	7
S12	Information sharing and visibility	8
S2	Surplus green inventory	9
S6	Hazard management and adoption of safety standards	10
S13	Transferring and sharing of risks	11
S1	Postponement	12
S5	Flexible and multimodal transportation	13

There is no denying that alignment of economic incentives like revenue sharing is a very potent strategy of trust building among supply chain partners (Swami and Shah, 2013) and this acquires the 5th position in ranking of mitigation strategies. Adoption of green practices in clothing manufacturing, particularly in dyeing operation, is of utmost important as it consumes huge amount of water and creates effluents loaded with harmful chemicals and auxiliaries (Majumdar and Sinha, 2021). Thus, it becomes imperative to install effluent treatment plant to make the supply chain environmentally sustainable. This creates enormous financial burden on the supplier of dyed fabrics. Therefore, there must be a revenue sharing model between the clothing brands and dyed fabric suppliers so that the risk is equitably distributed among the supply chain partners.

Strategies like surplus green inventory, transferring and sharing of risks, and postponement are ranked 9th, 11th and 12th, respectively. These traditional risk mitigation strategies are found to be not very effective in mitigating risks in environmentally sustainable clothing supply chain, despite being highly effective for traditional supply chains (Chopra and Sodhi, 2004; Tang, 2006; Wieland and Wallenburg, 2012). Flexible and multimodal transportation is found to be the least potent strategy for mitigating SSC risks.

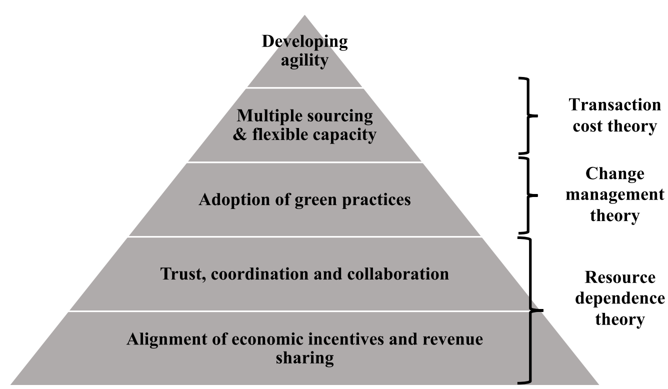

Fig. 3. Risk mitigation strategies and organisational theories.

4.1. Insights from Organisational theories

To understand the risk mitigation strategies, we take recourse to three organisational theories, namely resource dependence theory, change management theory and transaction cost theory as depicted in Fig. 3. The organisational dependence for resources can be of two types, namely symbiotic (interdependence) and competitive (Xiao et al., 2019). Our results, in terms of risk mitigation strategies, posit that clothing supply chain partners should develop a symbiotic resource dependence by building good reputation, co-optation, long-term contracts, minority ownership, etc. Alignment of economic incentives and revenue sharing among the supply chain partners should be practiced, wherever possible, so that the benefits and risks are shared and the symbiotic network relationship is strengthened (lower part of Fig. 3). When alignment of economic incentives and revenue sharing become the part of inter-organisational relation, mutual trust and coordination are generated which provide necessary impetus to the organisations to adopt green practices. Taking cue from Lewin's force field model of change management, we argue that there will be some resisting forces like existing structure, culture and practices of the organisation which will try to thwart the adoption of green practices (van Hoek et al., 2010; Swanson and Creed, 2014). However, the positive push from the alignment of economic incentives, and mutual trust and coordination will help the organisations to unfreeze from the existing condition and reach the new equilibrium through the adoption of green practices as delineated in Fig. 4. When a large number of supply chain players will adopt green practices,

Table 7
Risk mitigation matrix of environmentally sustainable clothing supply chain.

Risks	Mitigation strategies				
	Developing agility	Multiple green sourcing and flexible capacity	Adoption of green practices	Trust, coordination and collaboration	Alignment of economic incentives and revenue sharing
Sourcing of funds for green investment	Responsiveness to customers facilitates better financial performance			Reduces the financial risks by risk sharing	Enables supply chain partners to invest in green initiatives
Change of environmental legislation	Acts and adapts swiftly to new environmental legislation		Helps to meet the stringent environmental legislation		
Exchange rate fluctuation		Protects from higher import costs of materials at currency devaluation			Risks and rewards are equitably distributed among partners
Key customer failure	Enhanced visibility and access to real-time POS data provides early signal of customer failure			Paves the way for risk sharing arising from key customer failure	Supply chain partners share the risks in case of green customer failure
Cost of green materials		Optimises order allocation among suppliers to minimise green material cost	Can give improved financial gains by offsetting the higher cost of green materials	Long term partnerships give price flexibility	
Natural disaster	Resilience helps to restore the supply chain quickly after disruptions	Affected supplier can easily be replaced by the redundant one		Facilitates the supply chain to bounce back quickly after disruption	
Uncertainty of demand for green product	Market sensitivity helps to capture emerging trends and act accordingly	Risks can be shared among suppliers in terms of quantity flexibility	Proactive adoption mitigates the risk of demand shift from one product to another		
Non-availability of green materials		Minimises risks of green material availability		Long-term partnership ensures uninterrupted supply of green materials under scarcity	
Supplier failure	Electronic data exchange gives early signal of green supplier failure	Smooth transition of order from one supplier to another	Reduces the probability of supplier failure		Reduces supplier failure due to economic reasons
Political instability	Responds quickly to volatile political scenario				
Green technological change	Flexible manufacturing system ensures quick adaptation of new green technology		Adoption ensures better preparedness for green technological change		
Outsourcing risks	Virtual integration of supply chain partners and collaborative planning mitigates outsourcing risks	Minimises supply related outsourcing risks	Adoption by the supply chain partners reduces the outsourcing risks	Trust and partnership reduce outsourcing risks due to win-win situation	Suppliers remain motivated to adopt and implement green practices

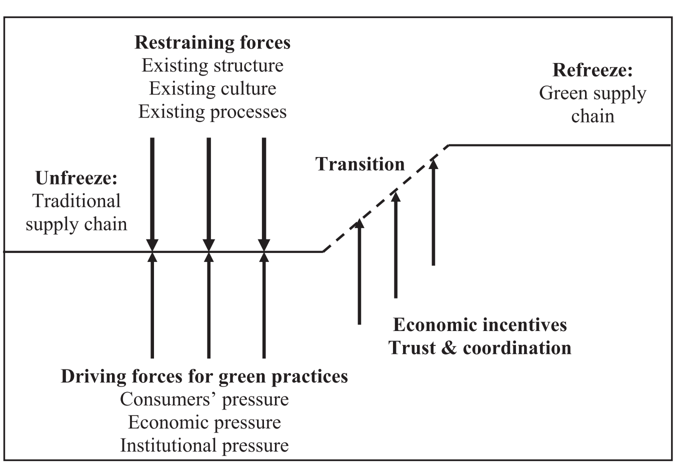

Fig. 4. Force field model of adoption of green practices.

the environmental richness will improve reducing the environmental uncertainty and supply chain risks. .

We also propound that the interplay between multiple sourcing and agility can be viewed through the lens of transaction cost economics theory (Ketchen and Hult, 2007; Schmidt and Wagner, 2019). With the increase in environmental uncertainty, transaction cost increases due to opportunism and risks related to specific assets (Grover and Malhotra, 2003). When an organisation is entirely dependent on one supplier for green raw materials, the potential of opportunism for the supplier is huge. On the other hand, if a supplier has committed relation-specific investment in machinery and research for developing a specific green material, then it can be exploited by the buyer (clothing manufacturer) as there may not be many alternate takers. From the clothing manufacturer's side, it is always better to have multiple suppliers of green materials and components with flexible capacity. This will definitely increase the coordination cost, as mentioned earlier, as more time and resources have to be spent to manage a large pool of suppliers (top part of Fig. 3). However, the reduction in transaction risk cost will surpass the increase in coordination cost (Xiao et al., 2019).

5. Discussion

This research prioritises risk mitigation strategies for sustainable clothing supply chains operating in India. Risk mitigation strategies were ranked by considering environmental sustainability risks relevant to this sector and then evaluating the efficacy of various strategies corresponding to each of the risks. A fuzzy group decision making framework was formulated to handle the ambiguity of experts' perception. The developed risk mitigation matrix portrays the way in which a particular strategy counters various supply chain risks. As supply chain involves multiple organisations often with conflicting objectives, the implementation of selected strategies has been seen through the lenses of some established organisational theories, namely resource dependence theory, change management theory and transaction cost theory. The prioritisation of strategies through a fuzzy MCDM framework and its underpinning with organisation theories makes contribution to the existing literature.

Managerial implication of this study revolves around a proposed approach for prioritising the risk mitigation strategies considering their influence on various risks. As there are many risk mitigation strategies, managers often find it difficult to select them to make a balanced portfolio that can be implemented with the resources available. The outcome of this research will help the managers of clothing supply chains to make judicious decisions for coupling resilience with sustainability. They can focus on the set of chosen mitigation strategies while giving lesser attention to the trivial ones. Most of the clothing manufacturing companies in South Asian countries fall under the ambit of small and medium enterprises (SMEs). Typically these organisations work under financial constraints and therefore, are compelled to make a delicate balance between environmental and economic priorities. While large organisations implement the environmental initiatives like zero liquid discharge by investing in machines and technology, SMEs often lag behind, exposing the supply chain to greater environmental risks. Therefore, for the clothing supply chain managers, it becomes imperative to develop their own portfolio of risk mitigation strategies looking at the supply chain partners. The study also reveals that a bottom-up approach would be effective which should start with revenue sharing, and trust building in supply chain. Multiple sourcing of green and recycled materials from suppliers who have adopted green practices must be espoused by the supply chain managers. Finally, the manager should strive to achieve the paramount goal of agility. By implementing these mitigation strategies, a supply chain manager can reap more economic benefits by ensuring less frequent and less impactful disruption in business.

Though this study has not considered the disruptions created by pandemics separately, the managers can apply the proposed framework to build resilience in supply chain to tackle pandemic induced disruptions.

6. Conclusion

Risk mitigation strategies for environmentally sustainable clothing supply chain have been prioritised using fuzzy TOPSIS. Developing agility in supply chain is found to be the most important strategy for risk mitigation. Multiple green sourcing and flexible capacities (2nd); adoption of green practices (3rd); trust, coordination and collaboration building (4th); and alignment of economic incentives and revenue sharing (5th) are the other dominant risk mitigation strategies, in descending order. Therefore, clothing organisations desirous to mitigate supply chain risks, should invest their resources to implement this portfolio of strategies.

The developed risk mitigation matrix delineates the interaction between the mitigation strategies and risks by translating the perception of domain experts. It demonstrates that developing agility, multiple green sourcing and adoption of green practices can mitigate nine, seven and six risks, respectively, protecting the supply chain against various environmental risks. Finally, better handling of inter-organisational resource dependency and change management can help in implementation of these mitigation strategies and also lead to favourable transaction cost economics for the entire supply chain network.

This research makes a contribution by presenting a decision making framework of risk mitigation, in sustainable clothing supply chain, by considering important risks and mapping the efficacies of various mitigation strategies corresponding to each risk. Besides, the risk mitigation strategies have been analysed through the lens of resource dependence, change management and transaction cost theories.

This study has been conducted for risk mitigation in environmentally sustainable clothing supply chains operating in India. Therefore, results of this research should not be generalised for other supply chains or even for clothing supply chains operating in other geographic areas as the efficacy of mitigation strategies will be dependent on industry type, associated supply chain issues and prevailing business environment. The results reported in this research are subjected to the knowledge, information and bounded rationality of the decision makers involved. A future research direction could be to develop a more holistic framework by incorporating the perception of different supply chain partners in a multitier clothing supply chain.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.spc.2021.06.021.

Appendix A. Fuzzy TOPSIS methodology

The importance or weights of various risks (criteria) and scores of mitigation strategies (alternatives) were considered as linguistic variables. Decision makers used linguistic ratings to evaluate the importance of risks and performance score of mitigation strategies with respect to various risks. Triangular fuzzy numbers, as given in

Table A1
Linguistic ratings for criteria weights and alternative scores.

Linguistic ratings	Triangular fuzzy numbers	
	Criteria	Alternatives
Very low (VL)	(0.1, 0.1, 0.3)	(1.00, 1.00, 3.00)
Low (L)	(0.1, 0.3, 0.5)	(1.00, 3.00, 5.00)
Medium (M)	(0.3, 0.5, 0.7)	(3.00, 5.00, 7.00)
High (H)	(0.5, 0.7, 0.9)	(5.00, 7.00, 9.00)
Very high (VH)	(0.7, 0.9, 0.9)	(7.00, 9.00, 9.00)

Table A2
Linguistic ratings of risk weights.

Risk code	Risks	Linguistic rating DM1	DM2	DM3
R1	Sourcing of funds for green investment	H	VH	H
R2	Change of environmental legislation	VH	H	H
R3	Exchange rate fluctuation	L	L	VL
R4	Key customer failure	H	M	M
R5	Cost of green materials	M	H	H
R6	Natural disaster	L	L	VL
R7	Uncertainty of demand for green product	M	H	M
R8	Non-availability of green materials	M	H	H
R9	Supplier failure	L	M	L
R10	Political instability	L	L	VL
R11	Green technological change	VL	L	L
R12	Outsourcing risks	L	M	L

Table A3
Aggregated fuzzy weights of risks.

Risks	Fuzzy weights given by decision makers			Aggregated weight
	DM1	DM2	DM3	
R1	0.5, 0.7, 0.9	0.7, 0.9, 0.9	0.5, 0.7, 0.9	0.5, 0.767, 0.9
R2	0.7, 0.9, 0.9	0.9, 0.7, 0.5	0.5, 0.7, 0.9	0.5, 0.767, 0.9
R3	0.1, 0.3, 0.5	0.1, 0.3, 0.5	0.1, 0.1, 0.3	0.1, 0.233, 0.5
R4	0.5, 0.7, 0.7	0.3, 0.5, 0.7	0.5, 0.7, 0.9	0.3, 0.633, 0.9
R5	0.3, 0.5, 0.7	0.5, 0.7,0.9	0.3, 0.5, 0.7	0.3, 0.567, 0.9
R6	0.1, 0.3, 0.5	0.1, 0.3, 0.5	0.1, 0.1, 0.3	0.1, 0.233, 0.5
R7	0.3, 0.5, 0.7	0.5, 0.7, 0.9	0.3, 0.5, 0.7	0.3, 0.567, 0.9
R8	0.3, 0.5, 0.7	0.5, 0.7, 0.9	0.5, 0.7, 0.9	0.3, 0.633, 0.9
R9	0.1, 0.3, 0.5	0.3, 0.5, 0.7	0.1, 0.3, 0.5	0.1, 0.367, 0.7
R10	0.1, 0.3, 0.5	0.1, 0.3, 0.5	0.1, 0.1, 0.3	0.1, 0.233, 0.5
R11	0.1, 0.1, 0.3	0.1, 0.3, 0.5	0.1, 0.3, 0.5	0.1, 0.233, 0.5
R12	0.1, 0.3, 0.5	0.3, 0.5, 0.7	0.1, 0.3, 0.5	0.1, 0.367, 0.7

Table A1, have been used in this research as they are computationally easier to handle.

Let the problem has a set of K decision makers$D = \{D_1, D_2, ..., D_K\}$, a set of n criteria or risks$R = \{R_1, R_2, ..., R_n\}$, a set of m alternatives or strategies$S = \{S_1, S_2, ..., S_m\}$. All the decision makers have equal importance on the decision. If the fuzzy ratings of criteria weights given by the decision makers are denoted by $\tilde{W}_{jk} = \{p_{jk}, q_{jk}, r_{jk}\}, k = 1, 2, ..., K$, then the aggregated fuzzy weight for j th criterion is given by $\tilde{W}_j = \{p_j, q_j, r_j\}$, where

$$p_j = \min_k \{p_{jk}\}, q_j = \frac{1}{K}\sum_{k=1}^{K} q_{jk},\ rj = \max_k \{r_{jk}\} \tag{A1}$$

The aforesaid method ensures that the range of aggregated fuzzy ratings includes the range of ratings given by individual decision maker. If the fuzzy scores of alternatives given by the k th decision maker are$\tilde{X}_{ijk} = (a_{ijk}, b_{ijk}, c_{ijk})$, then aggregated fuzzy score of i th alternative with respect to j th criterion are given by $\tilde{X}_{ij} = \{a_{ij}, b_{ij}, b_{ij}\}$, where

$$a_{ij} = \min_k \{a_{ijk}\}, b_{ij} = \frac{1}{K}\sum_{k=1}^{K} b_{ijk}, cij = \max_k \{c_{ijk}\} \tag{A2}$$

The fuzzy decision matrix, having criteria and alternatives, is constructed as follows:

$$\tilde{D} = \begin{array}{c|cccc} & C_1 & C_2 & & C_n \\ A_1 & \tilde{x}_{11} & \tilde{x}_{12} & \ldots & \tilde{x}_{1n} \\ A_2 & \tilde{x}_{21} & \tilde{x}_{22} & \ldots & \tilde{x}_{2n} \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ A_m & \tilde{x}_{m1} & \tilde{x}_{m2} & \ldots & \tilde{x}_{mn} \end{array}, i = 1, 2, \ldots, m; j = 1, 2, \ldots, n; \tag{A3}$$

To avoid the complicated normalisation formula used in classical TOPSIS, the linear scale of transformation is used here to transform various criteria scales into a comparable scale. The normalised fuzzy decision matrix $\tilde{R}$is given by

$$\tilde{R} = \left[\tilde{r}_{ij}\right]_{m\times n}, i = 1, 2, ..., m; j = 1, 2, ..., n,$$

where

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) \text{and } c_j^* = \max_i c_{ij}\ (J \in \text{benefit criteria}) \tag{A4}$$

$$\tilde{r}_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right) \text{and } a_j^- = \min_i a_{ij}\ (J \in \text{cost criteria}) \tag{A5}$$

The weighted normalised matrix $\tilde{V}$is computed by multiplying the criteria weights $\tilde{W}_j$ with the normalised fuzzy decision matrix $\tilde{R}_{ij}$ as shown below.

$$\tilde{V} = [\tilde{v}_{ij}]_{m\times n},\ i = 1, 2, ..., m; j = 1, 2, ..., n$$

where

$$\tilde{v}_{ij} = \tilde{r}_{ij}(.)\tilde{w}_j \tag{A6}$$

The fuzzy positive ideal solution (FPIS or A^*) and fuzzy negative ideal solution (FNIS or A^-) are then computed as follows:

$$A^* = (\tilde{v}_1^*, \tilde{v}_2^*, ..., \tilde{v}_n^*)$$

$$\text{where } \tilde{v}_j^* = \max_i\left(v_{ij3}\right),\ i = 1,\ 2,\ ...,\ m;\ j = 1, 2, ..., n\ (\text{for benefit criteria}) \tag{A7}$$

$$A^- = \left(\tilde{v}_1^-, \tilde{v}_2^-, ..., \tilde{v}_n^-\right)$$

$$\text{where } \tilde{v}_j^- = \min_i\left(v_{ij1}\right),\ i = 1,\ 2,\ ...,\ m;\ j = 1,\ 2, ..., n\ (\text{for cost criteria}) \tag{A8}$$

The distances between each normalised weighted alternative from FPIS and FNIS are determined as follows:

$$d_i^* = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, \tilde{v}_j^*\right), i = 1, 2, ..., m \tag{A9}$$

$$d_i^- = \sum_{j=1}^{n} d\left(\tilde{v}_{ij}, \tilde{v}_j^-\right), i = 1, 2, ..., m \tag{A10}$$

where $d_v(\tilde{m}, \tilde{n})$ is the distance between two fuzzy numbers $\tilde{m}$ and $\tilde{n}$, calculated using the following expression.

$$d(\tilde{m}, \tilde{n}) = \sqrt{\frac{1}{3}\left[(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2\right]} \tag{A11}$$

The closeness coefficient (CC_i) of each alternative is calculated as follows:

$$CC_i = \frac{d_i^-}{d_i^- + d_i^*},\ i = 1,\ 2,\ ...,\ m \tag{A12}$$

Finally, the alternatives are ranked according to the descending order of closeness coefficient. The best alternative has the highest closeness coefficient and vice versa.

See Appendix tables:
Table A1, Table A2, Table A3, Table A4

Table A4
Linguistic ratings of risk mitigation strategies (S1 to S6).

Risks	Mitigation strategies																	
	S1			S2			S3			S4			S5			S6		
	DM 1	DM 2	DM 3	DM 1	DM 2	DM 3	DM 1	DM 2	DM 3	DM 1	DM 2	DM 3	DM 1	DM 2	DM 3	DM 1	DM 2	DM 3
R1	VL	VL	VL	L	VL	VH	M	M	M	H	H	VH	VL	VL	M	VL	VL	H
R2	VL	VL	VL	VL	VL	VL	VL	M	L	VL	VL	VH	M	M	VL	VH	H	VH
R3	L	L	L	M	VL	H	M	M	M	M	M	H	VL	L	M	VL	VL	M
R4	H	M	H	M	VL	H	H	M	H	M	M	VH	VL	M	L	L	L	H
R5	M	L	L	M	M	M	L	L	M	M	M	VH	VL	L	VL	M	VL	M
R6	M	M	M	M	M	H	VL	M	H	M	M	M	H	H	VH	VL	VL	VL
R7	H	H	H	VH	H	H	L	H	H	L	L	VH	M	M	L	VL	L	M
R8	M	L	M	L	M	H	VL	H	VH	L	L	VH	M	M	VL	H	L	H
R9	H	L	H	VL	H	H	M	M	VH	M	M	VH	M	M	L	M	M	H
R10	L	M	L	VL	M	L	M	M	L	VL	VL	M	M	M	M	VL	VL	VL
R11	L	VL	L	L	L	H	L	VL	M	M	M	H	VL	VL	L	VL	VL	M
R12	H	VL	H	H	L	H	H	M	H	VH	VH	VH	L	L	M	H	H	H

Risks	Mitigation strategies																				
	S7			S8			S9			S10			S11			S12			S13		
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM 3	DM1	DM2	DM3
R1	L	VL	H	VL	VL	M	VL	VL	M	M	M	M	VL	L	M	VL	VL	M	M	M	M
R2	H	H	VH	H	M	M	M	M	M	VL	M	M	VL	M	M	M	M	M	M	M	M
R3	VL	VL	M	M	M	M	M	M	M	M	L	M	VL	M	M	L	L	M	M	M	M
R4	M	M	H	H	VH	H	H	H	VH	H	M	VH	H	M	H	M	M	VH	L	L	VH
R5	L	L	VH	H	H	H	H	M	VH	M	M	VH	M	L	H	L	L	VH	L	L	VH
R6	VL	VL	H	M	M	M	H	M	H	L	L	H	H	L	M	L	L	H	H	H	H
R7	VL	VL	VH	VH	VH	VH	VH	VH	VH	H	VH	VH	M	M	VH	M	M	VH	H	H	VH
R8	VH	VH	VH	M	M	VH	M	M	VH	M	H	VH	M	M	H	H	H	VH	VL	VL	VH
R9	H	H	H	VH	VH	VH	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
R10	VL	VL	L	M	M	L	M	M	VL	M	M	VL	M	M	L	M	M	VL	VL	VL	VL
R11	VL	L	H	H	H	H	L	M	H	H	H	H	M	M	M	H	H	H	VL	VL	H
R12	H	H	H	H	H	H	H	H	H	H	H	H	VH	H	M	H	H	H	H	H	H

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