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ORIGINAL RESEARCH

A decision support model to investigate the pandemic recovery challenges and strategies in the leather supply chain

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Abstract
The COVID-19 has caused unprecedented disruptions to supply chains (SC) worldwide, posing numerous challenges for industries, particularly in the emerging economies (EE). These economies are undergoing a phase of recovery from the pandemic devastations now, requiring investigation into the recovery challenges (RCs) and propositions for effective recovery strategies (RSs) to address RCs. Given this backdrop, this study aims to explore the COVID-19-related RCs in the Bangladeshi leather industry and build an integrated decision-making model to formulate RSs to counteract the RCs while the industry seeks to recover. This study used Pareto analysis to deduce lists of the nine most critical RCs and nine vital RSs for the Bangladeshi leather industry. This study also applied the best worst method (BWM) to identify a long-term liquidity crisis and an increasing bankruptcy of business stakeholders as the most urgent RCs, highlighting financial sustainability as a significant matter of concern for the sector. With regard to the RSs, the application of the fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) indicated a need to solve the existing problems of central effluent treatment plant (CETP) and provisioning of solid waste management facilities for long run business as priorities to make the leather industry SC more financially and operationally sustainable. The RSs formulated in this study have managerial implications for decision-makers in reducing the adversities caused by the pandemic and hence improving the SC performance of the leather industry. Although not totally, these

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valuable insights into the RCs and RSs for the leather industry during and following COVID-19 periods can be generalized across other industries in Bangladesh and EE regions affected by the pandemic.

Keywords COVID-19 pandemic · Recovery challenges · Recovery strategies · Decision making · Decision analytics · Sustainability

1 Introduction

The COVID-19 pandemic, the world's largest recent Black Swan event, caused unprecedented disruption to human lives, the business environment, and economies worldwide (Narayanamurthy & Tortorella, 2021; Yang et al., 2023; Ye et al., 2022). Originating in the Chinese Province of Wuhan on 31 December 2019 (WHO, 2022), the viral pandemic spread globally, resulting in the loss of 6,389,657 lives as of 9 July 2022 (Worldometer, 2022). The lockdowns and strict social distancing measures implemented in February 2020 across much of the world led to enormous corporate closures and/or shortfall in production and interruptions in SCs, including system blocks in logistical management (Bouteska et al., 2023). For example, Fortune Magazine reported that the supply chain (SC) of the 94% of the 1000 largest US enterprises were affected by the COVID-19 (Moktadir et al., 2022). Moreover, global trade witnessed a 9.2% overall fall in 2020 compared to the immediate pre-pandemic year (Barbero et al., 2021). The International Labour Organization (ILO) declared the pandemic to be the deadliest global event since WWII, infecting about 81% of the global workforce and costing 305 million full-time jobs (Sarker et al., 2021). Developing countries, especially populous regions such as South Asia, were particularly hit hard by the pandemic. Studies however have revealed that the disease was spread by visitors and returning pupils from highly affected countries such as China, the USA, Italy and Iran (Chalise & Pathak, 2020; World Bank, 2021a), and then fuelled by poorly equipped and flimsy health care systems in the midst of densely populated areas (Bouteska et al., 2023; Khan et al., 2022). GDP in the South Asian region plunged by 6.7% in 2020 due to momentous outbreaks followed by nationwide lockdowns, particularly in India and Bangladesh (Khan et al., 2022).

The literature has documented long- and short-term categories of the impacts of the COVID-19 pandemic. The short-term impacts on business are reflected in the form of 'mass layoffs', 'revenue loss', 'business closures', and 'liquidity' (Dai et al., 2020). For example, during the period of October 2020 to January 2021, 25% of the world's companies experienced 50-60% sales reductions, and sought to adjust payrolls by reducing working hours, wages, and/or granting leave (World Bank, 2021b). According to a study by LightCastle (2020) on the small- and medium-sized enterprises (SMEs) of the leather industry, due to the COVID-19 pandemic, 26.23% of employees were laidoff, 57% of the enterprises experienced a drop of 50–75% of revenue, 3.33% of the enterprises completely shut down their business operations and 12% of the factories experienced a lack of liquidity. The tannery owners experienced a one third drop in export order compared with the figures recorded in the pre-pandemic situation (Eusuf and Bhuiyan, 2021). On the other hand, in the recent literature, the long-term impacts of the COVID-19 pandemic are recorded as adoption of new technologies, localizing SCs, increasing market concentration (e.g. via mergers), remote working, and virtual selling as well as addressing changes in customers' demands (Chai et al., 2022; Eduardo Maqui, 2020; Kniffin et al., 2020; Sahut & Lissillour, 2023). For instance, Riom and Valero (2020) revealed that at least 60% of UK firms embraced contemporary digital technologies

for remote working or hybrid functioning of their business, and about 40% invested in e-commerce and business analytics. Bloom et al. (2021) reported that a large majority of the US firms transitioned to adopting digital modes of operation to support virtual meetings, teleworking and remote working. In the context of Bangladesh, Moktadir et al. (2022) reported that supply chain vulnerability for the leather industry is a long-term impact of the COVID-19 pandemic due to high dependency of importing raw materials for the footwear sector, which can be mitigated by building a resilient supply chain. Meanwhile, Sarker et al. (2021) stressed that the leather industry will face social sustainability long term impacts such as workplace safety and remote working due to the pandemic. At the national level, adequate vaccination and other preventative measures were activated to limit death tolls, and financial support was provided to ensure the sustainability of businesses, in particular SMEs. Despite this, while recently undergoing something of a post-pandemic recovery phase, national economies and their business ecosystems still face numerous long-term COVID-19 'recovery challenges' (RCs) (Alam et al., 2021; Chowdhury et al., 2020; Ishida, 2020; Moktadir et al., 2022; Sharma et al., 2020). Given the finding of earlier research that 80% of those businesses that neglected to recognize the significance of RCs to address the adversities caused by Black Swan events (Bouteska et al., 2023; Chen et al., 2023) eventually struggle to ensure normalcy in business (Cerullo & Cerullo, 2004), it becomes crucial for regulators, practitioners and researchers to focus more attention on the COVID-19 RCs while developing a long-term strategic map for counteracting disasters.

Among the South Asian countries, Bangladesh displayed many features of a thriving pre-pandemic economy, having recently emerged as the second largest economy in the region after India (Khan et al., 2022), with the industrial sector contributing 29% to national GDP in 2019 (Nath et al., 2020). However, this rosy outlook was halted almost overnight by the COVID-19, resulting from the stringent restrictions associated with the pandemic. GDP growth plummeted to 3.5%, causing a loss of five million full-time jobs (ADB, 2021) and around 20 million jobs in the informal sector, accounting in sum for 87% of total employment (UNDP, 2020) and inflating the poverty rate to 20.5% in by mid-2020 (ADB, 2021). Similar to the advanced world, Bangladesh's government announced an economic stimulus package, in this case $11.90 billion for 19 industries, to support the alleviation of the ensuing economic crisis (Islam et al. 2022). Despite the continued downturn in the world economy, Bangladesh was showing some early signs of economic resilience by late 2020 and onwards. As the pandemic caused significant changes in the global business ecosystem, including having a substantial impact on SCs in particular (Chowdhury et al., 2020; Ibn-Mohammed et al., 2021; Xu et al., 2020), the issue of resilience and sustainability of SC in the manufacturing sector of Bangladesh and associated challenges is worthy of an in-depth investigation (Paul et al., 2021). Given its substantial contribution to the country's economy, an industry which meets 10% of the global demand for leather (Shibli & Islam, 2020) and earned over $1.245 billion for the national exchequer in the 2021–2022 fiscal year (The Daily Star, 2022). This research focuses on the leather industry of Bangladesh as a case example within the context of an emerging economy (EE).

The leather industry in Bangladesh includes three sub-sectors, namely tanneries, leather products, and footwear, in which around 0.85 million people are directly employed or indirectly benefit (Islam, 2022). Like other industries, the leather industry also faced a devastating economic shock from the COVID-19 pandemic due to its strong global connectivity in terms of its backward linkages (raw materials) and its forward linkages (exports). In particular, China, one of the worst affected countries, had only been a supplier of raw materials but also a major buyer of Bangladeshi leather, leather goods and footwear. Given that the leather industry is the second largest export earning sector (Islam, 2022), and the government has

set an ambitious export target of $12 billion by 2030 (The Daily Star, 2022), we concur with Paul et al. (2021) that there is a vigorous need "to identify potential supply chain recovery challenges (RCs) and their influence on post-disaster [COVID-19] recovery to ensure that supply chains formulate the appropriate strategies to overcome such issues" (p. 316). Hence, for these reasons, we choose the leather industry of Bangladesh as our case study and aim to develop a decision support model to investigate the RCs and recovery strategies (RSs) which have resulted from the impact of the pandemic on the leather SC. In this connection, we will seek answers to the following research questions:

(a) What are the COVID-19 RCs and how can we assess the criticality of these challenges for the leather industry of Bangladesh as an example of an emerging economy?
(b) What are the COVID-19 RSs required to mitigate these RCs?
(c) How can the COVID-19 RSs be prioritized according to their significance?

Against this backdrop, we formulate the following objectives to accomplish the aim of this study: (i) to identify the most important COVID-19 RCs and relevant RSs to mitigate these challenges in the leather industry of Bangladesh; (ii) to rank the COVID-19 RCs based on their criticality and find the most essential RSs in a priority list; (iii) to provide important managerial insights into making the leather industry's SC more resilient and sustainable in the future.

This study firstly conducts a literature review and considers expert opinion to develop a list of COVID-19 RCs and RSs. We then perform a Pareto analysis to select the most suitable RCs and RSs. We employ the BWM (best worst method) a multi-criteria decision making (MCDM) tool to evaluate the RCs. Since its introduction by Rezaei (2015), the BWM has gained much popularity among researchers as a robust and fruitful MCDM method. The BWM uses two vectors of pairwise combinations to compute the optimal weights of the alternatives to ensure a more consistent result. It is superior to other decision-making techniques, e.g., AHP, fuzzy-AHP, etc. in a number of ways. For instance, it involves a few pair-wise comparison matrices like other MCDM tools, and therefore requires less time to compute; it uses a convenient rating scale; it provides consistent and reliable results (Guo & Zhao, 2017; Mi et al., 2019; Petrudi et al., 2022; Rezaei, 2015, 2016); and it has numerous applications in decision-making problems in SC management (Abdel-Basset et al., 2020; Badri Ahmadi et al., 2017; Sarker et al., 2022). At the same time, we address the RSs to overcome COVID-19 using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). We use fuzzy TOPSIS instead of TOPSIS, as it can handle uncertainty, ambiguities and vagueness in expert data (Gaikwad et al., 2020). The fuzzy-TOPSIS method is generally used for picking an option from a set of options to handle real-life decision-making problems in uncertainties (Mohammed, 2020; Singh et al., 2018). The fuzzy TOPSIS method has several benefits over other MCDM tools (Kim et al., 1997; Shih et al., 2007). For instance, it is a logical tool that considers human subjective judgement; it uses a scalar value for evaluating the worst and best options; and it is straightforward to compute the process and can handle ambiguities in decision making. In the SC literature, there are several uses of fuzzy-TOPSIS in MCDM problems (Kusi-Sarpong et al., 2015; Palczewski & Sałabun, 2019; Rayhan, et al., 2021).

In recognition of the fact that the effects of the COVID-19 highlight the importance of designing a recovery paradigm, this research adds value to the existing body of knowledge in a number of ways. First, as practitioners need, firstly, to know the COVID-19 RCs prior to designing a concomitant recovery model, this work fulfils this requirement by identifying the COVID-19 RCs and RSs for the economy of Bangladesh, an N-11 emerging economy (O'Neill 2018). Moreover, as the extant literature records very few investigations into modelling the COVID-19 RCs without also modelling RSs, we respond to the ensuing urge for

further research (Paul et al., 2021) by modelling the COVID-19 RCs and RSs for Bangladesh's leather industry. Secondly, this study employs a novel combination of the BWM and fuzzy TOPSIS methods and a sensitivity test to evaluate and offer solutions to the COVID-19 RCs. There is no record of applying such approach in any of the previous studies on our current topic of research.

The remainder of the study is composed as follows. Section 2 presents the literature review. Section 3 outlines the research methodology. The study's results and a discussion are found in Sect. 4. The final section offers some conclusions, considers the study's limitations, and points to some future perspectives for further research in this area.

2 Literature review

This segment considers the RCs posed by the COVID-19 pandemic within the SC of Banglaesh's leather industry and the RSs by SC managers to counter these challenges, the background of the applied qualitative and MCDM tools the study employs, and finally the research gaps our study aims to fill.

2.1 Impact of COVID-19 on the supply chains of bangladeshi leather industry

The extant literature documents findings from studies on the impact of the COVID-19 in various industry and country contexts (e.g., Abedin et al., 2021; Burlea-Schiopoiu et al., 2021; Narayanamurthy & Tortorella, 2021; Paul et al., 2022a; Queiroz et al., 2020; Rodríguez-Antón & Alonso-Almeida, 2020). In connection with the leather industry of Bangladesh, the literature reveals significant consequences due to the pandemic, resulting in a massive loss in export orders worth of USD 316 million as of April 2020, as reported by the Leather Goods and Footwear Manufacturers and Exporters Association of Bangladesh (quoted in Sarker et al., 2022). Sarker et al. (2022) highlighted a picture of a devastating impact on the SMEs involved in the leather industry of Bangladesh, comprising 7106 medium and 859,318 small enterprises which together account for 25% of the country's GDP. Further, the authors highlighted the ways the recent pandemic has impacted these leather-based SMEs, for instance, a plummeting demand, order cancellations, a liquidity crisis, transport disruptions, employee absenteesim, workplace insecurity, and a shortage of raw materials. As a result of the pandemic, the production volume of the SMEs in the leather industry experienced a 40% drop in 2020–21 fiscal year compared to the previous year, 2019–2020 (Sarker et al., 2022). Locally, 47% of leather-based SMEs experienced a drop of 10% in sales and a majority of them encountered a 61% increase in distribution costs (LightCastle, 2020). On the global level, the earnings of the leather industry of Bangladesh accumulated to a total of $943.83 million during the pre-pandemic period of July 2018 to May 2019, followed by declines of 21.67% and 2.72% in 2019–20 and 2020–21 (also from July to May), respectively (Islam, 2022). Following the Bangladeshi government's stimulus package of BDT 5,000 crore (@1 crore = $94,600, as of 18 March 2023) for export-oriented manufacturers to meet expenses including salaries (Gautam et al., 2022), this sector managed export earnings of $1.245 billion in the fiscal year 2021–22 fiscal (July–June), retrieving the position of number two export earning sector in the country, a growth of 32.31% against fiscal year 2020–21 (The Daily Star, 2022). Yet, despite showing positive export growth compared to the performance during the height of the pandemic (2020–21) and having a huge potential to achieve the government's ambitious export earnings target, the industry continues to face numerous post-pandemic

RCs. One such example is the environmental and social compliance issues that the SC of the industry had been facing since its inception (Moktadir et al., 2020; Munny et al., 2019; Sarker et al., 2021), which was aggravated further by the pandemic imposing additional costs and adding to the industry's vulnerability.

2.2 RCs and RSs following the COVID-19 pandemic

The world is currently in the recovery stage from the COVID-19, with businesses facing several challenges to make their companies more sustainable and resilient. For any industry, identifying the right set of RCs is essential to mitigate the severity of the pandemic and, likewise, formulating an effective set of RSs is crucial to make any firm competitive during such a disaster. In this section, we focus on exploring the literature that has offered insights into the COVID-related RCs and RSs.

The extant literature documents contributions in a limited number of studies on the RCs facing companies as a result of the COVID-19. SC restructuring (Chowdhury et al., 2020; Ishida, 2020; Sharma et al., 2020), bankruptcy of SC partners (Choi, 2020; Paul et al., 2021), employee layoffs (Chowdhury et al., 2020; Paul et al., 2021; Sarker et al., 2021), new technological adoption (Ahmed et al., 2023; Gurbuz & Ozkan, 2020; Sharma et al., 2020; van Hoek, 2020), global economic recession (Ivanov, 2020; Lalon, 2020; Sen, 2020; Singh et al., 2020), declining demand (Lalon, 2020; Majumdar et al., 2020; Sharma et al., 2020), ensuring SC sustainability (Lalon, 2020; Majumdar et al., 2020), capital flows (Majumdar et al., 2020; Sen, 2020), lack of resources (Leite et al., 2020), and smooth production flows (Leite et al., 2020; Paul et al. 2020) are deduced as the major RC issues.

A small number of studies have attempted to formulate RSs in various industry and country contexts. For example, Rahman et al. (2022) identified the COVID-19 RSs for the SC in the health care sector of Bangladesh; Marimuthu et al. (2022) identified 10 COVID-19 green RSs in the context of the Indian mining industry; Khurana et al. (2021) proposed nine COVID-19 RSs for a range of Indian industries; and Caballero-Morales (2021) found innovation as the optimum RS for the Mexican SMEs. Moreover Moosavi et al. (2021) designed a simulation-based COVID-19 resiliency model to assess the effects of RSs on a multi-tier SC of a LED panel light manufacturing company in Iran; Rodríguez-Antón et al. (2020) carried out research to explore COVID-19 RCs and proposed a number of RSs for the hospitality industry of Spain; Barman et al. (2021) investigated the ways in which the COVID-19 had affected SCs in India's food industry and proposed a number of RSs; finally, Dayour et al. (2020) proposed long- and short-term the COVID-19 RSs for Ghana's hospitality and tourism industries. The common propositions these studies have made to ensure higher resilience and business sustainability include implementing dynamic prediction and planning, devising support systems for uninterrupted supply and distribution, broadening production capacity, maintaining alternative supplier options during crises, devising eco-innovation exercises, developing health and safety and environmental awareness, adopting digital resources, networking across the industry, research-led innovation, enhancing education and skills training, and maintaining spare inventories. Moreover, given the uncertain and unpredictable nature of the pandemic, reactive policies might be adopted for addressing COVID-19 RCs (Paul et al., 2021), possibly to be integrated with the RSs.

2.3 Research gaps and contributions

Our review of the literature has revealed a number of research gaps and aspires to fill these gaps. Instead of studying the COVID-19 recovery models, most researchers have sought to analyze the social and economic consequences caused by the pandemic and the challenges that businesses faced and continue to face (Akbulaev et al., 2020; Goel et al., 2021; Sarker et al., 2021, 2022). Second, most studies have merely focused on the RCs resulting from the COVID-19 rather than seeking to formulate effective RSs (Alam et al., 2021; Paul et al., 2021; Ul Islam et al., 2022). Finally, no study was found to have taken an EE as a case example for modelling COVID-19 RCs and RSs jointly. Since RCs and RSs may vary from country to country and may also vary according to the nature of a firm's business, additional study is necessary to model the COVID-19 RCs and RSs for an EE context. Our study fills these gaps in the extant literature and contributes to the body of knowledge in several areas. First, it is the first attempt which not only identifies the COVID-19 RCs based on their criticality but also formulates RSs to mitigate these RCs in a priority list. Second, this study uses an EE context, an approach which may unveil other significant aspects of the COVID-19 that might be absent from existing studies. Third, from the methodological viewpoint, this research makes combined use of three methods—Pareto, BWM and fuzzy TOPSIS—all of which are unused in the literature related to the COVID-19 RCs and RSs. Lastly, robustness of the study's findings is guaranteed through use of a sensitivity analysis, also adding value to the study.

3 Research methodology

The proposed research framework in this paper is shown in Fig. 1. The complete procedure, along with data analysis and model implementation, is set out below.

3.1 Phase 1: identification of RCs and RSs to overcome the effects of the COVID-19 pandemic through a structured literature review on various scientific databases.

To identify the RCs and RSs, a systematic literature review was performed. Several keywords such as "recovery challenges and COVID-19", "challenges and COVID-19", "strategies and COVID-19", "recovery strategies and COVID-19", and "recovery challenges OR strategies and COVID-19" were utilized to search the relevant work in scholarly databases, i.e., Google Scholar, ScienceDirect, and Scopus. The sorted RCs and RSs from previous studies are presented in Tables 1, 2, 3 and 4.

3.2 Phase 2: validation of identified RCs and RSs to mitigate the impacts of the COVID-19 pandemic based on experts' feedback

The validation process of the identified RCs and RSs to overcome the COVID-19 consequences in the leather industry's SCs was completed via a survey of experts and case companies, i.e., selected deliberately to validate the identified RCs and RSs. In this stage, the experts were invited by personal communication and field visits. They helped to devise the relevant RCs and the RSs to tackle the impacts of the pandemic on the leather industry. We invited more than 30 experts and received feedback from 20 of them spread across 18 leather

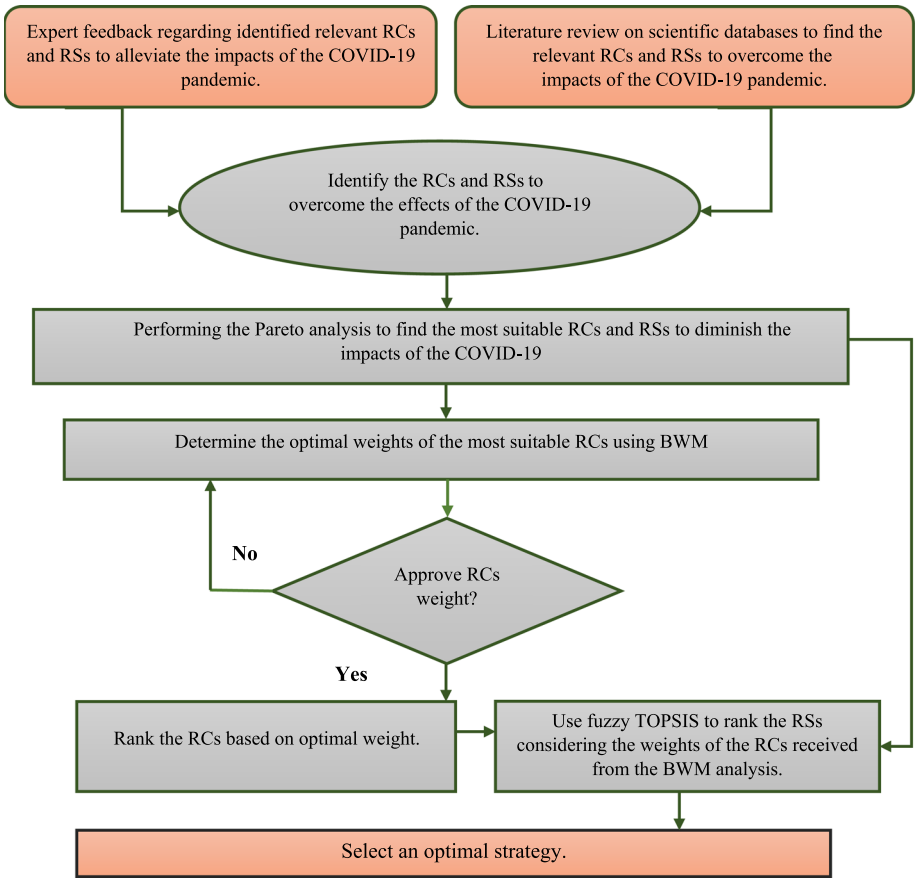

Fig. 1 Flowchart of the method

enterprises, 1 leather chemical seller and 1 academic institute. While collecting feedback from these experts, a developed data collection protocol (see Appendix-A) was provided to them to ascertain their opinions. Finally, a total of 16 RCs and 11 RSs were identified, of which 7 new RCs were identified and 4 new RSs (see Tables 3 and 4). The case companies' information is supplied in Appendix-A, Table 17. The experts' profiles in this stage are supplied in Table 5.

3.3 Phase 3: selection of the most relevant RCs and strategies to mitigate the effects of COVID-19 in the leather industry using Pareto analysis

In order to select the most relevant RCs and RSs for mitigating the effects of the COVID-19 pandemic, we performed a Pareto analysis, an effective decision making tool developed by Vilfredo Pareto (Erdil, 2019). As a decision support tool, Pareto analysis can separate factors statistically under 'desirable' or 'vital few' and 'undesirable' or 'trivial many'. In this way, it is possible to identify the vital few factors from among many factors in a system. A Pareto graph can easily identify the vital few statistically (Karmaker et al., 2021). In Pareto analysis,

Table 1 RCs of the COVID-19 pandemic in Bangladesh's leather industry

Name of the challenges	Definition	References
Massive order suspensions from foreign buyers *(RC_1)*	Order suspensions from buyers were noticed due to the reduction in demand for leather products around the world during COVID-19. This challenge will impact the recovery of normal SC conditions	Paul et al. (2021)
Closing of partners' SC operations *(RC_2)*	Due to restrictions imposed by the government and health agencies, there is a significant chance that SC partners' businesses will shut down. This could interfere with normal SC activities while the system is recovering	Paul et al. (2021)
World economic collapse in longer term *(RC_3)*	A global economic collapse will occur, posing a major challenge for the leather industry. It may take a long time to recover from the worst of the situation	Ivanov (2020, Lalon (2020), Sen (2020), Singh et al. (2020)
Increasing bankruptcy of business stakeholders *(RC_4)*	As the pandemic disrupted business and imposed huge losses, there will be a high chance of bankruptcy of business stakeholders	Choi (2020), Paul et al. (2021)
High degree of layoffs of skilled workers *(RC_5)*	As the processing of leather is reduced due to COVID-19, there is a high risk of skilled workers' layoff by the industry owners	Chowdhury et al. (2020); Paul et al. (2021); Sarker et al. (2021)
Complications in confirming workplace safety *(RC_6)*	Complications in confirming workplace safety due to the pandemic occur	Sarker et al. (2021)
Challenges to safety protocol development *(RC_7)*	It will be necessary to make a standard safety protocol for running the production flow	Sarker et al. (2021)
Lack of preparedness to handle the pandemic *(RC_8)*	The leather processing industry is far from the application of advanced technology, which may make the industry owners incapable of being well prepared to handle large disruption	Paul et al. (2021)
Poor relationships among suppliers *(RC_9)*	In the leather processing industry's SCs, several suppliers are involved. Poor relationships among them may inhibit recovery from the pandemic	Paul et al. (2021)

Table 2 RSs to mitigate the effects of the COVID-19 Pandemic on Bangladesh's leather industry

Name of the strategies	Definition	References
Financial support, i.e., tax cuts, incentives, long term government loans *(S_1)*	The pandemic has resulted in significant losses to business owners. Hence, the financial assistance from the authorities may help them to survive in a more competitive business environment	Gupta et al. (2022), Paul et al. (2021), Sarker et al. (2021)
Ensure efficient disruption risk management facilities *(S_2)*	The pandemic shows how vulnerable our SCs are. Hence, an efficient risk management culture may assist SC managers to lessen the impact of the pandemic	Ambrogio et al. (2022); Barman et al. (2021); Paul et al. (2021)
Digitize the leather industry's SCs through automation and IT, etc. *(S_3)*	The leather industry's SCs are very conventional and require an update towards making them more sustainable. The pandemic shows the significance of the digitalization of SCs. Hence, digitizing the SCs via automation and IT would be an excellent strategy to alleviate the consequences of the pandemic	Ambrogio et al. (2022), Gupta et al. (2022), Raj et al. (2022)
Develop recovery policies to handle SC disruption risks like the COVID-19 pandemic *(S_4)*	Efficient RSs may handle the risks to SCs. Hence, a strategy to develop recovery policies to handle SC disruption risks may be the driving factor for the industry to reduce the impact of the pandemic	Ozdemir et al. (2022), Paul et al. (2021), Rozhkov et al. (2022)
Ensure strong collaboration among materials suppliers including chemical suppliers, and buyers *(S_5)*	The scarcity of raw material supplies, including chemicals, may halt manufacturing operations. Hence, ensuring strong collaboration among these suppliers and buyers would help to mitigate the effects of the pandemic	Orji et al. (2021), Paul et al. (2021), Raj et al. (2022)
Ensure high level of preparedness by adopting latest technology *(S_6)*	High level of preparedness may reduce the impacts of disruption risks that happened suddenly to SCs. Therefore, ensuring a high level of preparedness by adopting the latest technologies would be a significant strategy to reduce the effects of the pandemic	Orji and Ojadi (2021), Ozdemir et al. (2022)

Table 2 (continued)

Name of the strategies	Definition	References
Develop safety protocols against the COVID-19 pandemic and other health risks *(S_7)*	Without safety protocol development, it is quite difficult to maintain production. Therefore, efficient safety protocol development would guide practitioners to continue the regular production process	Paul et al. (2021), Sarker et al. (2021)

Table 3 *New* RCs of the COVID-19 pandemic in Bangladesh's leather industry

Name of the challenges	Definition	References
Decreasing amount of leather processing *(RC_{10})*	The production process of leather manufacturing declined due to COVID-19 restriction. This happened owing to order suspensions, closure of operations, lockdowns, and transportation restrictions	Experts' feedback
Long term crisis of liquidity *(RC_{11})*	The liquidity crisis hampers the SC activities by imposing huge pressure on the owners of leather companies	Experts' feedback
Rising cost of leather processing chemicals *(RC_{12})*	Chemical suppliers are unable to maintain a rapid and steady supply of chemicals due to global restrictions. This has halted manufacturing activities as well as increasing the price of leather processing chemicals	Experts' feedback
Fall in demand for leather for an extended period *(RC_{13})*	There is a big challenge to maintain regular demand for leather owing to a reduction in customers' incomes. This may increase the recovery time	Experts' feedback
Lack of fitness of SCs' re-configurability *(RC_{14})*	COVID-19 is a special type of SC disruption risk. Hence, it requires a re-configuring of SCs. However, leather processing firms will face huge challenges to do this	Experts' feedback
Unavailability of recovery policies *(RC_{15})*	Currently, in the leather processing industry, no recovery policies are available to tackle the impacts of the pandemic	Experts' feedback
Unavailability of sustainable communication facilities *(RC_{16})*	It is rare to find a sustainable communication framework in the leather industry, which is a major obstacle to tackling the impacts of the pandemic on this industry	Experts' feedback

80/20 or 70/30 is used as a reference value and the real relationship is more disproportionate or proportional than the reference value (Moktadir et al., 2021). In this regard, convenient rules can be applied to find the more favorable output. Therefore, in this study, the threshold value was set at 65 or above as the scoring value to consider the most crucial RCs and RSs for subsequent quantitative analysis. In this study, the Pareto analysis followed a disproportionate relationship of 63/38 for RCs and 85/15 for RSs. In this way, we received nine RCs and nine

Table 4 New strategies to mitigate the effects of the COVID-19 pandemic in Bangladesh's leather industry

Name of the strategies	Definition	References
Making available of business data analytics tools in the leather industry *(S_8)*	Business data analytics tools are getting popular day by day to the manufacturing organizations as they can be able to predict the market conditions. Therefore, in the leather SC, availability of business data analytics tools may assist to predict the market conditions and help to take necessary actions quickly	Experts' feedback
Develop standard employment management facility to avoid layoff *(S_9)*	The standard employment management facility can aid in reducing the high rate of layoff of skilled workers. Therefore, this strategy should be initiated immediately in the leather industry to reduce the consequences of the pandemic	Experts' feedback
Make the leather supply re-configurability *(S_{10})*	Due to the complexity, during the COVID-19 period, it is crucial to re-configure the leather SC for maintaining the SC activities smoothly. Therefore, re-configuration of the leather SC is a pivotal strategy to recover the consequences of the pandemic	Experts' feedback
Solve the existing problems of CETP and provide solid waste management facility for long run business *(S_{11})*	Due to the chemical-intensive industry, the leather industry needs to ensure the effluent treatment plant and solid waste management facility towards environmental safety and running the business in the long run. Hence, this strategy should be immediately implemented in the leather industry to lessen the impacts of the pandemic	Experts' feedback

RSs (see Figs. 2 and 3). The data of the experts' feedback for the Pareto analysis, both for RCs and RSs, are provided in Appendix-B, Tables 18 and 19.

3.4 Phase 4: application of the BWM to compute the optimal weights of the RCs

In this stage, we employed a multi-criteria decision making (MCDM) tool which has drawn great attention from researchers in SC management. As a popular MCDM technique, we used the best worst method (BWM) (Razaei 2015) to evaluate the RCs. The procedure of the BWM is outlined next:

Step 1: Initially, the nine RCs sorted from the Pareto analysis were set to implement the BWM. The finalized set of RCs can be denoted as (RC_1, RC_2, ..., RC_n).

Step 2: In this process, from the identified set of RCs, the experts selected the best and the worst.

Step 3: The experts rated the RCs by comparing the best RC following the preference scale given in Table 6. The rating vector of best-to-other RCs is expressed as $A_B = (a_{BRC_1}, a_{BRC_2}, ..., a_{BRC_n})$, where a_{BRC_j} = Rating value of best RC in respect to the other RCs *RCj*. It is noted that the rating value of a_{BB} will be 1.

Table 5 The profiles of the experts who participated in this study

Experts Code	Industry/Organization	Designation	Working area	Job Experience
L1	Tannery	Chief leather technologist (LT)	Leather processing	21 +
L2	Tannery	Senior LT	Quality leather processing	20 +
L3	Tannery	Chief LT	Leather finishing	18 +
L4	Tannery	Manager	Management	17 +
L5	Tannery	Chief LT	Quality leather production	16 +
L6	Tannery	LT	Leather finishing	15 +
L7	Tannery	Manager	Management	14 +
L8	Leather Chemical	Executives	Quality control in recipe preparation	12 +
L9	Tannery	SC manager	Merchandising and overall management	11 +
L10	Tannery	LT	Leather processing	11 +
L11	Tannery	Senior manager	Management	10 +
L12	Tannery	Chief LT	Leather processing	10 +
L13	Tannery	LT	Quality control	12 +
L14	Tannery	Technologist	Quality control	10 +
L15	Tannery	Chemists	Recipe preparation	10 +
L16	Tannery	Leather chemists	Recipe preparation	8 +
L17	Tannery	Junior LT	Leather processing	8 +
L18	Academic	Assistant Professor	Research and development	7 +
L19	Tannery	Executives	Leather processing	7 +
L20	Tannery	Executives	Maintenance and Quality control	6 +

Step 4: Similarly, the experts rated the RCs by comparing other RCs to worst RC following the preference scale given in Table 6. The rating vector of others-to-worst RCs is denoted as $A_w = \left(a_{RC_1W}, a_{RC_2W}, ..., a_{RC_nW}\right)^T$, where a_{RC_jW} = Rating value of other RCs RC_j in respect to the worst RC. It is noted that the rating value of a_{WW} will be 1.

Step 5: Finally, the optimum weights of all the RCs were determined as $\left(w_1^*, w_2^*, ..., w_n^*\right)$.

The main function of this stage was to compute the optimal weights of the RCs in such a way that the maximum absolute variances for all j were minimized of the subsequent set $\left\{ \left|w_B - a_{BRC_j} w_{RC_j}\right|, \left|w_{RC_j} - a_{RC_jW} w_W\right| \right\}$.

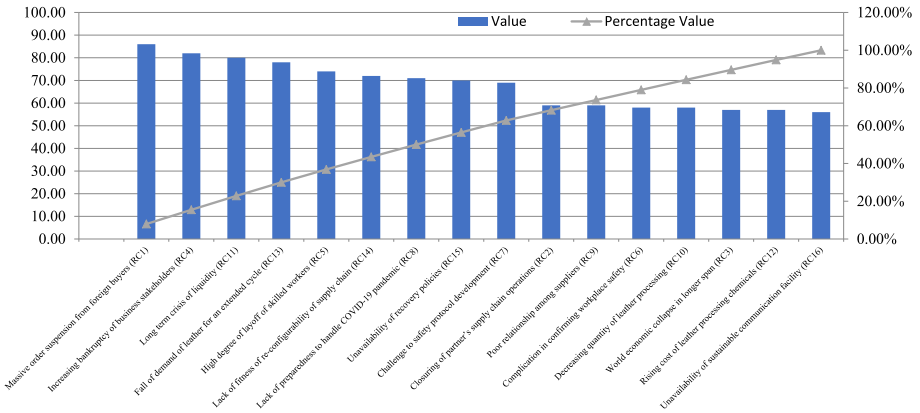

Fig. 2 Pareto analysis of identified RCs

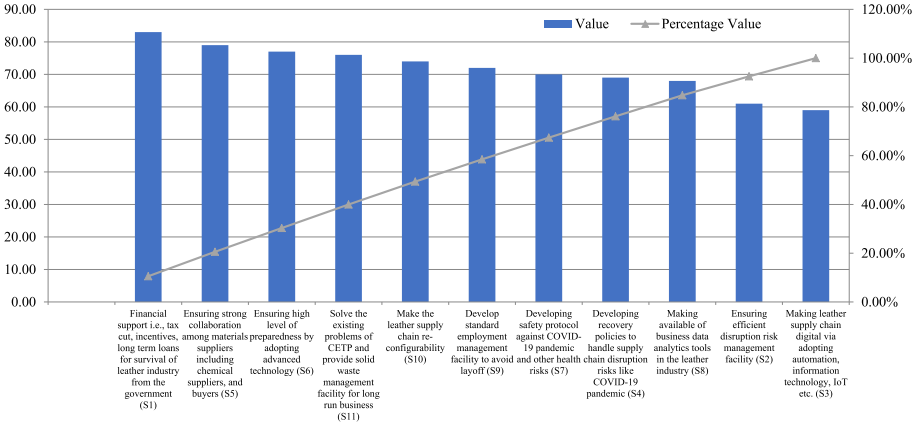

Fig. 3 Pareto analysis of identified RSs

A minimax model is established from the set,

$$\begin{aligned} &\min \max\left\{\left|w_B - a_{BRC_j} w_{RC_j}\right|, \left|w_{RC_j} - a_{RC_j W} w_W\right|\right\} \\ &s.t. \sum\nolimits_j w_{RC_j} = 1 \\ &w_{RC_j} \geq 0, \ \ for\ all\ RC_j \end{aligned} \tag{1}$$

The transformation of model (1) into a linear model is written as follows,

$$\begin{aligned} &\min \xi^L \\ &\left|w_B - a_{BRC_j} w_{RC_j}\right| \leq \xi^L, \ \ for\ all\ RC_j \\ &\left|w_{RC_j} - a_{RC_j W} w_w\right| \leq \xi^L, \ \ for\ all\ RC_j \\ &\sum\nolimits_j w_{RC_j} = 1 \\ &w_{RC_j} \geq 0, \ \ for\ all\ RC_j \end{aligned} \tag{2}$$

Table 6 BWM rating scale for the assessment of the RCs

Equally important of RC *i* over *j*	Equal to moderately more important of RC *i* over *j*	Moderately more important of RC *i* over *j*	Moderately to strongly more important of RC *i* over *j*	Strongly more important of RC *i* over *j*	Strongly to very strongly more important of RC *i* over *j*	Very strongly more important of RC *i* over *j*	Very strongly to extremelymore important of RC *i* over *j*	Extremely more important of RC *i* over *j*
1	2	3	4	5	6	7	8	9

The optimized weights of the RCs $\left(w_1^*, w_2^*, ..., w_n^*\right)$ and optimal values of ξ^L were determined solving the model (2). A consistency ξ^L value close to 0 means more consistence (Rezaei, 2015).

3.5 Phase 5: application of fuzzy TOPSIS for evaluation of the RSs

Here, we address the overcoming strategies of the RCs using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), introduced by Hwang and Yoon (1981). The TOPSIS procedure was followed according to the assumption that the best alternative will have the least possible distance from the Positive Ideal solution (PIS) and the highest distance from the Negative Ideal Solution (NIS) (Zhu et al., 2020). The major stages in the fuzzy TOPSIS method are set out below (Nazim et al., 2022; Rafi et al., 2022):

Step 6: In this step, the linguistic scale seen in Table 7 was followed to make the comparison matrices M among the total number of RSs s with the total number of RCs n. After that, the linguistic variables were transferred into a quantitative scale.

$$M = \left[m_{ij}\right]_{s\times n}; where\ i = 1, 2, ..., s;\ j = 1, 2, ..., n;\ \ and\ m_{ij} = (l_{ij}, k_{ij}, u_{ij})$$

where m_{ij} defines the rating value of RSs (i) with respect to RCs (j).

Step 7: In this step, all the comparison matrices received from the e number of experts were used to make the combined comparison matrix using Eq. (3):

$$l = \min_e\{l_{ij}\};\ k = \frac{1}{e}\sum_{e=1}^{E} k_{ij};\ and\ u = \max_e\{u_{ij}\} \tag{3}$$

Step 8: The pair-wise comparison matrices m were then transferred to weighted normalized decision matrix Z among s number of strategies and n number of RCs, as shown in Eq. (4).

$$Z = \left[z_{ij}\right]_{s\times n}; where\ i = 1, 2, ..., s;\ and\ j = 1, 2, ...,\ n$$

$$z_{ij} = m_{ij} \otimes w_j \tag{4}$$

Step 9: FPIS and FNIS are computed using Eqs. (5–6).

$$\begin{aligned} &A^+ = \left\{z_1^+, ..., z_n^+\right\}, \\ &where\ z_j^+ = \left\{\max\left(z_{ij}\right) if\ j \in J; \min\left(z_{ij}\right) if\ j \in J'\right\},\ j = 1, ..., n. \end{aligned} \tag{5}$$

$$\begin{aligned} &A^- = \left\{z_1^-, ..., z_n^-\right\}, \\ &where\ z_j^- = \left\{\min\left(z_{ij}\right) if\ j \in J; \max\left(z_{ij}\right) if\ j \in J'\right\},\ j = 1, ..., n. \end{aligned} \tag{6}$$

Table 7 Linguistic scale for fuzzy TOPSIS

Linguistic attributes	Corresponding fuzzy numbers
Very low (VL)	(0.0, 0.0, 0.2)
Low (L)	(0.0, 0.2, 0.4)
Medium (M)	(0.2, 0.4, 0.6)
High (H)	(0.4, 0.6, 0.8)
Very high (VH)	(0.6, 0.8, 1.0)
Excellent (E)	(0.8, 1.0, 1.0)

Step 10: The distance of each alternative from the FPIS and the FNIS was determined using the following equations.

$$e_i^+ = \left\{ \sum_{j=1}^{n} \left(z_{ij} - z_{ij}^+ \right)^2 \right\}^{1/2}, \; i = 1, \ldots, s$$
$$e_i^- = \left\{ \sum_{j=1}^{n} \left(z_{ij} - z_{ij}^- \right)^2 \right\}^{1/2}, \; i = 1, \ldots, s \tag{7}$$

Step 11: The closeness coefficient CC_i was determined using Eq. (8).

$$CC_i = \frac{e_i^-}{e_i^- + e_i^+} \; i = 1, \ldots, s \; CC_i \in (0, 1) \tag{8}$$

Step 12: Finally, the strategies were evaluated in descending order based on the CC values.

3.6 Implementation of the proposed method

The proposed decision support model was employed to assess the RCs and RSs in terms of overcoming the consequences of the COVID-19 pandemic in the leather industry of Bangladesh. The leather industry must scrutinize these RCs and RSs in order to ensure the sector's sustainable development. This study identified and assessed the RCs and RSs to deal with the impacts of the COVID-19 pandemic using integrated decision support tools (i.e., Pareto, BWM and fuzzy TOPSIS). The implication of the integrated methodology is explained below in three phases:

Stage 1: Identification and validation of relevant RCs and strategies using pareto analysis

In this phase, the relevant RCs and RSs were fixed through the procedure noted in Sect. 3.1–3.3 (Phases 1–3). In this regard, the experts were helped to obtain data towards fixing the most relevant RCs and RSs. The output was shown in Figs. 2 and 3.

Stage 2: Application of the BWM to assess the most relevant nine RCs

The BWM was applied to evaluate the most relevant nine RCs identified via Pareto analysis. The complete assessment process (see Sect. 3.4 in Phase 4) is described below.

Step 1: In this step, the most relevant nine RCs were fixed to collect the data from the experts for BWM analysis. Table 8 shows the most relevant nine RCs that met the threshold value from the Pareto analysis.

Step 2: Identification of the best and worst RCs

The experts selected the best and worst RCs from the total set of identified RCs. We collected feedback for the BWM and fuzzy-TOPSIS analysis from the most experienced 15 experts (longest experience was the selection criterion) from among the 20 participants using the questionnaire (Q1–Q4—see Appendix-C. Table 9 represents the best and worst RCs chosen by the 15 experts.

Step 3: Comparison of best RC over all other RCs

The fifteen experts were requested to rate the best RC using the scale provided in Table 6. The best RC chosen by experts 1–15 is presented in Table 10.

Step 4: Comparison of all other RCs with the worst RC

Table 8 Most relevant nine RCs along with code received from the Pareto analysis (according to priority position in the Pareto analysis)

Name of the finalized RC with code	Code
Massive order suspensions from foreign buyers	(RC_1)
Increasing bankruptcy of business stakeholders	(RC_4)
Long-term crisis of liquidity	(RC_{11})
Fall in demand for leather over an extended period	(RC_{13})
High number of layoffs of skilled workers	(RC_5)
Lack of fitness of re-configurability of SC	(RC_{14})
Lack of preparedness to handle the COVID-19 pandemic	(RC_8)
Unavailability of recovery policies	(RC_{15})
Challenges to safety protocol development	(RC_7)

Table 9 Best and worst RCs as chosen by the experts

RC name with code	Best RCs acknowledged by experts	Worst RCs acknowledged by experts
Massive order suspensions from foreign buyers (RC_1)	*LT2, LT5, LT13, LT15*	
Increasing bankruptcy of business stakeholders (RC_4)	*LT7, LT12*	
Long-term crisis of liquidity (RC_{11})	*LT1, LT3, LT14*	
Fall in demand for leather over an extended period (RC_{13})	*LT6, LT10*	
High number of layoffs of skilled workers (RC_5)	*LT9, LT11*	
Lack of fitness of re-configurability of SC (RC_{14})	*LT8*	
Lack of preparedness to handle the COVID-19 pandemic (RC_8)		*LT5, LT9, LT10, LT12*
Unavailability of recovery policies (RC_{15})	*LT4*	*LT2*
Challenges to safety protocol development (RC_7)		*LT1, LT3, LT4, LT6, LT7, LT8, LT11, LT13, LT14, LT15*

The experts were requested to rate all other RCs over the worst RC using the scale described in step 3 (see Table 11).

Step 5: Optimal weights determination of the RCs

The optimization model and all the constraints stated in Eq. 2 were used to get the optimal weights of the RCs. For example, the optimization model and developed constraints for expert-1 are shown below.

Min, ξ^L

Table 10 Best RC from among all RCs as chosen by experts 1–15

Expert	*Best RC*	*RCs*								
		RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
LT1	RC_{11}	2	4	1	3	6	8	7	5	9
LT2	RC_1	1	3	2	4	7	6	5	8	9
LT3	RC_{11}	3	2	1	5	4	8	6	7	9
LT4	RC_{15}	5	3	4	7	2	8	6	1	9
LT5	RC_1	1	3	2	4	6	5	9	8	7
LT6	RC_{13}	5	3	4	1	7	2	8	6	9
LT7	RC_4	2	1	5	3	4	7	8	6	9
LT8	RC_{14}	4	3	2	6	5	1	8	7	9
LT9	RC_5	5	4	3	2	1	7	9	8	6
LT10	RC_{13}	3	2	4	1	7	5	9	6	8
LT11	RC_5	2	5	3	4	1	7	8	6	9
LT12	RC_4	4	1	3	5	2	6	9	7	8
LT13	RC_1	1	2	4	3	5	8	7	6	9
LT14	RC_{11}	2	3	1	5	4	7	8	6	9
LT15	RC_1	1	4	3	2	7	5	6	8	9

Subject to,

$$
\begin{aligned}
&\left|w_{RC_{11}} - 2w_{RC_1}\right| \le \xi^L; \left|w_{RC_{11}} - 4w_{RC_4}\right| \le \xi^L; \left|w_{RC_{11}} - 1w_{RC_{11}}\right| \le \xi^L;\\
&\left|w_{RC_{11}} - 3w_{RC_{13}}\right| \le \xi^L; \left|w_{RC_{11}} - 6w_{RC_5}\right| \le \xi^L; \left|w_{RC_{11}} - 8w_{RC_{14}}\right| \le \xi^L;\\
&\left|w_{RC_{11}} - 7w_{RC_8}\right| \le \xi^L; \left|w_{RC_{11}} - 5w_{RC_{15}}\right| \le \xi^L; \left|w_{RC_{11}} - 9w_{RC_7}\right| \le \xi^L;\\
&\left|w_{RC_1} - 8w_{RC_7}\right| \le \xi^L; \left|w_{RC_4} - 6w_{RC_7}\right| \le \xi^L; \left|w_{RC_{11}} - 9w_{RC_7}\right| \le \xi^L;\\
&\left|w_{RC_{13}} - 7w_{RC_7}\right| \le \xi^L; \left|w_{RC_5} - 5w_{RC_7}\right| \le \xi^L; \left|w_{RC_{14}} - 3w_{RC_7}\right| \le \xi^L;\\
&\left|w_{RC_8} - 2w_{RC_7}\right| \le \xi^L; \left|w_{RC_{15}} - 4w_{RC_7}\right| \le \xi^L; \left|w_{RC_7} - 1w_{RC_7}\right| \le \xi^L;\\
&w_{RC_1} + w_{RC_4} + w_{RC_{11}} + w_{RC_{13}} + w_{RC_5} + w_{RC_{14}} + w_{RC_8} + w_{RC_{15}} + w_{RC_7} = 1\\
&w_{RC_1}, w_{RC_4}, w_{RC_{11}}, w_{RC_{13}}, w_{RC_5}, w_{RC_{14}}, w_{RC_8}, w_{RC_{15}}, w_{RC_7} \ge 0
\end{aligned}
$$

Using Excel Solver, the shown above was devised to get the optimal weights for the RCs. The optimal weights of the RCs for expert-1 are shown in Table 12 (row L1). Similarly, the models for the remaining experts (2–15) were constructed in Excel Solver. The average weight of each RC was determined using a simple arithmetic mean process. Table 12 displays the ultimate optimal weights and rankings of each RC.

Stage 3: Evaluating the RSs using the fuzzy TOPSIS method

The Fuzzy-TOPSIS technique described in Phase 5 (see Sect. 3.5) was used in this stage to evaluate the RSs. The most relevant nine strategies from the Pareto analysis were used for further assessment (summarized in Table 13).

Step 6: Expert opinion of fuzzy TOPSIS and converting the linguistic data into a fuzzy set

Table 11 Comparison matrix of others-to-worst RC

	Experts														
	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8	LT9	LT10	LT11	LT12	LT13	LT14	LT15
Others- to- worst	RC_7	RC_{15}	RC_7	RC_7	RC_8	RC_7	RC_7	RC_7	RC_8	RC_8	RC_7	RC_8	RC_7	RC_7	RC_7
RC_1	8	9	8	5	9	3	7	6	5	7	7	6	9	8	9
RC_4	6	7	7	8	7	7	9	7	6	8	5	9	8	7	6
RC_{11}	9	8	9	6	8	5	4	8	7	6	8	7	7	9	7
RC_{13}	7	6	5	2	6	9	8	4	8	9	6	5	6	5	8
RC_5	5	3	6	7	4	3	6	5	9	3	9	8	4	6	3
RC_{14}	3	4	2	3	5	8	3	9	3	5	3	4	2	3	5
RC_8	2	5	4	4	1	2	2	3	1	1	2	1	3	2	4
RC_{15}	4	2	3	9	3	4	5	2	2	4	4	2	5	4	2
RC_7	1	1	1	1	2	1	1	1	4	2	1	3	1	1	1

Table 12 Optimal weight and ranking of the RCs

Expert	K^*	*Weights*								
		RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
LT1	(0.0707)	0.1920	0.0960	0.3133	0.1280	0.0640	0.0480	0.0549	0.0768	0.0270
LT2	(0.0684)	0.3146	0.1277	0.1915	0.0958	0.0547	0.0638	0.0766	0.0479	0.0274
LT3	(0.0774)	0.1290	0.1935	0.3095	0.0774	0.0967	0.0484	0.0645	0.0553	0.0258
LT4	(0.0774)	0.0774	0.1290	0.0967	0.0553	0.1935	0.0484	0.0645	0.3095	0.0258
LT5	(0.0625)	0.0625	0.1597	0.1736	0.1458	0.1181	0.1319	0.0139	0.1042	0.0903
LT6	(0.0665)	0.0764	0.1274	0.0956	0.3157	0.0546	0.1911	0.0478	0.0637	0.0277
LT7	(0.0774)	0.1935	0.3095	0.0774	0.1290	0.0967	0.0553	0.0484	0.0645	0.0258
LT8	(0.0684)	0.0958	0.1277	0.1915	0.0638	0.0766	0.3146	0.0479	0.0547	0.0274
LT9	(0.0684)	0.0766	0.0958	0.1277	0.1915	0.3146	0.0547	0.0274	0.0479	0.0638
LT10	(0.0684)	0.1277	0.1915	0.0958	0.3146	0.0547	0.0766	0.0274	0.0638	0.0479
LT11	(0.0774)	0.1935	0.0774	0.1290	0.0967	0.3095	0.0553	0.0484	0.0645	0.0258
LT12	(0.0684)	0.0958	0.3146	0.1277	0.0766	0.1915	0.0638	0.0274	0.0547	0.0479
LT13	(0.0625)	0.0625	0.1736	0.1597	0.1458	0.1181	0.0903	0.1042	0.1319	0.0139
LT14	(0.0684)	0.1915	0.1277	0.3146	0.0766	0.0958	0.0547	0.0479	0.0638	0.0274
LT15	(0.0625)	0.0625	0.1458	0.1597	0.1736	0.1042	0.1319	0.1181	0.0903	0.0139
Average Weights	(0.0696)	0.1301	0.1598	0.1709	0.1391	0.1296	0.0953	0.0546	0.0862	0.0345
Rank	4	2	1	3	5	6	8	7	9	

Table 13 Most relevant nine RSs along with code received from the Pareto analysis (according to priority position in Pareto analysis)

Strategies	Code
Financial support i.e., tax cuts, incentives, long-term government loans for survival of the leather industry	(S_1)
Ensure strong collaboration among materials suppliers, including chemical suppliers, and buyers	(S_5)
Ensure high level of preparedness by adopting advanced technology	(S_6)
Solve the existing problems of CETP and provide solid waste management facilities for long-run business	(S_{11})
Make the leather SC more easily re-configurable	(S_{10})
Develop standard employment management facility to avoid layoffs	(S_9)
Develop safety protocols against the COVID-19 pandemic and other health risks	(S_7)
Develop recovery policies to handle SC disruption risks like COVID-19 pandemic	(S_4)
Make available business data analytics tools in the leather industry	(S_8)

The 15 experts provided their feedback on how the RSs influence the RCs, using the linguistic scale shown in Table 7 and the questionnaire provided in Appendix-C (question 4). The feedback received from the 15 experts in linguistic form is shown in Appendix-D, Tables 20−34. The linguistic attributes were then converted into fuzzy numbers (see Appendix-D, Tables 35–50).

Step 7: Constructing a combined matrix

According to step 7 (see Sect. 3.5) and using Eq. 3, a combined matrix was formed through consideration of all the experts' opinions (see Appendix-D, Table D31).

Step 8: Constructing a weighted average matrix

The optimal weights of the RCs received from the BWM were used to make a weighted average matrix. To do this, the weights of the RCs were multiplied by the combined matrix to construct the weighted average matrix (see Table 14).

Step 9: Determination of the FPIS and the FNIS

Then the FPIS and the FNIS were calculated using Eq. (5). The FPIS will be $Z^+ = (0,0,0)$ and the FNIS will be $Z^- = (1,1,1)$.

Steps 10, 11 and 12: Determination of best strategy distance

The closeness of each RC from the FPIS and FNIS was then determined. Next, e^+ and e^- were calculated using Eq. (6), and from these two values *CCi* was calculated using Eq. (7). Then the best strategy was ranked based on the CC_i values in a descending order (see Table 15).

4 Results and discussion

The COVID-19 pandemic has significantly impacted global SCs (Gebhardt et al., 2022; Zhang et al., 2022) as well as business activities and public health (Paul et al., 2022b), compelling SC practitioners to rethink their business sustainability in this uncertain environment. The leather industry, a major contributor to Bangladesh's economy, had already been suffering long-term

Table 14 Weighted average relation matrix

Weights	0.1301			0.1598			0.1709			0.1391		
Strategies	RC_1			RC_4			RC_{11}			RC_{13}		
(S_1)	0.0000	0.0624	0.1301	0.0000	0.0639	0.1598	0.0000	0.0501	0.1709	0.0278	0.0983	0.1391
(S_5)	0.0000	0.0572	0.1301	0.0000	0.0852	0.1598	0.0000	0.0934	0.1709	0.0000	0.0760	0.1391
(S_6)	0.0000	0.0711	0.1301	0.0000	0.0895	0.1598	0.0000	0.0752	0.1709	0.0000	0.0575	0.1391
(S_{11})	0.0000	0.0468	0.1301	0.0000	0.0682	0.1598	0.0000	0.0797	0.1709	0.0000	0.0593	0.1391
(S_{10})	0.0000	0.0642	0.1301	0.0000	0.0533	0.1598	0.0000	0.0843	0.1709	0.0000	0.0723	0.1391
(S_9)	0.0000	0.0555	0.1301	0.0000	0.0852	0.1598	0.0000	0.0820	0.1709	0.0000	0.0760	0.1391
(S_7)	0.0000	0.0572	0.1301	0.0000	0.0831	0.1598	0.0000	0.0866	0.1709	0.0000	0.0797	0.1391
(S_4)	0.0000	0.0850	0.1301	0.0000	0.0682	0.1598	0.0000	0.1116	0.1709	0.0000	0.0779	0.1391
(S_8)	0.0000	0.0572	0.1301	0.0000	0.0788	0.1598	0.0000	0.0889	0.1709	0.0000	0.0760	0.1391

Weights	0.1296			0.0953			0.0546			0.0862			0.0345		
Strategies	RC_5			RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0.0000	0.0656	0.1296	0.0000	0.0318	0.0953	0.0000	0.0240	0.0546	0.0000	0.0552	0.0862	0.0000	0.0179	0.0345
(S_5)	0.0000	0.0535	0.1296	0.0000	0.0546	0.0953	0.0000	0.0269	0.0546	0.0000	0.0506	0.0862	0.0000	0.0152	0.0345
(S_6)	0.0000	0.0587	0.1296	0.0000	0.0533	0.0953	0.0000	0.0291	0.0546	0.0000	0.0425	0.0862	0.0000	0.0129	0.0345
(S_{11})	0.0000	0.0605	0.1296	0.0000	0.0546	0.0953	0.0000	0.0269	0.0546	0.0000	0.0333	0.0862	0.0000	0.0156	0.0345
(S_{10})	0.0000	0.0656	0.1296	0.0000	0.0635	0.0953	0.0000	0.0277	0.0546	0.0000	0.0345	0.0862	0.0000	0.0106	0.0345
(S_9)	0.0000	0.0691	0.1296	0.0000	0.0406	0.0953	0.0000	0.0247	0.0546	0.0000	0.0483	0.0862	0.0000	0.0175	0.0345
(S_7)	0.0000	0.0795	0.1296	0.0000	0.0470	0.0953	0.0000	0.0262	0.0546	0.0000	0.0586	0.0862	0.0000	0.0170	0.0345
(S_4)	0.0000	0.0708	0.1296	0.0000	0.0432	0.0953	0.0000	0.0182	0.0546	0.0000	0.0471	0.0862	0.0000	0.0133	0.0345
(S_8)	0.0000	0.0708	0.1296	0.0000	0.0394	0.0953	0.0000	0.0291	0.0546	0.0000	0.0356	0.0862	0.0000	0.0184	0.0345

Table 15 Ranking of the Strategies

Strategies	e^+	e^-	CC_i	Ranking
Financial support, i.e., tax cuts, incentives, long-term government loans for survival of the leather industry *(S_1)*	0.3983	4.9157	0.9250	3
Ensure strong collaboration among materials suppliers, including chemical suppliers, and buyers *(S_5)*	0.4036	4.9130	0.9241	7
Ensure high level of preparedness by adopting advanced technology *(S_6)*	0.3995	4.9173	0.9249	4
Solve the existing problems of CETP and provide solid waste management facilities for long run business *(S_{11})*	0.3923	4.9258	0.9262	1
Make the leather supply chain more easily re-configurable *(S_{10})*	0.3977	4.9200	0.9252	2
Develop standard employment management facility to avoid layoffs *(S_9)*	0.4012	4.9156	0.9245	6
Develop safety protocols against the COVID-19 pandemic and other health risks *(S_7)*	0.4067	4.9087	0.9235	8
Develop recovery policies to handle SC disruption risks like COVID-19 (S_4)	0.4105	4.9089	0.9228	9
Make available business data analytics tools in the leather industry *(S_8)*	0.4008	4.9165	0.9246	5

challenges due to environmental issues. Alongside these issues, the industry suddenly had to confront additional challenges posed by the COVID-19 pandemic. To provides insights into how these challenges might be overcome, this study has offered an integrated decision support model to investigate the RCs and RSs in terms of reducing the consequences of the pandemic. This section discusses the findings of the BWM and Fuzzy TOPSIS methods, and then conducts a sensitivity analysis to validate the study's results.

4.1 Discussion of RCs and implications of the findings

The BWM analysis provides a ranking of the RCs listed based on the their optimal weight values in a descending order: Long-term liquidity crisis (RC_{11}) > Increasing bankruptcy of business stakeholders *(RC_4)* > Falling demand for leather over an extended period *(RC_{13})* > Massive order suspensions from foreign buyers *(RC_1)* > High numbers of layoffs of skilled workers *(RC_5)* > Lack of fitness of re-configurability of SCs *(RC_{14})* > Unavailability of recovery policies *(RC_{15})* > Lack of preparedness to handle the COVID-19 pandemic *(RC_8)* > Challenges to the development of safety protocols *(RC_7)* (see Table 12).

From the BWM analysis, the RC 'Long-term liquidity crisis' (RC_{11}) received the maximum optimal weight of 0.1709. This implies that the leather industry is facing a long-term liquidity crisis due to the pandemic, and recovering from the consequences of the pandemic is a critical issue for the industry. The liquidity struggles of factory owners' dates back to the early relocation of the country's leather industry from Hazaribagh to Savar. The pandemic then brought additional pressure on the industry, posing a direct and long-term threat to the competitiveness, growth, and long-term sustainability of businesses. On 23 March 2019, a lockdown was initiated by the government of Bangladesh to control the infection rate. This

severely hampered regular leather processing activities and deepened the liquidity crisis. LightCastle (2020) and Sarker et al. (2022) highlighted the liquidity crisis as a major challenge in the recovery from the adversities of the COVID-19 pandemic for the SMEs of the leather industry. Also, some other studies reported the liquidity crisis as a critical challenge for the manufacturing industry (Karim et al., 2021; Paul et al., 2022b). Moreover, this RC can impede the industry's growth prospects by restricting access to capital, hindering expansion, and potentially leading to business closures. Against this backdrop, the RC associated with liquidity is a number one priority. If not effectively addressed, the consequences can be dire, including a downward spiral of financial instability, decreased investor confidence, and potential systemic risks that may reverberate across the broader economy. It is crucial to address long-term liquidity issues promptly through strategic action financial planning, seeking external funding sources, and implementing measures to enhance cash flow and financial resilience. Therefore, the policy makers and stakeholders need to address this RC with higher priority by adopting appropriate strategy proposed in the study.

The RC 'Increasing bankruptcy of business stakeholders' (RC_4) obtained the second position in the BWM ranking, with a corresponding weight of 0.1598. Due to the global financial turmoil triggered by the COVID-19 pandemic, leather industry stakeholders faced bankruptcy or came close to bankruptcy and, as a consequence, many had to close or downsize their businesses. Based on the recent data, about BDT 40 billion loans have been disbursed in the leather industry of Bangladesh, while the total amount of loan default is BDT 32.5 billion (The Financial Express, 2020). The relocation of the tanneries from Hazaribagh, Dhaka (the capital of Bangladesh) to the new tannery industrial state, Savar and the COVID-19 pandemic have worsened this scenario. The sustainability of the leather industry has been severely impacted by the ongoing bankruptcies of the leather industry's stakeholders. The increasing bankruptcy of business stakeholders can lead to supply shortages, disrupted manufacturing operations, delayed deliveries, and decreased customer trust. If the increasing bankruptcy is not effectively addressed, it can lead to a domino effect, triggering a wave of bankruptcies, decreased investments, and a decline in industry resilience, potentially leading to business closures. It is vital for policy makers to mitigate the impact of this RC by implementing measures to support their recovery to ensure long-term viability.

The RC 'Falling demand for leather over an extended cycle' *(RC_{13})* took third position, with an optimal weight of 0.1391 in the BWM ranking. This finding is indicative of the decline in global demand for leather items over an extended time due to the global economic crisis and the decreasing purchasing power of customers resulting from the pandemic-induced job losses. The leather industry in Bangladesh is seriously experiencing this challenge, which accelerated the contraction of the leather production. On the supply side, global transportation restrictions badly disrupted raw material and finished goods SCs, negatively impacting the forward linkage, for example export earnings (Cariappa et al., 2022; Kazancoglu et al., 2022a). Sarker et al. (2022) found that the production of 92.96% of SMEs fell by an average of 48.5%. SC operations and the demand for products in many other sectors are facing the same issues caused by the COVID-19 pandemic (Rozhkov et al., 2022). One such example is readymade garments (RMG)—the largest export earning sector of the Bangladesh economy (Paul et al., 2021). The impact of this RC is numerous. For instance, a prolonged decline in demand for leather can lead to job losses, factory closures, and a decline in overall industry value. If the falling demand for leather is not effectively addressed, it can have far-reaching consequences, including a loss of skilled labor, reduced investments in innovation and technology, and a long-lasting negative impact on the entire leather industry ecosystem. Therefore, this RC should be addressed by the decision-makers of the leather industry seeking to sustain the sector in the global market.

The next RC is 'Massive order suspensions from foreign buyers' (RC_1), taking fourth position in the BWM order with an optimal weight of 0.1301. This finding is indicative of the huge number of order cancellations from dealers and foreign buyers that the leather industry had to absorb as a consequence of the pandemic (Muzquiz, 2020). On the forward linkage stream, foreign buying houses had to close their business operations in many advanced countries in response to the drastic fall in retail consumer demand due to job losses and a rise in online shopping behavior, especially of essential goods. From the logistical perspective, regular business activities were hampered due to limited transportation facilities and the rapid country-wide lockdown during the COVID-19 (Cariappa et al., 2022; Gamal et al., 2022; Raj et al., 2022). All these factors resulted in massive order cancellations. Moreover, there had been situations where finished leather providers had failed to secure the ideal price from buyers due to business disruptions, which negatively impacted their profit margin. Given this background, RC_1 comes across as a major issue for the leather industry. According to business conversations with the officials of the Bangladesh Tanners Association and the Leather Goods and Footwear Exporters Association of Bangladesh, a total order worth USD $400 million was cancelled as a result of the COVID-19. Sarker et al. (2022) reported that 85.56% of SMEs had order cancellation issues during the first year of the COVID-19. If massive order suspensions from foreign buyers are not effectively addressed, the consequences can be severe for businesses and the overall economy. Firstly, leather companies heavily reliant on exports may experience a significant decline in revenue and profitability, leading to financial instability and potential business undertaking appropriate strategies to mitigate the negative consequences on businesses and the broader economy.

The next RC—'High numbers of layoffs of skilled workers' (RC_5)—is the fifth most important challenge facing the leather industry, recording an optimal weight of 0.1296 in the BWM analysis. This RC pinpoints the huge numbers of skilled job losses that resulted as a result of the pandemic. During the pandemic, the industry faced a scarcity of capital flows and massive order cancellations, adversely impacting profit margins (Laorden et al., 2022). Also, the pandemic resulted in supply and demand shocks and SC disruption. Consequently, the owners of leather businesses experienced huge financial losses. As a coping measure, they downsized their operations and attempted to reduce the adverse financial impact by cutting the size of the skilled workforce through redundancies. According to a study on the SMEs of the leather industry, 26.23% of employees were laidoff due to the COVID-19 pandemic (LightCastle, 2020). Meanwhile, the Dhaka Tribune (2021) reported that approximately 13% of employees lost their jobs in all sectors of Bangladesh due to the pandemic between May 5 and May 20 2020. Further, Paul et al. (2021) revealed that the RMG sector undertook substantial layoffs due to the pandemic. As a result of the COVID-19, industry layoffs were generally a major problem on a global scale (McCloskey et al., 2020). If this RC is not effectively addressed, it can lead to a loss of expertise and talent within industries, hampering innovation and productivity. The remaining workforce may experience increased workloads and stress, potentially leading to decreased morale and employee satisfaction. Hence, it is essential to take necessary policies by the policy makers to mitigate this challenge.

The next RC is 'Lack of fitness of re-configurability of SCs' (RC_{14}), which received an optimal weight of 0.0953 in the BWM analysis, giving it the sixth ranking. This means that lack of re-configurability is an important RC for leather industry SCs as they tend to be conventional and have a low take-up of technological adaptation (Hong, 2018). Since the COVID-19 pandemic caused a specific type of disruption risk throughout SC networks (Alam et al., 2021; Moktadir et al., 2022; Warrier et al., 2021), SCs need to be re-configured to tackle such risks of disruption (Paul et al., 2022b; Queiroz & Fosso Wamba, 2021; Song et al., 2022), and an effective communication channel needs to be maintained to overcome

information asymmetry with regard to technology management, transfer and diffusion along leather industry SCs. Altogether, this scenario points to an urgent necessity to re-configure SC structure in the sector to accelerate operations to match the global standard. Otherwise, it can result in reduced operational efficiency, increased costs, and supply disruptions. Leather companies may struggle to adapt to changing market conditions, such as shifts in demand or disruptions in the global supply chain, leading to delayed deliveries, inventory shortages, and customer dissatisfaction. Leather companies may face difficulties in scaling operations, entering new markets, or implementing agile strategies, hindering their competitiveness and long-term sustainability. Therefore, the policymakers should address this RC with significant priority.

The remaining challenges, i.e., 'Unavailability of recovery policies' (RC_{15}), 'Lack of preparedness to handle the COVID-19 pandemic' (RC_8) and 'Challenges to the development of safety protocols' (RC_7) secured the seventh, eighth, and ninth rankings, with corresponding optimal weights of 0.0862, 0.0546 and 0.0345, respectively. As crucial RCs for the leather industry's SCs, industry practitioners ought to focus on them to minimise the long-term effects of the pandemic. Moreover, given that any recovery policies for the industry's SCs are currently non-existent, practitioners should focus on developing recovery policies, as suggested by Paul et al. (2021). The policymakers should adopt strategic policies immediately to address this RC. Otherwise, there is a high chance prolonging economic downturns and hindering the recovery process.

Our paper also adds a new challenge called 'Lack of preparedness to handle the COVID-19 pandemic'. A high level of preparedness may reduce the disruption risks significantly, whereas, in contrast, a low level of preparedness has shown that reducing the disruption risks emanating from such a threat as that posed by the COVID-19 would be a struggle (Chatterjee et al., 2022; Scarpin et al., 2022). The level of preparedness to handle disruption risk may confirm how much the impacts can, in turn, be minimized (Moktadir et al., 2022; Ye et al., 2022). The COVID-19 is an infectious disease that has appeared in at least eight variant forms since September 2020 (Mahase, 2021). Hence, to sustain the manufacturing process and mitigate the effects of the pandemic, it is vital to develop a heath protocol for the leather industry, as emphasized by Sarker et al. (2021). An effective mass vaccination program could play a supportive role in this regard. Therefore, without lack of preparedness to handle the COVID-19 pandemic, it can result in widespread health crises. The economy may suffer from extended lockdowns, business closures, and job losses, leading to a severe recession. Therefore, at the time the study was conducted, it appeared very crucial for policymakers to take necessary action to mitigate this RC.

4.2 Discussion of RSs and implications of the findings

This paper also demonstrates the identification and evaluation of RSs, which might diminish the impact of the COVID-19 on the leather industry. In this connection, the Pareto analysis helped to fix the most relevant RSs and fuzzy-TOPSIS analysis assisted in measuring the significance of each RS. The ranking of the RSs is shown in Table 15.

According to our findings, the priority strategy is to 'Solve the existing problems of CETP (Common Effluent Treatment Plant) and provide solid waste management facility for long run business' (S_{11}). This priority has a solid reasoning. First of all, the leather industry is known to be the most hazardous industry in Bangladesh, and most of the tanneries do not comply with environmental regulations (Shibli & Islam, 2020). Consequently, the industry has evolved into a mammoth source of carbon emissions, making a significant contribution to

climate change in the country (Hong, 2018). Secondly, the export performance of the leather industry of Bangladesh has declined in the last five years due to improper CETP (not fully functional as per requirements) and an unavailability of solid waste management facilities (Moktadir et al., 2021). Solid waste, around 80–85% of which are generated during leather manufacturing, are major a contributing factor to the environmental pollution caused by the leather industry. It is alarming in this connection that there is no solid waste management plant in the Savar tannery industrial estate. As 80% of the tanneries of Bangladesh are situated at Tannery industrial state, Hemayetpur, Savar, which are discharging their effluents with the help of the CETP without following standard effluent discharge limits showing the poor performance of the environmental sustainability, the most required compliance certification for the leather industry, i.e., LWG, isn't achievable for the tanneries under the CETP in current settings. Therefore, leather industry stakeholders should take immediate action to increase the functionality of the established CETP and construct a solid waste management plant at Savar to combat the COVID-induced RCs (RC4, RC11, RC5) and their consequences in the industry, which will help the industry to ensure environmental sustainability along its SCs. Thirdly, it is evident that the leather industry is facing serious challenges to achieve LWG certification, implying that the industry has not been successful in fostering best practice in its performance across environmental, social and governance (ESG) requirements. Now, the leading European and American leather buyers are sourcing their products from only LWG certified tanneries. From the global trading point of view, the lack of LWG certification of Bangladeshi tanneries is contributing to declining export orders. Hence, besides the COVID-19 pandemic, lack of LWG certification is bound up with the RCs that are causing a significant decline in export earnings, which is accounted for about USD 500 million according to a source of Bangladesh Tanners Association (BTA) (Bangladesh Posts, 2023). On a broader perspective, if the leather industry ensures the installation of effluent treatment plants (common or individual) and makes provisions for solid waste management facilities (instead of diverting the waste to the Buriganga river, the lifeline of the capital city of Bangladesh), it can meet Sustainable Development Goal (SDG) 13 (climate action) and continue to trade as a significant player in the global market, increasing its international market share and environmental sustainability performance. Although this strategy is not directly associated with the COVID-19 RSs, an effective adoption of this strategy would enable managers in the leather processing industry to install cleaner production practices (Sharif et al., 2022), thereby reducing carbon emissions meeting SDG 13 and eventually fulfilling ESG requirements, which will boost up the export earnings from this sector.

Next, the findings show that the strategy 'Make the leather supply chain more easily re-configurable' (S_{10}) obtained the second most important status. This position can be justified by the numerous challenges the leather industry is facing in terms of how to lessen the effects of the COVID-19 pandemic. As the pandemic demonstrated an unprecedented type of disruption risk in the SC process, the need to re-configure SC activities has become crucial to ensure smooth business operations (Goldschmidt & Stasko, 2022; Njomane & Telukdarie, 2022). Hence, to reduce the RCs, i.e., lack of fitness of re-configurability of and lack of preparedness to handle the COVID-19 pandemic, it is essential to modify leather SC networks and how they operate. During the pandemic, human control operations needed to be controlled to slow down the infection rate (Modgil et al., 2021, 2022). Therefore, integration of automation and a strong technological infrastructural development may help to reduce the effects of the pandemic (Cui et al., 2022; Kazancoglu, et al., 2022b; Ye et al., 2022). This, in turn, requires careful policy planning (Paul et al. 2020) and integration in the RS, given the traditional and risk-averse nature of the leather SC and its poor history of technological adaptation (Hong, 2018). Altogether, it is evident that SC re-configuration

can remove the poor re-configuration fitness of leather SC, which will help in handling the COVID-19 pandemic. Therefore, SC re-configuration should be given special attention by the leather industry decision-makers for building up its SC more resilient. Implementing this RS can help to address the several RCs (rc14, rc8 simultaneously.

The next two most important strategies are 'Financial support, i.e., tax cuts, incentives, and long-term government loans for survival of the leather industry' *(S_1)* and 'Ensure a high level of preparedness by adopting advanced technology' *(S_6)*. Both strategies have a significant impact on the identified RCs to mitigate the effects of the COVID-19 pandemic. The liquidity crisis, bankruptcies, and layoffs of skilled workers can be mitigated largely by providing financial support to the leather industry and its stakeholders (Ambrogio et al., 2022; Raj et al., 2022). The financial support may also help in re-configuring the leather SC network. The authorities should therefore consider providing financial support in the form of tax cuts, incentives, and long-term loans to business owners for minimizing the effects of the pandemic. These financial aids will help the sector become more financially secure, which will make it easier for it to become financially sustainable. Global SC practitioners have already experienced that advanced technology has played a major role in diminishing the effects of the COVID-19 pandemic (Ciaburro, 2022; Moosavi et al. 2021; Orlando et al., 2022). This paper ranks the strategy of ensuring a high level of preparedness by adopting advanced technology as the fourth most important strategy for addressing the RCs. A high level of preparedness by adopting advanced technology, i.e., big data analytics, AI, robotics, block chain, may help to minimize the effects of the pandemic (Eryarsoy et al., 2022). Using these technologies, the practitioners of the leather industry can estimate the future demand for leather and leather products, which can help them cope with any changes in market demand. Also, these technologies can facilitate industrial automation for the leather industry that will minimize physical workstations and lower the risk of viral disease transmission chance. We reiterate in this regard that the leather SC is very traditional in nature and has a poor record of technological adoption (Hong, 2018). Therefore, this strategy should be a high priority for practitioners in the industry in terms of effective planning and execution.

The next five strategies are 'Make available business data analytics tools in the leather industry' *(S_8)*, 'Develop standard employment management facilities to avoid layoffs' *(S_9)*, 'Ensure strong collaboration among materials suppliers, including chemical suppliers, and buyers' *(S_5)*, 'Develop safety protocols against the COVID-19 pandemic and other health risks' *(S_7)*, and 'Develop recovery policies to handle SC disruption risks like the COVID-19 pandemic' (S_4). These five strategies have had considerable impact on the RCs recorded in this study. Data analytics tools can be used to predict the global demand for leather items, which would help decision-makers to balance supply and demand (Industry Today, 2022). Currently, in Bangladesh's leather industry, no data analytics tools are used for business activities. Therefore, decision-makers should think about modern business analytics tools to analyze market demand. It is crucial to ensure that such tools are used in the leather industry to minimize the effects of disruption risks like the COVID-19 pandemic. Various studies have reported that during the pandemic, the layoff rate was exceedingly high (Ambrogio et al., 2022). Due to the pandemic, 26.23% of employees were laidoff from the SMEs of the leather industry (LightCastle, 2020). To minimize this impact, it is essential to develop standard employment management facilities that may help to reduce this rate (Sarkis, 2021). An hourly-based working system may help in this regard. Decision-makers should think about implementing this strategy immediately to lessen the employees' layoff rate the leather industry has encountered in the face of the COVID-19, which will help to ensure social sustainability in the industry, as reported by Sarker et al. (2021). For the industry's SCs, multiple suppliers are included in the business cycle. Each one is important in its own way

for keeping the processing ongoing. It is reported that due to a lack of effective networking and collaboration among suppliers, SC activities were hampered during the pandemic (Alam et al., 2021; Moktadir et al., 2022; Nader et al., 2022). Therefore, ensuring strong collaboration among materials suppliers including chemical suppliers, and buyers, is crucial to maintain smooth operations in leather processing. Hence, managers in the industry should make efforts to collaborate by offering incentives to ensure the just-in-time (JIT) supply of raw materials.

Without safety protocols, it is difficult to maintain physical distance among employees. As the leather industry needs a lot of manual labor, the establishment of a safety policy for employees is very much imperative. Therefore, to continue production throughout the pandemic and post-pandemic, it is essential to develop effective safety protocols. Therefore, managers of industry SCs should immediately develop safety protocols that consider the COVID-19 issues. A study conducted by Sarker et al. (2021) suggested to develop the safety protocol for the leather industry to ensure social sustainability in the industry. Finally, last but not the least, the strategy 'Develop recovery policies to handle SC disruption risks like the COVID-19 pandemic' (S_4) can play a significant part in lessening the vulnerabilities of the COVID-19 pandemic. As with the SC disruption caused by the COVID-19, this similar SC disruption may happen at any time in the future (Queiroz et al., 2020; Song et al., 2022). To minimize such a disruption risk, it is necessary to devise and implement recovery policies (Dohale et al., 2022; Queiroz & Fosso Wamba, 2021). Many industries have considered a variety of recovery policies to recover from the pandemic. Managers in the leather industry should be no exception in this regard and are advised to devise specific and targeted demand-based recovery policies to overcome the effects of the pandemic. Many such policies—for example, ensuring the transparency of multi-tier SCs, optimizing leather production and finished leather distribution capacity, assessing realistic demand for leather, and assessing available inventories, among others—could be helpful in the fight against the disruption caused by the COVID-19 pandemic.

5 Sensitivity analysis

A sensitivity analysis was conducted to validate the results of the study (Memari et al., 2019). This type of analysis is now commonly used by academics and professionals to eliminate bias (Laorden et al., 2022). To perform the sensitivity analysis, the weight value of the highly ranked RC 'Long-term crisis of liquidity' (RC_{11}) was taken from 0.1 to 0.9 and the weights of other RCs were differentiated subsequently. The weight variations for 'Long-term crisis of liquidity' (RC_{11}) and the other RCs are presented in Table 16. Figs. 4 and 5 exhibit the ranking of the RCs obtained from the sensitivity analysis. The minor variations happened during the sensitivity analysis, otherwise the ranking is stable and consistent.

Next, the rankings of the RSs were calculated (see Fig. 6). Minor variations were noticed during the sensitivity analysis for the identified strategies. However, excluding these minor variations, the analysis was free from bias.

6 Conclusions, limitations and future research

The recent COVID-19 pandemic was—and remains, to some extent—a remarkable and extraordinary event, which has severely disrupted global SCs. The pandemic is truly a unique challenge for manufacturing and service companies alike to mitigate disruption to their

Table 16 The weight variation of 'Long-term crisis of liquidity' (RC_{11}) and other RCs

RCs	Normal (0.1709)	Preference weights values for listed RCs								
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RC_1	0.1301	0.1412	0.1255	0.1098	0.0941	0.0784	0.0628	0.0471	0.0314	0.0157
RC_4	0.1598	0.1735	0.1542	0.1349	0.1156	0.0964	0.0771	0.0578	0.0385	0.0193
RC_{11}	0.1709	0.1000	0.2000	0.3000	0.4000	0.5000	0.6000	0.7000	0.8000	0.9000
RC_{13}	0.1391	0.1510	0.1342	0.1174	0.1007	0.0839	0.0671	0.0503	0.0336	0.0168
RC_5	0.1296	0.1406	0.1250	0.1094	0.0938	0.0781	0.0625	0.0469	0.0313	0.0156
RC_{14}	0.0953	0.1034	0.0919	0.0804	0.0689	0.0574	0.0460	0.0345	0.0230	0.0115
RC_8	0.0546	0.0593	0.0527	0.0461	0.0395	0.0329	0.0263	0.0198	0.0132	0.0066
RC_{15}	0.0862	0.0936	0.0832	0.0728	0.0624	0.0520	0.0416	0.0312	0.0208	0.0104
RC_7	0.0345	0.0375	0.0333	0.0291	0.0250	0.0208	0.0166	0.0125	0.0083	0.0042
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

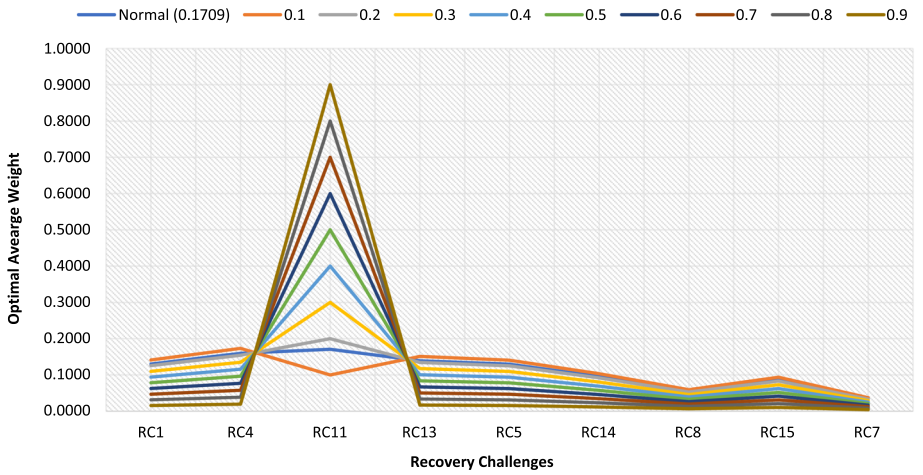

Fig. 4 The weight variation of the 'long-term crisis of liquidity' (RC_{11}) and other RCs

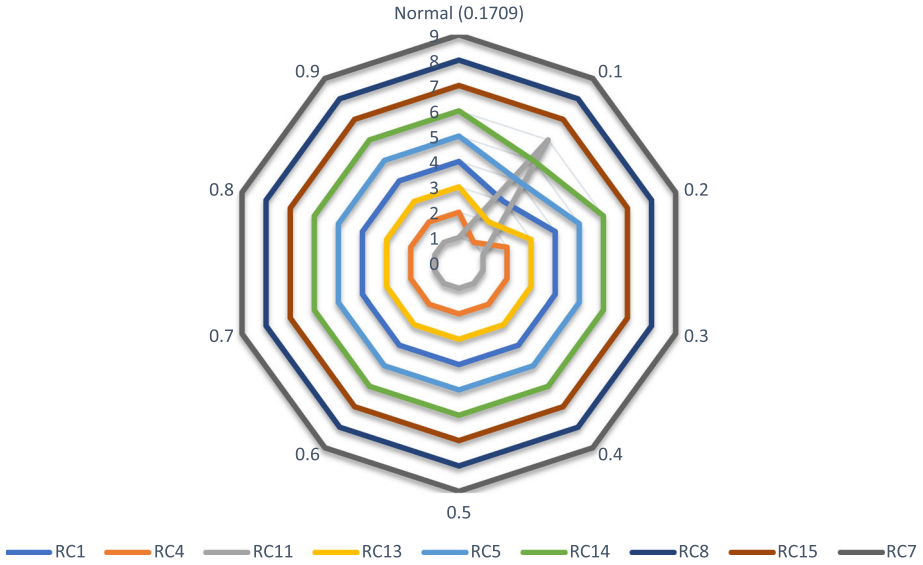

Fig. 5 RCs rankings from the sensitivity analysis

SCs. In particular, the leather industry in EEs like Bangladesh has been brutally impacted by the pandemic. Hence, this paper has provided novel insights into the RCs and RSs in terms of alleviating the impact of the COVID-19 pandemic on the leather industry in an EE (Bangladesh in this study). The study used a combination of decision support tools—Pareto analysis, the BWM and Fuzzy-TOPSIS—in an integrated way to select and assess the RCs and RSs for the aforementioned industry. A list of 16 RCs and 11 RSs was developed based on the findings of a literature review and the opinions of a group of industry experts. The Pareto analysis was then employed to identify nine RCs and RSs, according to relevance,

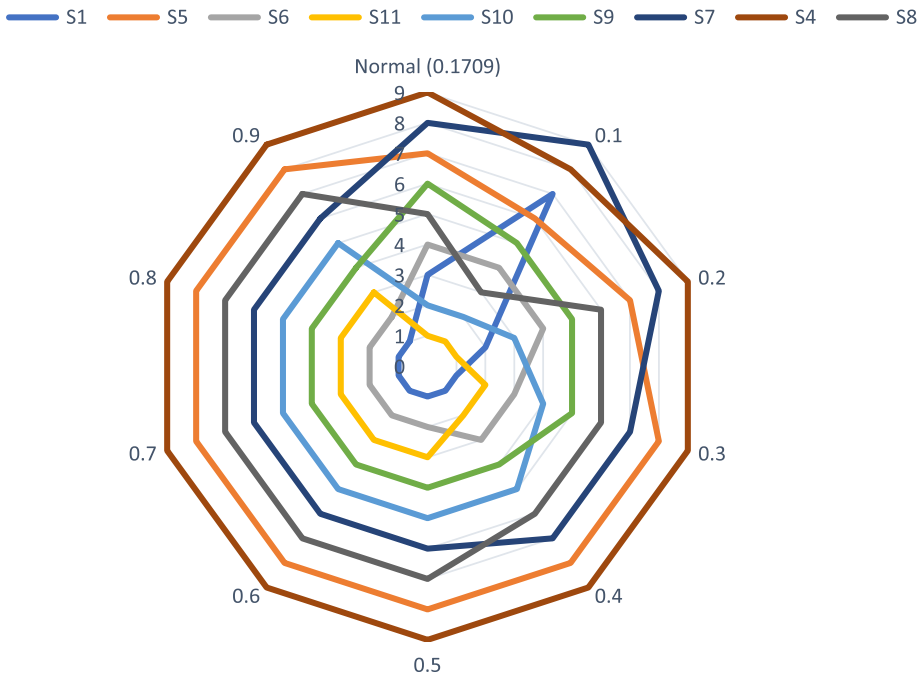

Fig. 6 RS rankings from the sensitivity analysis

most to least impactful. At this stage, the BWM was applied to evaluate this list of identified RCs and the fuzzy-TOPSIS followed to determine the importance of the RSs. A sensitivity analysis was also offered to check the consistency of the obtained results.

The results of the study indicated that the practitioners of the leather industry of Bangladesh should provide significant attention to the RCs and the RSs if they want to combat the vulnerabilities revealed by the COVID-19 pandemic and to ensure their business sustainability, especially in the event of another such Black Swan incident. The five most important RCs—'Long-term liquidity crisis', 'Increasing bankruptcy of business stakeholders', 'Falling demand for leather over an extended period', 'Massive order suspensions from foreign buyers', and a 'High degree of layoffs of skilled workers'—appeared to be particularly important for decision-makers in the leather industry, respectively. Given that these RCs have affected leather industry SCs severely, decision-makers need to seriously consider the RSs identified as having potential to overcome these RCs and reduce the effects of the pandemic. The fuzzy TOPSIS analysis indicated five strategies, i.e., 'Solve the existing problems of CETP and provide solid waste management facilities for long run business', 'Make the leather industry's SCs more easily re-configurable', 'Financial support, i.e., tax cuts, incentives, and long-term government loans for the survival of the leather industry', 'Ensure a high level of preparedness by adopting advanced technology', and 'Make available business data analytics tools in the leather industry' as the most important RSs, which might serve to reduce the challenges posed by COVID-9. These strategies need to be considered if the performance of SCs in the leather industry are to be improved.

Finally, no research study is free from limitations (Ross & Bibler Zaidi, 2019). Likewise, this study has a number of limitations. Firstly, there is a time-varying issue to consider as the spread and impact of the COVID-19 varied from time to time and from country to country.

Indeed, records show that the COVID-19 has infected people in various parts of the world in at least eight variant forms since September 2020 (Mahase, 2021). Also, the impact of the analyzed RCs may differ according to periods when the pandemic hit or was at its height in terms of the intensity of infections and consequences. Accordingly, the study's findings may vary according to specific country—or even regional—variations. Secondly, since the SC activities of any industry can vary based on the nature of the business whereas this study merely focused on the leather industry of Bangladesh, the results may not be completely appropriate for other industrial sectors—in different countries including Bangladesh. Therefore, future research might be broadened to include different case companies from different parts of the world, EEs in particular. Thirdly, this study did not investigate the cause-and-effect nexus among the identified RCs. In this regard, fuzzy based methodologies like fuzzy cognitive analysis, fuzzy-decision making trial and evaluation laboratory, or Total Interpretive Structural Modelling method could be applied to explore the causal interrelationship(s) among the challenges posed by the COVID-19. Moreover, to ensure uniformity and homogeneity in methodologies, fuzzy BWM and fuzzy TOPSIS might be combined in future research. Finally, given its popularity in empirical research (Kirch & Terra, 2019), other methodological tools such as structural equation modelling (SEM) might also be considered to interlink the RCs with the RSs while investigating the impact of the COVID-19 and formulate a preventive mechanism using large-scale data.

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Declarations

Conflict of interest No conflict of interest exists.

Human and animal rights This article does not contain any studies with human participants performed by any of the authors.

Appendix A

Dear Respondent

Greetings!!!!

We are conducting research to evaluate the challenges and strategies of the COVID-19 pandemic outbreak in the leather industry of Bangladesh. We have identified nine RCs from existing literature. Kindly provide your responses about the relevance of these RCs of the COVID-19 pandemic outbreak to overcome the impact on the leather industry. You are also free to merge/delete/rephrase/ the challenges which you think are relevant in the given context. Please respond based on the scale 5—High Significant to 1—not at all Significant.

Challenges of COVID-19 pandemic outbreak in the leather industry of Bangladesh	Response				
	5: Highly Significant and 1: Not at all Significant				
	5	4	3	2	1
Massive order suspension from foreign buyers					
Closuring of partner's supply chain operations					
World economic collapse in longer span					
Increasing bankruptcy of business stakeholders					
High degree of layoff of skilled workers					
Complication in confirming workplace safety					
Challenge to safety protocol development					
Lack of preparedness to handle the COVID-19 pandemic					
Poor relationship among suppliers					
……					
……					
……					
If any others, please add…					
Please give your suggestion if we can merge/delete/rephrase of RCs:					

We have identified nine strategies from existing literature. Kindly provide your responses about the relevance of these strategies to overcome the impacts of the COVID-19 pandemic outbreak. You are also free to merge/rephrase the strategies which you think are relevant in the given context. Please respond based on the scale 5—High Significant to 1—not at all Significant.

Strategies to overcome the impacts of the COVID-19 pandemic outbreak in the leather industry of Bangladesh	Response				
	5: Highly Significant and 1: Not at all Significant				
	5	4	3	2	1

Strategies to overcome the impacts of the COVID-19 pandemic outbreak in the leather industry of Bangladesh	Response 5: Highly Significant and 1: Not at all Significant				
	5	4	3	2	1
Financial support i.e., tax cut, incentives, long term loans for survival of the leather industry from the government					
Ensuring efficient disruption risk management facility					
Making leather supply chain digital via adopting automation, information technology, IoT etc					
Developing recovery policies to handle supply chain disruption risks like COVID-19 pandemic					
Ensuring strong collaboration among materials suppliers including chemical suppliers, and buyers					
Ensuring high level of preparedness by adopting latest technology					
Developing safety protocol against the COVID-19 pandemic and other health risks					
Making available of business data analytics tools in the leather industry					
Develop standard employment management facility to avoid layoff					
……					
If any others, please add…					
Please give your suggestion if we can merge/ rephrase of recovery strategies:					

Industry/Academic/others: _____
Designation: _____
Working area: _____
Job Experience: _____
Area of Working: _____

Table 17 Case company's profile

Case Company 1: Tannery Industry *Production rate (Annual)*: Around 32 million square feet of leather *Types of products*: Crust and finished leather for leather goods and shoes manufacturing	Case Company 2: Tannery Industry *Production rate (Annual)*: Greater than 15 million square feet of leather *Types of products*: Wet blue, Crust and finished leather
Case Company 3: Tannery Industry *Production rate (Annual)*: Around 8 million square feet of leather *Types of products*: Crust and finished leather	Case Company 4: Tannery Industry *Production rate (Annual)*: Around 7 million square feet of leather *Types of products*: Crust and finished leather
Case Company 5: Tannery Industry *Production rate (Annual)*: Around 12 million square feet of leather *Types of products*: Crust and finished leather	Case Company 6: Tannery Industry *Production rate (Annual)*: Around 15 million square feet of leather *Types of products*: Crust and finished leather
Case Company 7: Tannery Industry *Production rate (Annual)*: Around 6 million square feet of leather *Types of products*: Crust and finished leather	Case Company 8: Tannery Industry *Production rate (Annual)*: Around 10 million square feet of leather *Types of products*: Crust and finished leather
Case Company 9: Tannery Industry *Production rate (Annual)*: Around 05 million square feet of leather *Types of products*: Crust and finished leather	Case Company 10: Tannery Industry *Production rate (Annual)*: Around 06 million square feet of leather *Types of products*: Crust and finished leather
Case Company 11: Tannery Industry *Production rate (Annual)*: Around 11 million square feet of leather *Types of products*: Crust and finished leather	Case Company 12: Tannery Industry *Production rate (Annual)*: Around 04 million square feet of leather *Types of products*: Crust and finished leather
Case Company 13: Tannery Industry *Production rate (Annual)*: Around 05 million square feet of leather *Types of products*: Crust and finished leather	Case Company 14: Tannery Industry *Production rate (Annual)*: Around 07 million square feet of leather *Types of products*: Crust and finished leather
Case Company 15: Tannery Industry *Production rate (Annual)*: Around 08 million square feet of leather *Types of products*: Crust and finished leather	Case Company 16: Tannery Industry *Production rate (Annual)*: Around 04 million square feet of leather *Types of products*: Crust and finished leather
Case Company 17: Tannery Industry *Production rate (Annual)*: Around 06 million square feet of leather *Types of products*: Crust and finished leather	Case Company 18: Tannery Industry *Production rate (Annual)*: Around 07 million square feet of leather *Types of products*: Crust and finished leather

Appendix B

See Tables 18 and 19.

Table 18 Data of Pareto analysis for RCs

Challenges of COVID-19 pandemic outbreak in the leather industry of Bangladesh	Experts										Total Score
	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8	LT9	LT10	
Massive order suspension from foreign buyers *(RC_1)*	5	5	4	5	5	3	4	5	3	5	86.00
Closuring of partner's supply chain operations *(RC_2)*	2	3	4	2	3	2	4	2	3	2	59.00
World economic collapse in longer span *(RC_3)*	3	3	2	3	2	3	4	3	4	3	57.00
Increasing bankruptcy of business stakeholders *(RC_4)*	5	3	4	5	4	3	4	5	3	4	82.00
High degree of layoff of skilled workers *(RC_5)*	4	3	5	3	2	4	3	5	4	3	74.00
Complication in confirming workplace safety *(RC_6)*	3	2	3	2	3	2	3	4	2	3	58.00
Challenge to safety protocol development *(RC_7)*	4	4	3	3	2	4	3	2	5	4	69.00
Lack of preparedness to handle the COVID-19 pandemic *(RC_8)*	3	4	3	4	5	4	3	2	4	4	71.00
Poor relationship among *suppliers* *(RC_9)*	3	4	3	2	3	4	3	4	2	4	59.00
Decreasing quantity of leather processing *(RC_{10})*	4	3	4	3	2	3	4	2	3	4	58.00
Long term crisis of liquidity *(RC_{11})*	4	5	4	3	5	4	5	3	5	4	80.00
Rising cost of leather processing chemicals *(RC_{12})*	3	4	3	2	4	2	3	2	3	2	57.00
Fall of demand of leather for an extended cycle *(RC_{13})*	5	3	4	3	5	4	3	4	4	5	78.00
Lack of fitness of re-configurability of supply chain *(RC_{14})*	3	5	4	3	5	3	4	4	3	3	72.00
Unavailability of recovery policies *(RC_{15})*	2	4	3	4	2	4	2	4	3	5	70.00

Table 18 (continued)

Challenges of COVID-19 pandemic outbreak in the leather industry of Bangladesh	Experts										Total Score
	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8	LT9	LT10	
Unavailability of sustainable communication facility *(RC16)*	2	3	2	4	3	4	2	3	2	4	56.00

Challenges of COVID-19 pandemic outbreak in the leather industry of Bangladesh	Experts										Total Score
	LT11	LT12	LT13	LT14	LT15	LT16	LT17	LT18	LT19	LT20	
Massive order suspension from foreign buyers *(RC1)*	4	5	3	4	5	4	3	5	4	5	86.00
Closuring of partner's supply chain operations *(RC2)*	2	4	3	5	2	2	4	3	4	3	59.00
World economic collapse in longer span *(RC3)*	3	2	3	2	3	2	4	3	2	3	57.00
Increasing bankruptcy of business stakeholders *(RC4)*	5	4	5	3	4	5	4	3	4	5	82.00
High degree of layoff of skilled workers *(RC5)*	4	4	4	3	3	4	5	3	4	4	74.00
Complication in confirming workplace safety *(RC6)*	4	2	3	3	4	3	3	4	2	3	58.00
Challenge to safety protocol development *(RC7)*	4	3	4	4	3	4	3	3	4	3	69.00

Table 18 (continued)

Challenges of COVID-19 pandemic outbreak in the leather industry of Bangladesh	Experts										Total Score
	LT11	LT12	LT13	LT14	LT15	LT16	LT17	LT18	LT19	LT20	
Lack of preparedness to handle the COVID-19 pandemic *(RC$_8$)*	3	2	3	4	3	4	5	4	4	3	71.00
Poor relationship among *suppliers (RC$_9$)*	3	3	2	3	4	2	3	2	2	3	59.00
Decreasing quantity of leather processing *(RC$_{10}$)*	2	3	2	3	4	2	2	3	3	2	58.00
Long term crisis of liquidity *(RC$_{11}$)*	5	2	3	4	3	5	3	4	5	4	80.00
Rising cost of leather processing chemicals *(RC$_{12}$)*	3	3	3	3	4	3	2	3	3	2	57.00
Fall of demand of leather for an extended cycle *(RC$_{13}$)*	4	3	4	3	4	4	3	4	5	4	78.00
Lack of fitness of re-configurability of supply chain *(RC$_{14}$)*	4	4	3	3	4	3	4	3	4	3	72.00
Unavailability of recovery policies *(RC$_{15}$)*	4	5	4	3	4	5	2	3	4	3	70.00
Unavailability of sustainable communication facility *(RC$_{16}$)*	3	2	3	3	2	4	3	2	3	2	56.00

Table 19 Data of Pareto analysis for strategies

Strategies to overcome the impacts of the COVID-19 pandemic outbreak in the leather industry of Bangladesh	Experts										Total Score
	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8	LT9	LT10	
Financial support i.e., tax cut, incentives, long term loans for survival of the leather industry from the government (S1)	5	3	4	5	4	5	3	5	4	4	83.00
Ensuring efficient disruption risk management facility (S2)	3	2	3	4	3	3	2	3	1	3	61.00
Making leather supply chain digital via adopting automation, information technology, IoT etc. (S3)	2	5	1	2	3	5	2	3	3	4	59.00
Developing recovery policies to handle supply chain disruption risks like COVID-19 pandemic (S4)	4	3	4	4	5	3	2	3	3	4	69.00
Ensuring strong collaboration among materials suppliers including chemical suppliers, and buyers (S5)	5	4	3	5	4	3	5	4	2	3	79.00
Ensuring high level of preparedness by adopting advanced technology (S6)	5	4	4	2	4	3	4	4	5	4	77.00
Developing safety protocol against the COVID-19 pandemic and other health risks (S7)	4	3	3	5	3	4	3	4	2	4	70.00
Making available of business data analytics tools in the leather industry (S8)	3	4	3	2	3	4	3	5	3	4	68.00
Develop standard employment management facility to avoid layoff (S9)	3	2	3	5	4	5	3	4	3	3	72.00

Table 19 (continued)

Strategies to overcome the impacts of the COVID-19 pandemic outbreak in the leather industry of Bangladesh	Experts										Total Score
	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8	LT9	LT10	
Make the leather supply chain re-configurability (S10)	5	4	3	4	5	4	3	4	5	4	74.00
Solve the existing problems of CETP and provide solid waste management facility for long run business (S11)	4	3	4	5	3	5	4	2	5	3	76.00
Strategies to overcome the impacts of the COVID-19 pandemic outbreak in the leather industry of Bangladesh	Experts										Total Score
	LT11	LT12	LT13	LT14	LT15	LT16	LT17	LT18	LT19	LT20	
Financial support i.e., tax cut, incentives, long term loans for survival of the leather industry from the government (S1)	5	4	5	5	3	2	4	5	3	5	83.00
Ensuring efficient disruption risk management facility (S2)	2	5	2	3	4	3	3	5	3	4	61.00
Making leather supply chain digital via adopting automation, information technology, IoT etc. (S3)	3	4	3	2	4	2	3	3	2	3	59.00
Developing recovery policies to handle supply chain disruption risks like COVID-19 pandemic (S4)	2	3	2	4	3	3	5	4	3	5	69.00

Table 19 (continued)

Strategies to overcome the impacts of the COVID-19 pandemic outbreak in the leather industry of Bangladesh	Experts										Total Score
	LT11	LT12	LT13	LT14	LT15	LT16	LT17	LT18	LT19	LT20	
Ensuring strong collaboration among materials suppliers including chemical suppliers, and buyers (S5)	4	5	4	4	5	4	4	4	4	3	79.00
Ensuring high level of preparedness by adopting advanced technology (S6)	3	4	5	3	5	4	3	3	4	4	77.00
Developing safety protocol against the COVID-19 pandemic and other health risks (S7)	3	4	3	4	3	2	4	3	5	4	70.00
Making available of business data analytics tools in the leather industry (S8)	5	4	3	2	3	3	2	4	3	5	68.00
Develop standard employment management facility to avoid layoff (S9)	4	2	5	4	4	3	4	5	4	2	72.00
Make the leather supply chain re-configurability (S10)	3	5	3	4	3	3	2	5	2	3	74.00
Solve the existing problems of CETP and provide solid waste management facility for long run business (S11)	4	3	2	5	3	4	3	5	4	5	76.00

Appendix C

Q1: Which of the following RCs are the best RC and worst RCs in the context of the Leather Industry considering the COVID-19 pandemic? Please select one RC as best and one RC as worst RC.

RCs name with code	Best RCs acknowledged by experts'	Worst RCs acknowledged by experts'
Massive order suspension from foreign buyers (RC_1)		
Increasing bankruptcy of business stakeholders (RC_4)		
Long term crisis of liquidity (RC_{11})		
Fall of demand of leather for an extended cycle (RC_{13})		
High degree of layoff of skilled workers (RC_5)		
Lack of fitness of re-configurability of supply chain (RC_{14})		
Lack of preparedness to handle the COVID-19 pandemic (RC_8)		
Unavailability of recovery policies (RC_{15})		
Challenge to safety protocol development (RC_7)		

Q2: Rate the best RC over all other RCs

Expert	*Best RC*	*RCs*								
		RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
	RCj									

Q3: Rate the other RCs over the worst RC

Others to the worst	Expert code *RCj*
RC_1	
RC_4	
RC_{11}	
RC_{13}	
RC_5	
RC_{14}	
RC_8	
RC_{15}	
RC_7	

Q4: Please fill the following comparison matrix using linguistic attributes. For example, if you think that the strategy "Financial support i.e., tax cut, incentives, long term loans for survival of the leather industry from the government (S1)" has "Excellent (E)" contribution to the recovery challenge "Massive order suspension from foreign buyers (RC1)" Please put the linguistic attribute "E".

Strategies	RCs								
	Massive order suspension from foreign buyers *(RC1)*	Increasing bankruptcy of business stakeholders *(RC4)*	Long term crisis of liquidity *(RC11)*	Fall of demand of leather for an extended cycle *(RC13)*	High degree of layoff of skilled workers *(RC5)*	Lack of fitness of re-configurability of supply chain *(RC14)*	Lack of preparedness to handle the COVID-19 pandemic *(RC8)*	Unavailability of recovery policies *(RC15)*	Challenge to safety protocol development *(RC7)*
Financial support i.e., tax cut, incentives, long term loans for survival of the leather industry from the government *(S1)*									

Strategies	RCs								
	Massive order suspension from foreign buyers *(RC_1)*	Increasing bankruptcy of business stakeholders *(RC_4)*	Long term crisis of liquidity *(RC_{11})*	Fall of demand of leather for an extended cycle *(RC_{13})*	High degree of layoff of skilled workers *(RC_5)*	Lack of fitness of re-configurability of supply chain *(RC_{14})*	Lack of preparedness to handle the COVID-19 pandemic *(RC_8)*	Unavailability of recovery policies *(RC_{15})*	Challenge to safety protocol development *(RC_7)*
Ensuring strong collaboration among materials suppliers including chemical suppliers, and buyers *(S_5)*									
Ensuring high level of preparedness by adopting advanced technology *(S_6)*									

Strategies	RCs								
	Massive order suspension from foreign buyers *(RC_1)*	Increasing bankruptcy of business stakeholders *(RC_4)*	Long term crisis of liquidity *(RC_{11})*	Fall of demand of leather for an extended cycle *(RC_{13})*	High degree of layoff of skilled workers *(RC_5)*	Lack of fitness of re-configurability of supply chain *(RC_{14})*	Lack of preparedness to handle the COVID-19 pandemic *(RC_8)*	Unavailability of recovery policies *(RC_{15})*	Challenge to safety protocol development *(RC_7)*
Solve the existing problems of CETP and provide solid waste management facility for long run business *(S_{11})*									
Make the leather supply chain re-configurability *(S_{10})*									

Strategies	RCs								
	Massive order suspension from foreign buyers *(RC1)*	Increasing bankruptcy of business stakeholders *(RC4)*	Long term crisis of liquidity *(RC11)*	Fall of demand of leather for an extended cycle *(RC13)*	High degree of layoff of skilled workers *(RC5)*	Lack of fitness of re-configurability of supply chain *(RC14)*	Lack of preparedness to handle the COVID-19 pandemic *(RC8)*	Unavailability of recovery policies *(RC15)*	Challenge to safety protocol development *(RC7)*
Develop standard employment management facility to avoid layoff *(S9)*									
Developing safety protocol against the COVID-19 pandemic and other health risks *(S7)*									

Strategies	RCs								
	Massive order suspension from foreign buyers *(RC_1)*	Increasing bankruptcy of business stakeholders *(RC_4)*	Long term crisis of liquidity *(RC_{11})*	Fall of demand of leather for an extended cycle *(RC_{13})*	High degree of layoff of skilled workers *(RC_5)*	Lack of fitness of re-configurability of supply chain *(RC_{14})*	Lack of preparedness to handle the COVID-19 pandemic *(RC_8)*	Unavailability of recovery policies *(RC_{15})*	Challenge to safety protocol development *(RC_7)*
Developing recovery policies to handle supply chain disruption risks like COVID-19 pandemic *(S_4)*									
Making available of business data analytics tools in the leather industry *(S_8)*									

Strategies	RCs								
	Massive order suspension from foreign buyers *(RC1)*	Increasing bankruptcy of business stakeholders *(RC4)*	Long term crisis of liquidity *(RC11)*	Fall of demand of leather for an extended cycle *(RC13)*	High degree of layoff of skilled workers *(RC5)*	Lack of fitness of re-configurability of supply chain *(RC14)*	Lack of preparedness to handle the COVID-19 pandemic *(RC8)*	Unavailability of recovery policies *(RC15)*	Challenge to safety protocol development *(RC7)*
Financial support i.e., tax cut, incentives, long term loans for survival of the leather industry from the government *(S1)*									

Appendix D

See Tables 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49 and 50.

Table 20 Assessment of strategies by Expert-1 (LT1)

LT1	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	H	M	VH	H	H	VL	M	VH	VL
(S_5)	M	VL	H	VH	E	E	E	VH	L
(S_6)	L	VH	VL	H	H	M	E	M	VL
(S_{11})	M	VH	VH	M	L	E	VH	VH	M
(S_{10})	M	H	E	VH	L	VH	E	M	M
(S_9)	H	H	E	L	E	H	H	VH	VH
(S_7)	H	L	VH	VH	E	VH	VH	VH	VL
(S_4)	L	H	E	M	H	H	VH	H	M
(S_8)	VL	M	H	M	H	VH	M	VL	H

Table 21 Assessment of strategies by Expert-2 (LT2)

LT2	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	M	VL	M	M	H	VL	VL	M	E
(S_5)	M	VH	H	E	VL	VL	VL	VH	H
(S_6)	H	L	M	VH	VH	L	H	L	M
(S_{11})	VL	L	VL	M	M	E	M	H	VH
(S_{10})	E	M	M	VL	M	L	H	VL	VL
(S_9)	H	H	M	VH	VH	E	L	VH	VL
(S_7)	E	M	M	H	VH	VH	VL	M	H
(S_4)	E	VH	VL	M	H	E	M	VH	E
(S_8)	L	M	E	VL	L	H	L	H	VL

Table 22 Assessment of strategies by Expert-3 (LT3)

LT3	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	H	VL	M	M	L	VH	VH	E	L
(S_5)	VL	L	E	M	VH	M	VH	M	VL
(S_6)	VH	M	E	VL	M	VH	H	M	M
(S_{11})	H	M	VL	VH	H	E	H	L	L
(S_{10})	VL	L	M	VL	H	VH	VH	M	VH
(S_9)	E	E	M	L	L	VL	VL	M	M
(S_7)	VL	E	L	H	M	VL	M	M	VH
(S_4)	E	H	H	E	VH	M	H	VL	VL
(S_8)	M	VL	H	VH	VH	VL	M	L	L

Table 23 Assessment of strategies by Expert-4 (LT4)

LT4	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	L	VH	M	E	H	H	H	VH	VH
(S_5)	M	E	H	L	L	VL	VL	M	M
(S_6)	L	E	L	H	L	L	H	H	VH
(S_{11})	L	VL	H	H	L	L	E	L	L
(S_{10})	VH	VL	H	H	VH	VH	H	M	VL
(S_9)	M	L	H	H	E	M	H	E	H
(S_7)	H	L	H	M	E	M	L	E	H
(S_4)	E	L	VH	L	VH	VH	VL	H	E
(S_8)	VH	H	M	VH	L	H	E	L	M

Table 24 Assessment of strategies by Expert-5 (LT5)

LT5	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	M	M	VL	H	VL	VL	VH	E	H
(S_5)	H	M	VH	L	H	VH	VL	M	H
(S_6)	M	VH	VL	VL	VH	E	VL	H	VL
(S_{11})	M	L	L	VL	L	VH	H	L	L
(S_{10})	L	L	E	H	E	M	VH	VL	L
(S_9)	VL	H	H	H	M	L	H	VH	VH
(S_7)	M	VH	VH	H	M	L	E	M	L
(S_4)	H	E	H	VL	H	H	VL	H	H
(S_8)	M	H	L	M	L	VL	VH	M	M

Table 25 Assessment of strategies by Expert-6 (LT6)

LT6	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	H	VL	VL	VH	E	VL	M	L	M
(S_5)	H	E	VH	VL	H	M	VH	E	VH
(S_6)	E	M	L	L	H	VL	M	H	E
(S_{11})	H	L	H	L	M	L	VL	L	M
(S_{10})	VH	VL	M	H	H	E	E	M	VL
(S_9)	H	M	L	M	L	VL	VH	VL	E
(S_7)	M	L	E	VH	E	VH	VH	H	L
(S_4)	VH	L	E	VH	H	E	L	L	H
(S_8)	M	VL	VL	E	E	E	M	L	VL

Table 26 Assessment of strategies by Expert-7 (LT7)

LT7	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	VH	L	VL	E	L	E	VH	H	VH
(S_5)	VL	L	M	L	M	E	M	M	L
(S_6)	VH	VL	E	VL	H	VL	E	VL	VL
(S_{11})	VL	E	VH	L	VL	H	H	VL	VH
(S_{10})	L	M	H	M	E	E	L	E	VL
(S_9)	L	M	M	E	H	VL	L	E	H
(S_7)	VH	H	L	VH	M	L	E	M	VL
(S_4)	H	M	M	H	M	H	VL	H	M
(S_8)	E	H	M	E	E	L	VH	E	E

Table 27 Assessment of strategies by Expert-8 (LT8)

LT8	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	M	VL	M	E	M	VL	M	E	E
(S_5)	E	H	M	H	VL	VH	E	VL	M
(S_6)	M	VH	E	VL	L	VH	E	E	L
(S_{11})	H	H	H	H	VH	M	H	H	H
(S_{10})	VL	VL	H	M	VL	M	VL	E	H
(S_9)	E	L	VL	H	L	M	H	H	M
(S_7)	VH	M	H	L	VH	VH	H	VH	VH
(S_4)	H	M	VH	H	M	VL	M	H	M
(S_8)	VH	E	L	VH	L	M	E	L	L

Table 28 Assessment of strategies by Expert-9 (LT9)

LT9	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	VL	VH	L	VH	M	M	VL	E	VL
(S_5)	E	H	VH	E	H	M	VH	E	VH
(S_6)	M	H	M	H	L	M	VL	VH	M
(S_{11})	H	L	VH	H	VH	L	VL	E	E
(S_{10})	L	VL	VL	VH	VH	E	L	VH	L
(S_9)	L	M	VH	VL	H	VH	H	VL	VH
(S_7)	VL	VL	VL	E	L	E	L	E	L
(S_4)	H	L	L	E	E	VL	VL	M	H
(S_8)	M	E	E	VH	M	VH	H	M	VH

Table 29 Assessment of strategies by Expert-10 (LT10)

LT10	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	H	H	VH	VH	H	VL	E	H	M
(S_5)	L	VH	VL	H	M	VH	VL	M	H
(S_6)	VH	VH	VL	L	VL	VH	VH	VL	VL
(S_{11})	VH	VH	VL	E	E	M	H	L	VL
(S_{10})	E	L	VL	H	M	M	L	VH	VH
(S_9)	M	H	M	VH	VH	E	VH	M	VL
(S_7)	VL	VH	VL	VH	E	L	M	VL	E
(S_4)	E	M	VL	M	M	L	E	VL	VL
(S_8)	VH	M	E	M	VH	VL	VL	VL	H

Table 30 Assessment of strategies by Expert-11 (LT11)

LT11	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	VH	H	E	H	VH	H	VL	L	H
(S_5)	VH	H	M	E	M	VL	H	H	L
(S_6)	H	VH	VH	L	M	H	VH	E	H
(S_{11})	VL	L	VL	VL	M	H	H	VL	VH
(S_{10})	H	VH	L	E	M	H	VL	VL	H
(S_9)	L	H	H	H	E	VH	M	VL	VL
(S_7)	VL	VL	L	H	L	L	VL	E	E
(S_4)	M	VH	E	VH	VH	VL	VL	E	VL
(S_8)	VL	E	M	VL	VH	M	VH	H	H

Table 31 Assessment of strategies by Expert-12 (LT12)

LT12	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	L	E	VL	VH	L	VL	VL	VH	M
(S_5)	VH	L	VH	VH	M	VH	M	H	H
(S_6)	VL	VL	L	E	H	E	VL	VL	M
(S_{11})	M	VL	L	VH	VL	M	VL	VH	L
(S_{10})	VH	E	E	E	L	VL	E	VL	VL
(S_9)	VL	H	VL	VH	M	VL	VL	VH	H
(S_7)	VH	E	VH	M	E	L	VH	E	M
(S_4)	VL	H	E	E	M	VL	M	VH	VL
(S_8)	E	L	VL	VH	E	L	L	H	H

Table 32 Assessment of strategies by Expert-13 (LT13)

LT13	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	H	E	VL	H	VH	VH	L	M	VH
(S_5)	VL	VL	VL	L	L	H	E	VH	L
(S_6)	L	M	M	E	L	VH	VL	E	E
(S_{11})	VL	E	E	L	VL	VH	H	VH	M
(S_{10})	L	L	VH	VL	L	VH	M	M	VH
(S_9)	M	L	M	H	M	E	H	H	H
(S_7)	VL	E	VH	VH	H	L	H	E	E
(S_4)	VH	VL	H	VH	L	H	H	H	H
(S_8)	VL	M	VH	H	M	H	L	VH	E

Table 33 Assessment of strategies by Expert-14 (LT14)

LT14	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	E	VL	VL	VH	M	M	H	M	H
(S_5)	L	VH	H	L	L	VH	L	H	VH
(S_6)	E	E	H	H	VH	E	M	M	L
(S_{11})	VH	M	VH	VL	E	L	VL	L	M
(S_{10})	M	E	L	L	H	VH	M	L	L
(S_9)	M	E	H	M	VL	VL	VL	H	E
(S_7)	L	E	E	VL	M	H	M	M	VL
(S_4)	H	VL	E	VL	VL	L	VL	H	VL
(S_8)	M	H	H	L	VL	H	VH	E	H

Table 34 Assessment of strategies by Expert-15 (LT15)

LT15	*RCs*								
Strategies	RC_1	RC_4	RC_{11}	RC_{13}	RC_5	RC_{14}	RC_8	RC_{15}	RC_7
(S_1)	VL	L	VL	M	VH	M	H	M	L
(S_5)	L	VH	M	E	M	VH	M	H	L
(S_6)	VH	M	M	M	M	M	VH	M	L
(S_{11})	VL	M	H	H	E	VH	E	VL	M
(S_{10})	VH	VL	L	VH	M	E	M	L	VL
(S_9)	M	H	VH	H	M	L	VH	H	VL
(S_7)	E	L	L	L	VL	E	VL	E	H
(S_4)	H	L	VH	M	H	VH	H	VH	L
(S_8)	VL	L	H	L	H	VL	M	VL	E

Table 35 Numeric value of the assessment by LT1

LT1	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.4	0.6	0.8	0.2	0.4	0.6	0.6	0.8	1	0.4	0.6	0.8	0.4	0.6	0.8
(S_5)	0.2	0.4	0.6	0	0	0.2	0.4	0.6	0.8	0.6	0.8	1	0.8	1	1
(S_6)	0	0.2	0.4	0.6	0.8	1	0	0	0.2	0.4	0.6	0.8	0.4	0.6	0.8
(S_{11})	0.2	0.4	0.6	0.6	0.8	1	0.6	0.8	1	0.2	0.4	0.6	0	0.2	0.4
(S_{10})	0.2	0.4	0.6	0.4	0.6	0.8	0.8	1	1	0.6	0.8	1	0	0.2	0.4
(S_9)	0.4	0.6	0.8	0.4	0.6	0.8	0.8	1	1	0	0.2	0.4	0.8	1	1
(S_7)	0.4	0.6	0.8	0	0.2	0.4	0.6	0.8	1	0.6	0.8	1	0.8	1	1
(S_4)	0	0.2	0.4	0.4	0.6	0.8	0.8	1	1	0.2	0.4	0.6	0.4	0.6	0.8
(S_8)	0	0	0.2	0.2	0.4	0.6	0.4	0.6	0.8	0.2	0.4	0.6	0.4	0.6	0.8

LT1	*RCs*											
Strategies	RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0	0	0.2	0.2	0.4	0.6	0.6	0.8	1	0	0	0.2
(S_5)	0.8	1	1	0.8	1	1	0.6	0.8	1	0	0.2	0.4
(S_6)	0.2	0.4	0.6	0.8	1	1	0.2	0.4	0.6	0	0	0.2
(S_{11})	0.8	1	1	0.6	0.8	1	0.6	0.8	1	0.2	0.4	0.6
(S_{10})	0.6	0.8	1	0.8	1	1	0.2	0.4	0.6	0.2	0.4	0.6
(S_9)	0.4	0.6	0.8	0.4	0.6	0.8	0.6	0.8	1	0.6	0.8	1
(S_7)	0.6	0.8	1	0.6	0.8	1	0.6	0.8	1	0	0	0.2
(S_4)	0.4	0.6	0.8	0.6	0.8	1	0.4	0.6	0.8	0.2	0.4	0.6
(S_8)	0.6	0.8	1	0.2	0.4	0.6	0	0	0.2	0.4	0.6	0.8

Table 36 Numeric value of the assessment by LT2

LT2	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.2	0.4	0.6	0	0	0.2	0.2	0.4	0.6	0.2	0.4	0.6	0.4	0.6	0.8
(S_5)	0.2	0.4	0.6	0.6	0.8	1	0.4	0.6	0.8	0.8	1	1	0	0	0.2
(S_6)	0.4	0.6	0.8	0	0.2	0.4	0.2	0.4	0.6	0.6	0.8	1	0.6	0.8	1
(S_{11})	0	0	0.2	0	0.2	0.4	0	0	0.2	0.2	0.4	0.6	0.2	0.4	0.6
(S_{10})	0.8	1	1	0.2	0.4	0.6	0.2	0.4	0.6	0	0	0.2	0.2	0.4	0.6
(S_9)	0.4	0.6	0.8	0.4	0.6	0.8	0.2	0.4	0.6	0.6	0.8	1	0.6	0.8	1
(S_7)	0.8	1	1	0.2	0.4	0.6	0.2	0.4	0.6	0.4	0.6	0.8	0.6	0.8	1
(S_4)	0.8	1	1	0.6	0.8	1	0	0	0.2	0.2	0.4	0.6	0.4	0.6	0.8
(S_8)	0	0.2	0.4	0.2	0.4	0.6	0.8	1	1	0	0	0.2	0	0.2	0.4

LT2	*RCs*											
Strategies	RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0	0	0.2	0	0	0.2	0.2	0.4	0.6	0.8	1	1
(S_5)	0	0	0.2	0	0	0.2	0.6	0.8	1	0.4	0.6	0.8
(S_6)	0	0.2	0.4	0.4	0.6	0.8	0	0.2	0.4	0.2	0.4	0.6
(S_{11})	0.8	1	1	0.2	0.4	0.6	0.4	0.6	0.8	0.6	0.8	1
(S_{10})	0	0.2	0.4	0.4	0.6	0.8	0	0	0.2	0	0	0.2
(S_9)	0.8	1	1	0	0.2	0.4	0.6	0.8	1	0	0	0.2
(S_7)	0.6	0.8	1	0	0	0.2	0.2	0.4	0.6	0.4	0.6	0.8
(S_4)	0.8	1	1	0.2	0.4	0.6	0.6	0.8	1	0.8	1	1
(S_8)	0.4	0.6	0.8	0	0.2	0.4	0.4	0.6	0.8	0	0	0.2

Table 37 Numeric value of the assessment by LT3

LT3	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.4	0.6	0.8	0	0	0.2	0.2	0.4	0.6	0.2	0.4	0.6	0	0.2	0.4
(S_5)	0	0	0.2	0	0.2	0.4	0.8	1	1	0.2	0.4	0.6	0.6	0.8	1
(S_6)	0.6	0.8	1	0.2	0.4	0.6	0.8	1	1	0	0	0.2	0.2	0.4	0.6
(S_{11})	0.4	0.6	0.8	0.2	0.4	0.6	0	0	0.2	0.6	0.8	1	0.4	0.6	0.8
(S_{10})	0	0	0.2	0	0.2	0.4	0.2	0.4	0.6	0	0	0.2	0.4	0.6	0.8
(S_9)	0.8	1	1	0.8	1	1	0.2	0.4	0.6	0	0.2	0.4	0	0.2	0.4
(S_7)	0	0	0.2	0.8	1	1	0	0.2	0.4	0.4	0.6	0.8	0.2	0.4	0.6
(S_4)	0.8	1	1	0.4	0.6	0.8	0.4	0.6	0.8	0.8	1	1	0.6	0.8	1
(S_8)	0.2	0.4	0.6	0	0	0.2	0.4	0.6	0.8	0.6	0.8	1	0.6	0.8	1
LT3	*RCs*														
Strategies	RC_{14}			RC_8			RC_{15}			RC_7					
(S_1)	0.6	0.8	1	0.6	0.8	1	0.8	1	1	0	0.2	0.4			
(S_5)	0.2	0.4	0.6	0.6	0.8	1	0.2	0.4	0.6	0	0	0.2			
(S_6)	0.6	0.8	1	0.4	0.6	0.8	0.2	0.4	0.6	0.2	0.4	0.6			
(S_{11})	0.8	1	1	0.4	0.6	0.8	0	0.2	0.4	0	0.2	0.4			
(S_{10})	0.6	0.8	1	0.6	0.8	1	0.2	0.4	0.6	0.6	0.8	1			
(S_9)	0	0	0.2	0	0	0.2	0.2	0.4	0.6	0.2	0.4	0.6			
(S_7)	0	0	0.2	0.2	0.4	0.6	0.2	0.4	0.6	0.6	0.8	1			
(S_4)	0.2	0.4	0.6	0.4	0.6	0.8	0	0	0.2	0	0	0.2			
(S_8)	0	0	0.2	0.2	0.4	0.6	0	0.2	0.4	0	0.2	0.4			

Table 38 Numeric value of the assessment by LT4

LT4	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0	0.2	0.4	0.6	0.8	1	0.2	0.4	0.6	0.8	1	1	0.4	0.6	0.8
(S_5)	0.2	0.4	0.6	0.8	1	1	0.4	0.6	0.8	0	0.2	0.4	0	0.2	0.4
(S_6)	0	0.2	0.4	0.8	1	1	0	0.2	0.4	0.4	0.6	0.8	0	0.2	0.4
(S_{11})	0	0.2	0.4	0	0	0.2	0.4	0.6	0.8	0.4	0.6	0.8	0	0.2	0.4
(S_{10})	0.6	0.8	1	0	0	0.2	0.4	0.6	0.8	0.4	0.6	0.8	0.6	0.8	1
(S_9)	0.2	0.4	0.6	0	0.2	0.4	0.4	0.6	0.8	0.4	0.6	0.8	0.8	1	1
(S_7)	0.4	0.6	0.8	0	0.2	0.4	0.4	0.6	0.8	0.2	0.4	0.6	0.8	1	1
(S_4)	0.8	1	1	0	0.2	0.4	0.6	0.8	1	0	0.2	0.4	0.6	0.8	1
(S_8)	0.6	0.8	1	0.4	0.6	0.8	0.2	0.4	0.6	0.6	0.8	1	0	0.2	0.4

LT4	*RCs*											
Strategies	RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0.4	0.6	0.8	0.4	0.6	0.8	0.6	0.8	1	0.6	0.8	1
(S_5)	0	0	0.2	0	0	0.2	0.2	0.4	0.6	0.2	0.4	0.6
(S_6)	0	0.2	0.4	0.4	0.6	0.8	0.4	0.6	0.8	0.6	0.8	1
(S_{11})	0	0.2	0.4	0.8	1	1	0	0.2	0.4	0	0.2	0.4
(S_{10})	0.6	0.8	1	0.4	0.6	0.8	0.2	0.4	0.6	0	0	0.2
(S_9)	0.2	0.4	0.6	0.4	0.6	0.8	0.8	1	1	0.4	0.6	0.8
(S_7)	0.2	0.4	0.6	0	0.2	0.4	0.8	1	1	0.4	0.6	0.8
(S_4)	0.6	0.8	1	0	0	0.2	0.4	0.6	0.8	0.8	1	1
(S_8)	0.4	0.6	0.8	0.8	1	1	0	0.2	0.4	0.2	0.4	0.6

Table 39 Numeric value of the assessment by LT5

LT5	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.2	0.4	0.6	0.2	0.4	0.6	0	0	0.2	0.4	0.6	0.8	0	0	0.2
(S_5)	0.4	0.6	0.8	0.2	0.4	0.6	0.6	0.8	1	0	0.2	0.4	0.4	0.6	0.8
(S_6)	0.2	0.4	0.6	0.6	0.8	1	0	0	0.2	0	0	0.2	0.6	0.8	1
(S_{11})	0.2	0.4	0.6	0	0.2	0.4	0	0.2	0.4	0	0	0.2	0	0.2	0.4
(S_{10})	0	0.2	0.4	0	0.2	0.4	0.8	1	1	0.4	0.6	0.8	0.8	1	1
(S_9)	0	0	0.2	0.4	0.6	0.8	0.4	0.6	0.8	0.4	0.6	0.8	0.2	0.4	0.6
(S_7)	0.2	0.4	0.6	0.6	0.8	1	0.6	0.8	1	0.4	0.6	0.8	0.2	0.4	0.6
(S_4)	0.4	0.6	0.8	0.8	1	1	0.4	0.6	0.8	0	0	0.2	0.4	0.6	0.8
(S_8)	0.2	0.4	0.6	0.4	0.6	0.8	0	0.2	0.4	0.2	0.4	0.6	0	0.2	0.4
LT5	*RCs*														
Strategies	RC_{14}			RC_8			RC_{15}			RC_7					
(S_1)	0	0	0.2	0.6	0.8	1	0.8	1	1	0.4	0.6	0.8			
(S_5)	0.6	0.8	1	0	0	0.2	0.2	0.4	0.6	0.4	0.6	0.8			
(S_6)	0.8	1	1	0	0	0.2	0.4	0.6	0.8	0	0	0.2			
(S_{11})	0.6	0.8	1	0.4	0.6	0.8	0	0.2	0.4	0	0.2	0.4			
(S_{10})	0.2	0.4	0.6	0.6	0.8	1	0	0	0.2	0	0.2	0.4			
(S_9)	0	0.2	0.4	0.4	0.6	0.8	0.6	0.8	1	0.6	0.8	1			
(S_7)	0	0.2	0.4	0.8	1	1	0.2	0.4	0.6	0	0.2	0.4			
(S_4)	0.4	0.6	0.8	0	0	0.2	0.4	0.6	0.8	0.4	0.6	0.8			
(S_8)	0	0	0.2	0.6	0.8	1	0.2	0.4	0.6	0.2	0.4	0.6			

Table 40 Numeric value of the assessment by LT6

LT6	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.4	0.6	0.8	0	0	0.2	0	0	0.2	0.6	0.8	1	0.8	1	1
(S_5)	0.4	0.6	0.8	0.8	1	1	0.6	0.8	1	0	0	0.2	0.4	0.6	0.8
(S_6)	0.8	1	1	0.2	0.4	0.6	0	0.2	0.4	0	0.2	0.4	0.4	0.6	0.8
(S_{11})	0.4	0.6	0.8	0	0.2	0.4	0.4	0.6	0.8	0	0.2	0.4	0.2	0.4	0.6
(S_{10})	0.6	0.8	1	0	0	0.2	0.2	0.4	0.6	0.4	0.6	0.8	0.4	0.6	0.8
(S_9)	0.4	0.6	0.8	0.2	0.4	0.6	0	0.2	0.4	0.2	0.4	0.6	0	0.2	0.4
(S_7)	0.2	0.4	0.6	0	0.2	0.4	0.8	1	1	0.6	0.8	1	0.8	1	1
(S_4)	0.6	0.8	1	0	0.2	0.4	0.8	1	1	0.6	0.8	1	0.4	0.6	0.8
(S_8)	0.2	0.4	0.6	0	0	0.2	0	0	0.2	0.8	1	1	0.8	1	1

LT6	*RCs*											
Strategies	RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0	0	0.2	0.2	0.4	0.6	0	0.2	0.4	0.2	0.4	0.6
(S_5)	0.2	0.4	0.6	0.6	0.8	1	0.8	1	1	0.6	0.8	1
(S_6)	0	0	0.2	0.2	0.4	0.6	0.4	0.6	0.8	0.8	1	1
(S_{11})	0	0.2	0.4	0	0	0.2	0	0.2	0.4	0.2	0.4	0.6
(S_{10})	0.8	1	1	0.8	1	1	0.2	0.4	0.6	0	0	0.2
(S_9)	0	0	0.2	0.6	0.8	1	0	0	0.2	0.8	1	1
(S_7)	0.6	0.8	1	0.6	0.8	1	0.4	0.6	0.8	0	0.2	0.4
(S_4)	0.8	1	1	0	0.2	0.4	0	0.2	0.4	0.4	0.6	0.8
(S_8)	0.8	1	1	0.2	0.4	0.6	0	0.2	0.4	0	0	0.2

Table 41 Numeric value of the assessment by LT7

LT7	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.6	0.8	1	0	0.2	0.4	0	0	0.2	0.8	1	1	0	0.2	0.4
(S_5)	0	0	0.2	0	0.2	0.4	0.2	0.4	0.6	0	0.2	0.4	0.2	0.4	0.6
(S_6)	0.6	0.8	1	0	0	0.2	0.8	1	1	0	0	0.2	0.4	0.6	0.8
(S_{11})	0	0	0.2	0.8	1	1	0.6	0.8	1	0	0.2	0.4	0	0	0.2
(S_{10})	0	0.2	0.4	0.2	0.4	0.6	0.4	0.6	0.8	0.2	0.4	0.6	0.8	1	1
(S_9)	0	0.2	0.4	0.2	0.4	0.6	0.2	0.4	0.6	0.8	1	1	0.4	0.6	0.8
(S_7)	0.6	0.8	1	0.4	0.6	0.8	0	0.2	0.4	0.6	0.8	1	0.2	0.4	0.6
(S_4)	0.4	0.6	0.8	0.2	0.4	0.6	0.2	0.4	0.6	0.4	0.6	0.8	0.2	0.4	0.6
(S_8)	0.8	1	1	0.4	0.6	0.8	0.2	0.4	0.6	0.8	1	1	0.8	1	1

LT7	*RCs*											
Strategies	RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0.8	1	1	0.6	0.8	1	0.4	0.6	0.8	0.6	0.8	1
(S_5)	0.8	1	1	0.2	0.4	0.6	0.2	0.4	0.6	0	0.2	0.4
(S_6)	0	0	0.2	0.8	1	1	0	0	0.2	0	0	0.2
(S_{11})	0.4	0.6	0.8	0.4	0.6	0.8	0	0	0.2	0.6	0.8	1
(S_{10})	0.8	1	1	0	0.2	0.4	0.8	1	1	0	0	0.2
(S_9)	0	0	0.2	0	0.2	0.4	0.8	1	1	0.4	0.6	0.8
(S_7)	0	0.2	0.4	0.8	1	1	0.2	0.4	0.6	0	0	0.2
(S_4)	0.4	0.6	0.8	0	0	0.2	0.4	0.6	0.8	0.2	0.4	0.6
(S_8)	0	0.2	0.4	0.6	0.8	1	0.8	1	1	0.8	1	1

Table 42 Numeric value of the assessment by LT8

LT8	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.2	0.4	0.6	0	0	0.2	0.2	0.4	0.6	0.8	1	1	0.2	0.4	0.6
(S_5)	0.8	1	1	0.4	0.6	0.8	0.2	0.4	0.6	0.4	0.6	0.8	0	0	0.2
(S_6)	0.2	0.4	0.6	0.6	0.8	1	0.8	1	1	0	0	0.2	0	0.2	0.4
(S_{11})	0.4	0.6	0.8	0.4	0.6	0.8	0.4	0.6	0.8	0.4	0.6	0.8	0.6	0.8	1
(S_{10})	0	0	0.2	0	0	0.2	0.4	0.6	0.8	0.2	0.4	0.6	0	0	0.2
(S_9)	0.8	1	1	0	0.2	0.4	0	0	0.2	0.4	0.6	0.8	0	0.2	0.4
(S_7)	0.6	0.8	1	0.2	0.4	0.6	0.4	0.6	0.8	0	0.2	0.4	0.6	0.8	1
(S_4)	0.4	0.6	0.8	0.2	0.4	0.6	0.6	0.8	1	0.4	0.6	0.8	0.2	0.4	0.6
(S_8)	0.6	0.8	1	0.8	1	1	0	0.2	0.4	0.6	0.8	1	0	0.2	0.4

LT8	*RCs*											
Strategies	RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0	0	0.2	0.2	0.4	0.6	0.8	1	1	0.8	1	1
(S_5)	0.6	0.8	1	0.8	1	1	0	0	0.2	0.2	0.4	0.6
(S_6)	0.6	0.8	1	0.8	1	1	0.8	1	1	0	0.2	0.4
(S_{11})	0.2	0.4	0.6	0.4	0.6	0.8	0.4	0.6	0.8	0.4	0.6	0.8
(S_{10})	0.2	0.4	0.6	0	0	0.2	0.8	1	1	0.4	0.6	0.8
(S_9)	0.2	0.4	0.6	0.4	0.6	0.8	0.4	0.6	0.8	0.2	0.4	0.6
(S_7)	0.6	0.8	1	0.4	0.6	0.8	0.6	0.8	1	0.6	0.8	1
(S_4)	0	0	0.2	0.2	0.4	0.6	0.4	0.6	0.8	0.2	0.4	0.6
(S_8)	0.2	0.4	0.6	0.8	1	1	0	0.2	0.4	0	0.2	0.4

Table 43 Numeric value of the assessment by LT9

LT9	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0	0	0.2	0.6	0.8	1	0	0.2	0.4	0.6	0.8	1	0.2	0.4	0.6
(S_5)	0.8	1	1	0.4	0.6	0.8	0.6	0.8	1	0.8	1	1	0.4	0.6	0.8
(S_6)	0.2	0.4	0.6	0.4	0.6	0.8	0.2	0.4	0.6	0.4	0.6	0.8	0	0.2	0.4
(S_{11})	0.4	0.6	0.8	0	0.2	0.4	0.6	0.8	1	0.4	0.6	0.8	0.6	0.8	1
(S_{10})	0	0.2	0.4	0	0	0.2	0	0	0.2	0.6	0.8	1	0.6	0.8	1
(S_9)	0	0.2	0.4	0.2	0.4	0.6	0.6	0.8	1	0	0	0.2	0.4	0.6	0.8
(S_7)	0	0	0.2	0	0	0.2	0	0	0.2	0.8	1	1	0	0.2	0.4
(S_4)	0.4	0.6	0.8	0	0.2	0.4	0	0.2	0.4	0.8	1	1	0.8	1	1
(S_8)	0.2	0.4	0.6	0.8	1	1	0.8	1	1	0.6	0.8	1	0.2	0.4	0.6
LT9	*RCs*														
Strategies	RC_{14}			RC_8			RC_{15}			RC_7					
(S_1)	0.2	0.4	0.6	0	0	0.2	0.8	1	1	0	0	0.2			
(S_5)	0.2	0.4	0.6	0.6	0.8	1	0.8	1	1	0.6	0.8	1			
(S_6)	0.2	0.4	0.6	0	0	0.2	0.6	0.8	1	0.2	0.4	0.6			
(S_{11})	0	0.2	0.4	0	0	0.2	0.8	1	1	0.8	1	1			
(S_{10})	0.8	1	1	0	0.2	0.4	0.6	0.8	1	0	0.2	0.4			
(S_9)	0.6	0.8	1	0.4	0.6	0.8	0	0	0.2	0.6	0.8	1			
(S_7)	0.8	1	1	0	0.2	0.4	0.8	1	1	0	0.2	0.4			
(S_4)	0	0	0.2	0	0	0.2	0.2	0.4	0.6	0.4	0.6	0.8			
(S_8)	0.6	0.8	1	0.4	0.6	0.8	0.2	0.4	0.6	0.6	0.8	1			

Table 44 Numeric value of the assessment by LT10

LT10	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.4	0.6	0.8	0.4	0.6	0.8	0.6	0.8	1	0.6	0.8	1	0.4	0.6	0.8
(S_5)	0	0.2	0.4	0.6	0.8	1	0	0	0.2	0.4	0.6	0.8	0.2	0.4	0.6
(S_6)	0.6	0.8	1	0.6	0.8	1	0	0	0.2	0	0.2	0.4	0	0	0.2
(S_{11})	0.6	0.8	1	0.6	0.8	1	0	0	0.2	0.8	1	1	0.8	1	1
(S_{10})	0.8	1	1	0	0.2	0.4	0	0	0.2	0.4	0.6	0.8	0.2	0.4	0.6
(S_9)	0.2	0.4	0.6	0.4	0.6	0.8	0.2	0.4	0.6	0.6	0.8	1	0.6	0.8	1
(S_7)	0	0	0.2	0.6	0.8	1	0	0	0.2	0.6	0.8	1	0.8	1	1
(S_4)	0.8	1	1	0.2	0.4	0.6	0	0	0.2	0.2	0.4	0.6	0.2	0.4	0.6
(S_8)	0.6	0.8	1	0.2	0.4	0.6	0.8	1	1	0.2	0.4	0.6	0.6	0.8	1

LT10	*RCs*											
Strategies	RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0	0	0.2	0.8	1	1	0.4	0.6	0.8	0.2	0.4	0.6
(S_5)	0.6	0.8	1	0	0	0.2	0.2	0.4	0.6	0.4	0.6	0.8
(S_6)	0.6	0.8	1	0.6	0.8	1	0	0	0.2	0	0	0.2
(S_{11})	0.2	0.4	0.6	0.4	0.6	0.8	0	0.2	0.4	0	0	0.2
(S_{10})	0.2	0.4	0.6	0	0.2	0.4	0.6	0.8	1	0.6	0.8	1
(S_9)	0.8	1	1	0.6	0.8	1	0.2	0.4	0.6	0	0	0.2
(S_7)	0	0.2	0.4	0.2	0.4	0.6	0	0	0.2	0.8	1	1
(S_4)	0	0.2	0.4	0.8	1	1	0	0	0.2	0	0	0.2
(S_8)	0	0	0.2	0	0	0.2	0	0	0.2	0.4	0.6	0.8

Table 45 Numeric value of the assessment by LT11

LT11	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.6	0.8	1	0.4	0.6	0.8	0.8	1	1	0.4	0.6	0.8	0.6	0.8	1
(S_5)	0.6	0.8	1	0.4	0.6	0.8	0.2	0.4	0.6	0.8	1	1	0.2	0.4	0.6
(S_6)	0.4	0.6	0.8	0.6	0.8	1	0.6	0.8	1	0	0.2	0.4	0.2	0.4	0.6
(S_{11})	0	0	0.2	0	0.2	0.4	0	0	0.2	0	0	0.2	0.2	0.4	0.6
(S_{10})	0.4	0.6	0.8	0.6	0.8	1	0	0.2	0.4	0.8	1	1	0.2	0.4	0.6
(S_9)	0	0.2	0.4	0.4	0.6	0.8	0.4	0.6	0.8	0.4	0.6	0.8	0.8	1	1
(S_7)	0	0	0.2	0	0	0.2	0	0.2	0.4	0.4	0.6	0.8	0	0.2	0.4
(S_4)	0.2	0.4	0.6	0.6	0.8	1	0.8	1	1	0.6	0.8	1	0.6	0.8	1
(S_8)	0	0	0.2	0.8	1	1	0.2	0.4	0.6	0	0	0.2	0.6	0.8	1

LT11	*RCs*											
Strategies	RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0.4	0.6	0.8	0	0	0.2	0	0.2	0.4	0.4	0.6	0.8
(S_5)	0	0	0.2	0.4	0.6	0.8	0.4	0.6	0.8	0	0.2	0.4
(S_6)	0.4	0.6	0.8	0.6	0.8	1	0.8	1	1	0.4	0.6	0.8
(S_{11})	0.4	0.6	0.8	0.4	0.6	0.8	0	0	0.2	0.6	0.8	1
(S_{10})	0.4	0.6	0.8	0	0	0.2	0	0	0.2	0.4	0.6	0.8
(S_9)	0.6	0.8	1	0.2	0.4	0.6	0	0	0.2	0	0	0.2
(S_7)	0	0.2	0.4	0	0	0.2	0.8	1	1	0.8	1	1
(S_4)	0	0	0.2	0	0	0.2	0.8	1	1	0	0	0.2
(S_8)	0.2	0.4	0.6	0.6	0.8	1	0.4	0.6	0.8	0.4	0.6	0.8

Table 46 Numeric value of the assessment by LT12

LT12	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0	0.2	0.4	0.8	1	1	0	0	0.2	0.6	0.8	1	0	0.2	0.4
(S_5)	0.6	0.8	1	0	0.2	0.4	0.6	0.8	1	0.6	0.8	1	0.2	0.4	0.6
(S_6)	0	0	0.2	0	0	0.2	0	0.2	0.4	0.8	1	1	0.4	0.6	0.8
(S_{11})	0.2	0.4	0.6	0	0	0.2	0	0.2	0.4	0.6	0.8	1	0	0	0.2
(S_{10})	0.6	0.8	1	0.8	1	1	0.8	1	1	0.8	1	1	0	0.2	0.4
(S_9)	0	0	0.2	0.4	0.6	0.8	0	0	0.2	0.6	0.8	1	0.2	0.4	0.6
(S_7)	0.6	0.8	1	0.8	1	1	0.6	0.8	1	0.2	0.4	0.6	0.8	1	1
(S_4)	0	0	0.2	0.4	0.6	0.8	0.8	1	1	0.8	1	1	0.2	0.4	0.6
(S_8)	0.8	1	1	0	0.2	0.4	0	0	0.2	0.6	0.8	1	0.8	1	1
LT12	*RCs*														
Strategies	RC_{14}			RC_8			RC_{15}			RC_7					
(S_1)	0	0	0.2	0	0	0.2	0.6	0.8	1	0.2	0.4	0.6			
(S_5)	0.6	0.8	1	0.2	0.4	0.6	0.4	0.6	0.8	0.4	0.6	0.8			
(S_6)	0.8	1	1	0	0	0.2	0	0	0.2	0.2	0.4	0.6			
(S_{11})	0.2	0.4	0.6	0	0	0.2	0.6	0.8	1	0	0.2	0.4			
(S_{10})	0	0	0.2	0.8	1	1	0	0	0.2	0	0	0.2			
(S_9)	0	0	0.2	0	0	0.2	0.6	0.8	1	0.4	0.6	0.8			
(S_7)	0	0.2	0.4	0.6	0.8	1	0.8	1	1	0.2	0.4	0.6			
(S_4)	0	0	0.2	0.2	0.4	0.6	0.6	0.8	1	0	0	0.2			
(S_8)	0	0.2	0.4	0	0.2	0.4	0.4	0.6	0.8	0.4	0.6	0.8			

Table 47 Numeric value of the assessment by LT13

LT13	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.4	0.6	0.8	0.8	1	1	0	0	0.2	0.4	0.6	0.8	0.6	0.8	1
(S_5)	0	0	0.2	0	0	0.2	0	0	0.2	0	0.2	0.4	0	0.2	0.4
(S_6)	0	0.2	0.4	0.2	0.4	0.6	0.2	0.4	0.6	0.8	1	1	0	0.2	0.4
(S_{11})	0	0	0.2	0.8	1	1	0.8	1	1	0	0.2	0.4	0	0	0.2
(S_{10})	0	0.2	0.4	0	0.2	0.4	0.6	0.8	1	0	0	0.2	0	0.2	0.4
(S_9)	0.2	0.4	0.6	0	0.2	0.4	0.2	0.4	0.6	0.4	0.6	0.8	0.2	0.4	0.6
(S_7)	0	0	0.2	0.8	1	1	0.6	0.8	1	0.6	0.8	1	0.4	0.6	0.8
(S_4)	0.6	0.8	1	0	0	0.2	0.4	0.6	0.8	0.6	0.8	1	0	0.2	0.4
(S_8)	0	0	0.2	0.2	0.4	0.6	0.6	0.8	1	0.4	0.6	0.8	0.2	0.4	0.6

LT13	*RCs*											
Strategies	RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0.6	0.8	1	0	0.2	0.4	0.2	0.4	0.6	0.6	0.8	1
(S_5)	0.4	0.6	0.8	0.8	1	1	0.6	0.8	1	0	0.2	0.4
(S_6)	0.6	0.8	1	0	0	0.2	0.8	1	1	0.8	1	1
(S_{11})	0.6	0.8	1	0.4	0.6	0.8	0.6	0.8	1	0.2	0.4	0.6
(S_{10})	0.6	0.8	1	0.2	0.4	0.6	0.2	0.4	0.6	0.6	0.8	1
(S_9)	0.8	1	1	0.4	0.6	0.8	0.4	0.6	0.8	0.4	0.6	0.8
(S_7)	0	0.2	0.4	0.4	0.6	0.8	0.8	1	1	0.8	1	1
(S_4)	0.4	0.6	0.8	0.4	0.6	0.8	0.4	0.6	0.8	0.4	0.6	0.8
(S_8)	0.4	0.6	0.8	0	0.2	0.4	0.6	0.8	1	0.8	1	1

Table 48 Numeric value of the assessment by LT14

LT14	*RCs*														
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.8	1	1	0	0	0.2	0	0	0.2	0.6	0.8	1	0.2	0.4	0.6
(S_5)	0	0.2	0.4	0.6	0.8	1	0.4	0.6	0.8	0	0.2	0.4	0	0.2	0.4
(S_6)	0.8	1	1	0.8	1	1	0.4	0.6	0.8	0.4	0.6	0.8	0.6	0.8	1
(S_{11})	0.6	0.8	1	0.2	0.4	0.6	0.6	0.8	1	0	0	0.2	0.8	1	1
(S_{10})	0.2	0.4	0.6	0.8	1	1	0	0.2	0.4	0	0.2	0.4	0.4	0.6	0.8
(S_9)	0.2	0.4	0.6	0.8	1	1	0.4	0.6	0.8	0.2	0.4	0.6	0	0	0.2
(S_7)	0	0.2	0.4	0.8	1	1	0.8	1	1	0	0	0.2	0.2	0.4	0.6
(S_4)	0.4	0.6	0.8	0	0	0.2	0.8	1	1	0	0	0.2	0	0	0.2
(S_8)	0.2	0.4	0.6	0.4	0.6	0.8	0.4	0.6	0.8	0	0.2	0.4	0	0	0.2

LT14	*RCs*											
Strategies	RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0.2	0.4	0.6	0.4	0.6	0.8	0.2	0.4	0.6	0.4	0.6	0.8
(S_5)	0.6	0.8	1	0	0.2	0.4	0.4	0.6	0.8	0.6	0.8	1
(S_6)	0.8	1	1	0.2	0.4	0.6	0.2	0.4	0.6	0	0.2	0.4
(S_{11})	0	0.2	0.4	0	0	0.2	0	0.2	0.4	0.2	0.4	0.6
(S_{10})	0.6	0.8	1	0.2	0.4	0.6	0	0.2	0.4	0	0.2	0.4
(S_9)	0	0	0.2	0	0	0.2	0.4	0.6	0.8	0.8	1	1
(S_7)	0.4	0.6	0.8	0.2	0.4	0.6	0.2	0.4	0.6	0	0	0.2
(S_4)	0	0.2	0.4	0	0	0.2	0.4	0.6	0.8	0	0	0.2
(S_8)	0.4	0.6	0.8	0.6	0.8	1	0.8	1	1	0.4	0.6	0.8

Table 49 Numeric value of the assessment by LT15

LT15	*RCs*															*RCs*											
Strategies	RC_1			RC_4			RC_{11}			RC_{13}			RC_5			RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0	0	0.2	0	0.2	0.4	0	0	0.2	0.2	0.4	0.6	0.6	0.8	1	0.2	0.4	0.6	0.4	0.6	0.8	0.2	0.4	0.6	0	0.2	0.4
(S_5)	0	0.2	0.4	0.6	0.8	1	0.2	0.4	0.6	0.8	1	1	0.2	0.4	0.6	0.6	0.8	1	0.2	0.4	0.6	0.4	0.6	0.8	0	0.2	0.4
(S_6)	0.6	0.8	1	0.2	0.4	0.6	0.2	0.4	0.6	0.2	0.4	0.6	0.2	0.4	0.6	0.2	0.4	0.6	0.6	0.8	1	0.2	0.4	0.6	0	0.2	0.4
(S_{11})	0	0	0.2	0.2	0.4	0.6	0.4	0.6	0.8	0.4	0.6	0.8	0.8	1	1	0.6	0.8	1	0.8	1	1	0	0	0.2	0.2	0.4	0.6
(S_{10})	0.6	0.8	1	0	0	0.2	0	0.2	0.4	0.6	0.8	1	0.2	0.4	0.6	0.8	1	1	0.2	0.4	0.6	0	0.2	0.4	0	0	0.2
(S_9)	0.2	0.4	0.6	0.4	0.6	0.8	0.6	0.8	1	0.4	0.6	0.8	0.2	0.4	0.6	0	0.2	0.4	0.6	0.8	1	0.4	0.6	0.8	0	0	0.2
(S_7)	0.8	1	1	0	0.2	0.4	0	0.2	0.4	0	0.2	0.4	0	0	0.2	0.8	1	1	0	0	0.2	0.8	1	1	0.4	0.6	0.8
(S_4)	0.4	0.6	0.8	0	0.2	0.4	0.6	0.8	1	0.2	0.4	0.6	0.4	0.6	0.8	0.6	0.8	1	0.4	0.6	0.8	0.6	0.8	1	0	0.2	0.4
(S_8)	0	0	0.2	0	0.2	0.4	0.4	0.6	0.8	0	0.2	0.4	0.4	0.6	0.8	0	0	0.2	0.2	0.4	0.6	0	0	0.2	0.8	1	1

Table 50 Combined matrix

Strategies	*RCs*														
	RC_1			RC_4			RC_{11}			RC_{13}			RC_5		
(S_1)	0.0000	0.4800	1.0000	0.0000	0.4000	1.0000	0.0000	0.2933	1.0000	0.2000	0.7067	1.0000	0.0000	0.5067	1.0000
(S_5)	0.0000	0.4400	1.0000	0.0000	0.5333	1.0000	0.0000	0.5467	1.0000	0.0000	0.5467	1.0000	0.0000	0.4133	1.0000
(S_6)	0.0000	0.5467	1.0000	0.0000	0.5600	1.0000	0.0000	0.4400	1.0000	0.0000	0.4133	1.0000	0.0000	0.4533	1.0000
(S_{11})	0.0000	0.3600	1.0000	0.0000	0.4267	1.0000	0.0000	0.4667	1.0000	0.0000	0.4267	1.0000	0.0000	0.4667	1.0000
(S_{10})	0.0000	0.4933	1.0000	0.0000	0.3333	1.0000	0.0000	0.4933	1.0000	0.0000	0.5200	1.0000	0.0000	0.5067	1.0000
(S_9)	0.0000	0.4267	1.0000	0.0000	0.5333	1.0000	0.0000	0.4800	1.0000	0.0000	0.5467	1.0000	0.0000	0.5333	1.0000
(S_7)	0.0000	0.4400	1.0000	0.0000	0.5200	1.0000	0.0000	0.5067	1.0000	0.0000	0.5733	1.0000	0.0000	0.6133	1.0000
(S_4)	0.0000	0.6533	1.0000	0.0000	0.4267	1.0000	0.0000	0.6533	1.0000	0.0000	0.5600	1.0000	0.0000	0.5467	1.0000
(S_8)	0.0000	0.4400	1.0000	0.0000	0.4933	1.0000	0.0000	0.5200	1.0000	0.0000	0.5467	1.0000	0.0000	0.5467	1.0000

Strategies	*RCs*											
	RC_{14}			RC_8			RC_{15}			RC_7		
(S_1)	0.0000	0.3333	1.0000	0.0000	0.4400	1.0000	0.0000	0.6400	1.0000	0.0000	0.5200	1.0000
(S_5)	0.0000	0.5733	1.0000	0.0000	0.4933	1.0000	0.0000	0.5867	1.0000	0.0000	0.4400	1.0000
(S_6)	0.0000	0.5600	1.0000	0.0000	0.5333	1.0000	0.0000	0.4933	1.0000	0.0000	0.3733	1.0000
(S_{11})	0.0000	0.5733	1.0000	0.0000	0.4933	1.0000	0.0000	0.3867	1.0000	0.0000	0.4533	1.0000
(S_{10})	0.0000	0.6667	1.0000	0.0000	0.5067	1.0000	0.0000	0.4000	1.0000	0.0000	0.3067	1.0000
(S_9)	0.0000	0.4267	1.0000	0.0000	0.4533	1.0000	0.0000	0.5600	1.0000	0.0000	0.5067	1.0000
(S_7)	0.0000	0.4933	1.0000	0.0000	0.4800	1.0000	0.0000	0.6800	1.0000	0.0000	0.4933	1.0000
(S_4)	0.0000	0.4533	1.0000	0.0000	0.3333	1.0000	0.0000	0.5467	1.0000	0.0000	0.3867	1.0000
(S_8)	0.0000	0.4133	1.0000	0.0000	0.5333	1.0000	0.0000	0.4133	1.0000	0.0000	0.5333	1.0000

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