Strategic Drivers to Overcome the Impacts of the COVID-19 Pandemic: Implications for Ensuring Resilience in Supply Chains

Abstract:

The recent coronavirus (COVID-19) pandemic has affected the manufacturing industry's entire supply chain system. It is important to investigate the strategic drivers to deal with the impacts of COVID-19 in the manufacturing industry. Accordingly, this study aims to identify the strategic drivers to overcome the impacts of the COVID-19 pandemic and improve the resiliency of the Bangladeshi footwear industry, an emerging economy. The strategic drivers are identified after reviewing research papers, reports, blogs, and discussions on social media platforms. The main drivers and their respective sub-drivers are finalized by discussing with domain experts. To offer strategic plans for building resiliency, it is crucial to know the importance of the main drivers and sub-drivers; therefore, the best-worst method is applied to determine the priority importance of the strategic drivers. The findings indicate that the top five drivers to defeat the impacts of COVID-19 are "high capability of reconfigurability," "enhance the relationship with suppliers," "develop health protocols to continue manufacturing," "government support through incentives, subsidy, tax rebate, etc.," and "set a policy to stable material supply". Based on the findings, this study also provides practical implications with proposed research themes for policymakers and operations managers towards mitigating the impacts of the COVID-19 pandemic. The study's contribution is unique and important for the footwear supply chain as the research on COVID-19 in the context of resiliency focusing on the footwear supply chain is non-existent.

***Keywords**:* COVID-19; Strategic drivers; Resiliency, Business impact.

1. Introduction

The recent COVID-19 outbreak has been affecting the global economy rigorously (Majumdar et al., 2020; Yu et al., 2021). A comprehensive and tragic worldwide health crisis, COVID-19 is a serious infectious disease that can spread exponentially within a short period. As of February 14, 2022, the total number of cases across the globe exceeded 413 million resulting in more than 5.8 million deaths (Worldometers, 2022). The situation is still evolving and expanding drastically (Sharma et al., 2020).

The severe conditions of COVID-19 have resulted in restrictions on public gatherings, full shutdowns of industries, limited air transport and transportation facilities, difficulties in moving in stores and everyday activities, and tremendous pressure on the manufacturing industry (Choi et al., 2020; Fasan et al., 2021). At the same time, the supply of raw materials has reduced significantly, resulting in difficulties maintaining the balance between supply and demand (Sarkis et al., 2020). Araz et al. (2020) outlined that the COVID-19 pandemic is a major disruptive event compared to other epidemic outbreaks, which is "breaking many global supply chains". It is an unexpected event for supply chain networks that has enormously affected countries' health, economic, and social activities (Haleem et al., 2020). For example, in the first quarter of 2020, global trade value declined by up to 3% due to the pandemic, and a quarter-on-quarter decline in world trade of 27% is expected (UNCTAD Report, 2020). The World Trade Organization (WTO) expects annual world trade to decline by 13%–32% in 2020 (WTO, 2020).

Three features characterize this particular type of pandemic outbreak: i) long-term unpredictable economic impacts on the supply chain due to the extended period; ii) drastic disruptions propagation (ripple effect) in the supply chain; and iii) significant disruptions to materials supply, demand for finished goods, and transportation facility (Dolgui et al., 2020). Therefore, the operations manager and policymakers have opportunities to rethink their supply chain, which will assist in building business resilience by reducing the impact of current and future global disruptions (Das et al., 2021).

Many studies have been conducted to investigate the impact of the COVID-19 pandemic. For example, Burgos and Ivanov, (2021) demonstrated the impact of the COVID-19 pandemic on the food supply chain using a digital supply chain twin. Their study applied a simulation approach to finding the most severe scenarios of the COVID-19 pandemic. Shafi et al., (2020) applied an exploratory research method to investigate the impacts of the COVID-19 pandemic on 184 small and medium-sized enterprises (SMEs), and findings revealed that over 83% of SMEs were severely impacted as they had no plan prepared to tackle the impact of the COVID-

19. Alam et al., (2021) performed a study to investigate the barriers to COVID-19 vaccine supply chain towards achieving SDGs. The study identified fifteen challenges and evaluated the interactions among challenges via the fuzzy decision-making trial and evaluation (DEMATEL) approach. Barman et al., (2021) scrutinized the impacts of COVID-19 on the food supply chain and recommended some recovery strategies to mitigate the impacts. Karmaker et al., (2021) investigated the drivers of supply chain sustainability in the context of an emerging economy using the Pareto-based total interpretive structural modeling (TISM) approach. Their study suggested that policy development considering health protocol development is the key driving factor for long-term sustainability. Paul et al., (2021) performed a study to identify and assess the operational challenges of the electronic industry's supply chain during the COVID-19 pandemic. Their study suggested that overstock of finished goods in theinventory is a key challenge for the electronic industry. Paul et al., (2021) investigated the interactions of recovery challenges of the COVID-19 pandemic in the garment industry's supply chain using the grey-DEMATEL approach. The literature review confirmed that no studies on the footwear supply chain had investigated the impacts of the COVID-19 pandemic. However, it is crucial to investigate the impacts of the COVID-19 and their overcoming strategies to make the footwear supply chain resilient and sustainable.

The footwear sector is one of the largest export-earning sectors making significant contributions to the country's economic growth (Munny et al., 2019). Currently, Bangladesh exports footwear to many developed countries and is identified as a favorable footwear supplier. However, due to the COVID-19 pandemic, in the fiscal year 2019–20, the export earnings from the footwear sector dropped to 21.24%, generating 478.75 million US dollars.

In the footwear supply chain, raw materials like leather, lining, sole, insole, shank, toe puff, lace, and accessories are required to manufacture a complete shoe. Also, the raw materials can be varied based on the design and the customer requirements. These raw materials are imported from foreign countries. Owing to the COVID-19 pandemic, short supply of raw materials, massive order cancellation, and delayed payment were the most critical impacts on the footwear supply chain, resulting in negative growth of export earnings. Considering these impacts on the footwear supply chain, research to ensure resilience is time demanding issue. Alongside economic impacts, the sector also faces various social sustainability challenges identified by Sarker et al. (2021). The COVID-19 pandemic has substantial long-term impacts on the footwear sector of Bangladesh. Hence, an extensive study to explore the impacts of the COVID-19 on the footwear supply chain is essential.

Therefore, this study poses the following research questions to ensure resilience of the footwear supply chain.

- *RQ1: What are the strategic drivers that can support industrial practitioners of footwear industry to diminish the impacts of the COVID-19 pandemic?*
- *RQ2: How can industrial practitioners of footwear industry evaluate the importance of each driver and their respective sub-drivers?*
- *RQ3: What will be the effective supply chain policies to cope with the COVID-19 pandemic?*

To address these research questions, the following objectives have been targeted:

a) Identify the strategic drivers for the COVID-19 pandemic toward a resilient footwear supply chain.

b) Examine the strategic drivers using the best-worst method (BWM).

c) Offer effective supply chain strategic policies to minimize during and post-pandemic impacts of COVID-19 in the footwear business.

This study delivers unique contributions to the literature. First, we investigate the strategic drivers to minimize the impacts of COVID-19 in the footwear supply chain. As COVID-19 is a rare type of disruption risk for the footwear supply chain, there is a dearth of study on strategic drivers in the existing body of knowledge. Due to the non-existent literature on drivers to minimize the impact of COVID-19 on the footwear supply chain, we conducted a survey of domain experts following a qualitative research method that helps identify a new set of drivers. Second, we articulate how a new multi-criteria decision-making (MCDM) tool named "best-worst method" (BWM) can be used to find the important and salient features of each driver to alleviate the impact of COVID-19. Third, a sensitivity analysis is performed to illustrate the robustness of the study's findings. Fourth, based on the research findings, a set of implications are offered for operations managers to help build a long-term strategic policy for overcoming the impacts of the COVID-19 pandemic.

In this study, we used a new MCDM tool named BWM due have some exceptional features such as i) BWM can make trustworthy and reliable results compared to analytical hierarchy process (AHP), fuzzy AHP (Mi et al., 2019), ii) Data analysis using BWM is very easy and comfortable as it needs less pairwise comparison matrix (Rezaei, 2015), iii) Scale used in BWM is convenient compared to AHP or fuzzy AHP as here uses 1-9 point rating scale but in

AHP or fuzzy AHP need to use a reciprocal rating scale to desire the results (Mi et al., 2019). These unique characteristics motivated us to use BWM in this research.

The rest of the paper is arranged as follows: Section 2 presents the related literature. Methods and case examples are illustrated in Sections 3 and 4 consequently. Section 5 debates the findings and sensitivity analysis of the study. Implications of the study and proposed research themes are discussed in Section 6. After all, Section 7 discusses the conclusions of the study.

2. Literature Review

An epidemic outbreak can occur at any time, and its potential impacts on the global economy depend on the severity of the incidents (Dubey et al., 2019; Ganasekeran and Abdulrahman, 2020). It is crucial to contain the severity of epidemic outbreaks by adopting reactive strategies (Gao et al., 2019; Dubey et al., 2021). COVID-19 is an extraordinary long-lasting pandemic outbreak and the COVID-19 pandemic is destroying the sustainability and resilience of manufacturing supply chains. For instance, the monetary impacts of the COVID-19 pandemic throughout the retail, garments, leather, footwear, leather products, hospital, and service industries are significant. It has resulted in many business organizations and production facilities shutting down and incurring financial losses (Zhang et al., 2020). For example, in Bangladesh, due to COVID-19, retail businesses suffered losses of around 1.25 billion taka over the new Banagli year occasion Boishakh (Newspaper Report, 2020). Due to the slowdown in China, Bangladesh was predicted to incur a total loss of 16 million USD, with around 15 million USD encountered in the leather industry alone (UNCTAD Report, 2020). It was also reported that global trade could fall by 2% each month due to COVID-19 (WTO, 2020). Hence, the impacts of the COVID-19 pandemic are rigorous for manufacturing firms.

To undertsnd the impact of COVID-19 in the manufacturing and service industry, scholars are still trying to investigate its impact on the global supply chains (GSCs) activities (Walker et al., 2020; Koçak et al., 2021). For example, Ivanov (2020) conducted a simulation-based study to analyze the impacts of COVID-19 on GSCs and concluded that during the pandemic, supply chain performance depended on timing, ripple effect, and facility opening and closing at different supply chain echelons. Sarkis et al. (2020) showed that COVID-19's impacts on businesses, firms, institutions, and social activities provided some interesting research opportunities for future researchers. These include reconstituting the global supply chain considering lean, just-in-time practices; the impact of the rebuilding process on environmental footprints and greenhouse gas emissions; and the effects of the epidemic on supply chain resiliency.

Govindan et al. (2020) applied a fuzzy-based decision support tool to manage demand in the healthcare supply chain considering the COVID-19 pandemic outbreak and grouped COVID-19 patients for effective management to mitigate the risk. Ivanov and Dolgui (2020) developed an intertwined supply network (ISN) for managing risk in epidemic conditions and showed how the ISN and viability could ensure the survivability of the supply chain on a large scale. Ivanov (2020) offered a viable supply chain (VSC) network to integrate sustainability, resilience, and agility and showed how the VSC model could help recover and rebuild the GSC after the COVID-19 pandemic. Queiroz et al. (2020) carried out a literature review on the epidemic outbreak, providing an overview of the COVID-19's impact. Paul and Chowdhury (2020) built recovery and management models for manufacturing supply chains considering the effects of the COVID-19 pandemic. Chowdhury et al. (2020) investigated the impact of the pandemic on the beverage and food industry using qualitative case studies. The authors also offered short- to long-term policies to deal with the effect of the COVID-19 pandemic on the food supply chain (FSC). Findings showed that the short-term impacts are severe, whereas medium- to long-term impacts are uncertain and complex. Shahed et al. (2021) offered an analytical model to manage the supply chain disruption caused by COVID-19 and showed how the inventory policy helped maximize profits during the pandemic. El Baz and Ruel (2021) demonstrated the vital role of a supply chain risk management (SCRM) framework in mitigating the impacts of COVID-19 operating structural equation modeling. Their study confirmed that the SCRM model might play a prominent role in mitigating the disruption caused by COVID-19.

Barman et al. (2021) investigated the effect of COVID-19 on the FSC. The authors suggested concentrating on maintaining the facility of employees, their working conditions, and health and safety. Belhadi et al. (2021) utilized grounded theory to examine the airline and automobile supply chain and facilitate insights into COVID-19 impacts. The authors demonstrated both short-term and long-term strategies to cope with the pandemic's effects and found prominent risk strategies included localized and Industry 4.0 technologies. Sarkis (2020) indicated that short-time environmental sustainability received significant scholarly attention, while the pandemic's long-term effects remain unpredictable and need further investigation. Chowdhury et al. (2021) conducted a systematic review of COVID-19 related studies in supply chain management. The authors classified the studies under four dimensions: COVID-19 impacts on supply chain, resilience approaches for managing impacts, the role of advanced technology, and sustainability of supply chain considering the COVID-19. Alongside, some studies focused on supply chain resiliency and traditional risk management (Ghadge et al., 2017; Fan and Stevenson, 2018; Ali and Gölgeci, 2019; Chaudhuri et al., 2020).

Notably, the latest literature on COVID-19 mostly provides either basic discussion on COVID-19, offers network design or mathematical models for healthcare management, or discusses the effect of the COVID-19 pandemic in other domains. The current study's unique contribution is identifying a set of drivers and offering an analytical tool to assess the drivers to relieve the effects of COVID-19 on the footwear supply chain. This study is important for operations managers toward engineering management of the footwear supply chain to make the supply chain more resilient and sustainable.

3. Methods

3.1 Qualitative Analysis based on Expert Opinions

This research uses a qualitative Analysis followed by quantitative analysis with the best-worst method (BWM). Qualitative analysis is a potent and structured research tool that helps to collect data qualitatively. In conducting qualitative analysis, various researchers have used a minimum number of experts to collect the data for better consistency and reliability. For example, Moktadir et al. (2019) considered the opinions of 10 experts to identify the barriers to big data analytics, Murry and Hammons (1995) suggested considering 10–13 experts, and Okoli and Pawlowski (2004) recommended consulting 10–18 experts during data collection. This study took the feedback of 10 experts in identifying strategic drivers.

3.2 Best-Worst Method

The BWM is one of the most popular MCDM tools. It is a powerful and handy MCDM tool that can be used in various complex decision-making problems. The scholar Rezaei in 2015 has invented this handy tool and mentioned its some unique and exciting criteria (Rezaei, 2015).

The applications of BWM in the existing literature have been increasing recently, indicating its popularity in the research field. For example, Moktadir et al. (2019a) investigated the key factors to energy efficiency in the leather domain using BWM and ISM. Moktadir et al. (2020)

evaluated the challenges to circular economy practices in the leather industry using BWM. Kheybari et al. (2019) utilized BWM for Bioethanol facility location selection. Malek and Desai (2019) investigated the barriers to sustainable manufacturing using BWM. Salimi and Rezaei (2018) applied BWM to assess the performance of the firm's R&D department. van de Kaa et al., (2017) employed BWM for biomass thermochemical conversion technology selection. Wan Ahmad et al., (2017) demonstrated the external factors to sustainability in the oil and gas industry using BWM. The systematic and sequential procedure of BWM is explained as follows (Gupta et al., 2017).

Step 1: Identification and fixation of decision-making attributes

In this methodological step, a set of decision-making attributes, herein drivers $\{D_1, D_2,..., D_n\}$ and sub-drivers $\{Sub\text{-}D_1, Sub\text{-}D_2,..., Sub\text{-}D_n\}$, are identified and listed out for the investigation.

Step 2: Determine the best and worst attributes

In this step, decision-makers or practitioners give their opinion to determine the best and worst decision-making attributes (herein drivers and sub-drivers) without any comparison.

Step 3: Construction of comparison vectors of best driver and sub-driver over the other drivers and sub-drivers

In this methodological step, decision-makers help construct the comparison vectors of best driver and sub-driver over the other drivers and sub-drivers using a linguistic 1–9 point rating value. The final companion's vector of drivers and sub-drivers can be shown as follows:

$$A_b = (a_{b1}, a_{b2} ,..., a_{bn})$$

Where, a_{bj} represents the preference of best driver and sub-driver over the other drivers and sub-drivers j. Hence, $a_{bb} = 1$.

Step 4: Construction of comparison vectors of all the other drivers and sub-drivers over the worst driver and worst sub-driver

In this methodological step, decision-makers help construct the comparison vectors of all the other drivers and sub-drivers over the worst driver and worst sub-driver using a 1–9 point rating scale. The final others-to-worst vector companion vectors of drivers and sub-drivers can be exemplified by as follows:

$$A_w = (a_{1w}, a_{2w},...., a_{nw})^T$$

Where, a_{jw} specifies that the preference of the j drivers and sub-drivers over the worst driver and sub-driver and $a_{ww} = 1$.

Step 5: Computation of the optimal weights of drivers and sub-drivers ($W_1^*, W_2^*,..., W_n^*$)

To determine the optimum weights of drivers and sub-drivers (W_1^*, W_2^*,..., W_n^*), the following problem can be formulated to minimize the value of $\{|W_b - a_{bj}W_j|, |W_j - a_{Jw}W_W|\}$ as follows:

$$\min \max_j \{|W_B - a_{bj}Ww_j|, |W_j - a_{jW}W_W|\}$$

$$\text{s.t.}, \sum_j W_j = 1, W_j \geq 0, \text{ for all } j \quad (1)$$

Model 1 can be converted to a linear model as follows:

$$\min \xi^L, \text{ s.t.},$$

$$|W_B - a_{bj}W_j| \leq \xi^L, \text{for all } j, |W_j - a_{jW}W_W| \leq \xi^L, \text{for all } j,$$

$$\sum_j W_j = 1, W_j \geq 0, \text{ for all } j. \quad (2)$$

The best solution of the model mentioned above can be found in Excel Solver and notes the optimal weights of drivers and sub-drivers (W_1^*, W_2^*,..., W_n^*) with acquiring the minimum value of ξ^L. The reliability and better solution of the problem can be determined by the value of ξ^L. The value of ξ^L close to zero indicates better consistency and vice versa.

4. Application of the Proposed Method in the Footwear Industry

The modernization of the footwear industry took place in the late 1980s and strongly contributed to the country's economic development. The latest data from the Export Promotion Bureau (BPB) shows that the revenue generated from the footwear sector in Bangladesh for the financial year 2019-2020 was 478.75 million USD, with negative growth of 21.24% owing to the COVID-19 pandemic (Report_1, 2020). As the infected cases of COVID-19 grew exponentially worldwide in March 2020, the WHO declared the global pandemic on March 11, resulting in a complete shutdown of the footwear industry. Subsequently, the pandemic has resulted in significant financial losses and put enormous pressure on the footwear industry of Bangladesh. To make the footwear supply chain more resilient in the post-COVID-19 period and diminish the post-pandemic effects, it is imperative to understand the nature of each driver that can reduce during and post-pandemic impact of COVID-19. Using qualitative analysis, this study first tries to find the most crucial and essential drivers to tackle the worst situation. Then, it assesses the drivers using a novel MCDM method, BWM, to help managers formulate strategic policy to defeat the impact of COVID-19. The study can be explained in two phases.

Phase-1: Identification of Drivers to Overcome the Impact of COVID-19

The domain experts identified the drivers and sub-drivers in this phase using qualitative analysis. The strategic drivers were identified after reviewing research papers, reports, blogs, and discussions on social media platforms. The following keywords were used to find the strategic drivers: "strategic drivers", "impact of COVID-19", "drivers to mitigate COVID-19 impact" in various databases like ScienceDirect, google, google scholars, Scopus and web of science. Then we collected feedback from domain experts via an online survey tool (Google Form), email communications, and telephone interviews. In this study, more than 20 senior experts from small, medium, and large-scale footwear companies were invited to participate in the primary data collection through email and telephonic conversation. Among them, ten experts participated in data collection of driver identification. The selected footwear companies produce various export-oriented footwear, including Oxford, Derby, Moccasin, Boot, Court, Sandal, and Sports. All experts have 15 years or more of work experience in footwear companies in the areas of production, quality control, supply chain, research and development, and merchandising. The summary of experts is given in Table 1. These experts helped categorize the drivers into the five mainstreams. Under these five streams, with the assistance of domain experts, we identified 25 sub-drivers in the first-round survey. The identified drivers and sub-drivers are listed in Table 2 displayed in Appendix-A.

Table 1: Profile of experts in this study for identifying drivers

<table>
<tr><th>Experts Code</th><th>Code and types of case companies</th><th>Designation of interviewee</th><th>Working Experience (in years)</th><th>Types of products companies produced</th></tr>
<tr><td>E1</td><td>A (large)</td><td>Production manager</td><td>>23</td><td rowspan="10">Various types of export-oriented footwear, including oxford, derby, moccasin, boot, court, sandal.</td></tr>
<tr><td>E2</td><td>A (large)</td><td>Footwear designer</td><td>15</td></tr>
<tr><td>E3</td><td>B (medium)</td><td>Supply chain manager</td><td>21</td></tr>
<tr><td>E4</td><td>B (medium)</td><td>Quality control manager</td><td>16</td></tr>
<tr><td>E5</td><td>C (small)</td><td>Production manager</td><td>17</td></tr>
<tr><td>E6</td><td>C (small)</td><td>Senior merchandiser</td><td>15</td></tr>
<tr><td>E7</td><td>E (large)</td><td>Production manager</td><td>>18</td></tr>
<tr><td>E8</td><td>F (small)</td><td>Merchandizer</td><td>16</td></tr>
<tr><td>E9</td><td>G (large)</td><td>Footwear designer</td><td>>20</td></tr>
<tr><td>E10</td><td>H (medium)</td><td>Supply chain manager</td><td>17</td></tr>
</table>

Phase 2: Assessing the Identified Drivers Using BWM

The identified drivers and sub-drivers are assessed in this phase using BWM. In the second round of the survey, we asked most experienced six experts (E1, E3, E9, E7, E10, and E5) among ten experts to assess the best and worst drivers and sub-drivers (shown in Table B1 in Appendix-B). Next, we assessed the importance of the drivers and sub-drivers, providing the experts with a 1–9 point rating scale shown in Table 3.

Table 3: Assessment scale for BWM analysis

Driver *i* equally important to Driver *j*	Driver *i* equal to moderately more important to Driver *j*	Driver *i* moderately more important to Driver *j*	Driver *i* moderately to strongly more important to Driver *j*	Driver *i* strongly more important to Driver *j*	Driver *i* strongly to very strongly more important to Driver *j*	Driver *i* very strongly more important to Driver *j*	Driver *i* very strongly to extremely more important to Driver *j*	Driver *i* extremely more important to Driver *j*
1	2	3	4	5	6	7	8	9

Perticipated experts helped fill the best for others and others to the worst vector for drivers and sub-drivers. Therefore, with the assistance of equation (2), we calculated the optimal weights for each driver and sub-drivers. For example, in Table 4, it is clearly shown that Expert-1 fills the best to others and others to the worst vector for drivers. Here, Expert-1 indicated *D5* as best and *D4* as worst main drivers. In Table 2, row 2 showed the comparison vector of best to others and row 3 showed the comparison of others to worst vector made by Expert-1. Therefore, the linear model based on equation (2) is constructed as follows:

Min, ξ^L

Subject to,

$|W_{D5} - 6W_{D1}| \leq \xi^L; |W_{D5} - 2W_{D2}| \leq \xi^L; |W_{D5} - 4W_{D3}| \leq \xi^L; |W_{D5} - 7W_{D4}| \leq \xi^L; |W_{D5} - 1W_{D5}| \leq \xi^L;$

$|W_{D1} - 2W_{D4}| \leq \xi^L; |W_{D2} - 4W_{D4}| \leq \xi^L; |W_{D3} - 3W_{D4}| \leq \xi^L; |W_{D4} - 1W_{D4}| \leq \xi^L; |W_{D5} - 7W_{D4}| \leq \xi^L;$

$W_{D1} + W_{D2} + W_{D3} + W_{D4} + W_{D5} = 1;$

$W_{D1}, W_{D2}, W_{D3}, W_{D4}, W_{D5} \geq 0$

The above-mentioned linear model for the main driver for Expert-1 is solved using Excel solver and received the optimal weight of drivers as shown in row 4 of Table 4. Similarly, the best to others and others to the worst vector for main drivers for remaining experts were constructed and linear models were developed and computed the optimal weights.

Table 4: Best/worst driver over the other drivers and the calculated weight of drivers

Expert Code		***D1***	***D2***	***D3***	***D4***	***D5***
E1	Best driver (D5)	6	2	4	7	1
	Worst driver (D4)	2	4	3	1	7
	Optimal weights (ξ^L=0.0497)	0.0861	0.2583	0.1291	0.0596	0.4669
E3	Best driver (D5)	6	3	4	7	1
	Worst driver (D4)	2	6	4	1	7
	Optimal weights (ξ^L=0.1173)	0.1013	0.2027	0.1520	0.0533	0.4907
E9	Best driver (D2)	2	1	6	4	3
	Worst driver (D3)	3	6	1	2	0
	Optimal weights (ξ^L=0.0229)	0.1013	0.2027	0.1520	0.0533	0.4907
E7	Best driver (D3)	6	2	1	4	3
	Worst driver (D1)	1	3	6	4	2
	Optimal weights (ξ^L=0.0888)	0.0533	0.2485	0.4083	0.1243	0.1657
E10	Best driver (D2)	5	1	3	7	2

	Worst driver (D4)	2	7	5	1	3
	Optimal weights (ξ^L=0.0815)	0.1039	0.4379	0.1731	0.0509	0.2342
E5	Best driver (D1)	1	2	5	9	4
	Worst driver (D4)	9	5	2	1	6
	Optimal weights (ξ^L=0.0969)	0.4457	0.2713	0.1085	0.0388	0.1357
Average optimal weights (ξ^L =0.0762)		0.1699	0.3090	0.1733	0.0736	0.2743

Similarly, using equation (2), we computed the optimal weights for each sub-driver under each main category of driver. The best sub-driver over the other sub-drivers and all the other sub-drivers over the worst sub-driver and the calculated weight of sub-drivers for six experts are displayed in Tables B2, B3, B4, B5, and B6 of Appendix-B. Finally, the global weights of each sub-driver were calculated by multiplying the weights of the main driver and sub-driver, and the final ranking is established, as presented in Table 5.

Table 5: Global ranking of each sub-driver along with global weight

Main-Drivers	Weight	Sub-drivers	Weight	Global Weight	Rank
D1	0.16988	D11	0.36323	0.06171	7
		D12	0.45391	0.07711	4
		D13	0.18286	0.03106	13
D2	0.30896	D21	0.20948	0.06472	6
		D22	0.11924	0.03684	11
		D23	0.08392	0.02593	17
		D24	0.27116	0.08378	1
		D25	0.05287	0.01634	21
		D26	0.26333	0.08136	2
D3	0.17329	D31	0.16610	0.02878	14
		D32	0.32389	0.05613	8
		D33	0.07635	0.01323	22
		D34	0.06292	0.01090	24
		D35	0.25892	0.04487	10
		D36	0.11182	0.01938	18
D4	0.07356	D41	0.15421	0.01134	23
		D42	0.08768	0.00645	25
		D43	0.38146	0.02806	15
		D44	0.37665	0.02771	16
D5	0.27430	D51	0.17531	0.04809	9
		D52	0.27275	0.07481	5
		D53	0.28220	0.07741	3
		D54	0.06791	0.01863	20
		D55	0.13366	0.03666	12
		D56	0.06817	0.01870	19

5. Discussions

This section highlights the research findings and beyond expands the debate to understand each driver’s role in reducing the impacts of COVID-19 in the footwear supply chain. The COVID-

19 pandemic resulted in many businesses shutting down their operations, and it has had numerous effects on the global economy. Therefore, it is a crucial and focal point for business organizations to find the drivers that can assist them in surviving in the world market. In this study, we articulated the drivers from domain experts' feedback and, with the help of a novel BWM, assessed how to lessen the impacts of COVID-19 on the footwear business.

The findings revealed that the driver "operations/supply chain (D2)", with the highest weight of 0.30896, received the top ranking. Therefore, the footwear industry should give special care to this driver as it can help drive supply chain operations efficiently during and post the COVID-19 pandemic. Due to restrictions in manufacturing activities and the global economic recession, some industries will have difficulty maintaining their production and timely shipment. In this regard, operations/supply chain drivers can predict the supply-demand relation, minimize the market loss, and help to achieve sustainability, which will significantly help the industry survive in the market (Ball and Lunt, 2019). Without an interactive and agile supply chain network, it is impossible to maintain production and other activities related to the supply chain (Dubey et al., 2019). Therefore, this driver has a significant positive role in the global footwear business. The study performed by Sarker et al. (2021) examined the social sustainability challenges of footwear supply chain considering COVID-19 pandemic. This work did not consider operations releated challenges. Alam et al., (2021) worked on COVID-19 vaccine supply chain challenges towards achieving SDGs, and Barman et al., (2021) analyzed the barriers of COVID-19 on FSC. The previous studies confirmed us that the findings received from this study is unique for the footwear supply chain

The driver "government/policy (D5)" received the second position with the weight of 0.27430 in the final rankings. As the pandemic suddenly impacted the supply chain, it is vital and urgently necessary to support operations managers to overcome the worst scenario by giving financial and policy support. Many countries have already received policy support from their government to overcome the impacts of COVID-19 (Sarkis et al., 2020). Karmaker et al., (2021) suggested that policy development may be a strong driver for achieving sustainability in supply chain. However, they did not consider the footwear supply chain. Hence, this driver will act significantly for industry survival and economic and social sustainability in the competitive world market.

The drivers "technology (D3)," "finance (D1)," and "marketing/promotion (D4)" were rated third, fourth, and fifth with weights of 0.17329, 0.16988, and 0.07356, correspondingly. The importance of each driver for the footwear business is remarkable as it will be difficult to minimize the impacts of COVID-19 without technological development. Many manufacturing industries can track the actual demand and market position and reduce the human control in operations that are strictly prohibited during the pandemic. In this way, they can enhance supply chain efficiency using the latest technologies such as Internet of Things (IoT), artificial intelligence, blockchain, big data analytics, and the data-driven predictive supply chain(Al-Talib et al., 2020). Finance can also be a major driver for the footwear business as financial incentives can give strength to survive in the market (Zhang et al., 2019) and help overcome the impact of COVID-19. Many studies worked on supply chain recovery challenges in other industries for the duration of the COVID-19 pandemic. For example, Barman et al., (2021) analyzed the barriers of COVID-19 on food supply chain, Karmaker et al., (2021) investigated the drivers of supply chain sustainability in the context of emerging economy, Paul, Chowdhury, Chowdhury, et al., (2021) conducted a study to identify and assess the operational challenges of electronic industry supply chain during COVID-19 pandemic, Paul, Chowdhury, Moktadir, et al., (2021) investigated the interactions of recovery challenges of COVID-19 pandemic in the domain of ready-made garments industry supply chain. Surprisingly, no previous study focused the footwear supply chain and investigated the drivers to overcome impact of COVID-19 pandemic. Moreover, the driver "marketing/promotion (D4)" is not negligible as promotion and marketing are vital activities for business firms. Without a marketing and promotion facility, it is tough to gain market share, and there is a significant chance of loss in the footwear market during the COVID-19 pandemic. Therefore, operations managers should focus on developing active and reactive approaches considering the study's findings. The previous studies either worked on recovery challenges (Barman et al., 2021; Paul, Chowdhury, Chowdhury, et al., 2021; Paul, Chowdhury, Moktadir, et al., 2021) or the strategies (Raj et al., 2022; Paul, Moktadir, & Ahsan, 2021; Paul, Moktadir, Sallam, et al., 2021) in the context of other industries to defeat the effect of the COVID-19 pandemic. In addition, no study offered any promotional drivers for alleviating the impacts of the COVID-19 pandemic.

5.1 Finance (D1) Related Drivers

In this category of driver, the drivers "government support through incentives, subsidy, tax rebate, etc. (D12)," "price flexibility system of raw material (D11)," and "financial assistance (loan, tax cut, cash handouts as a last resort) to the manufacturer (D13)" received first, second and third position and fourth, seventh and thirteenth in the global rank with weights of 0.07711, 0.06171, and 0.03106, respectively. The findings revealed that "government support through incentives, subsidy, tax rebate, etc." can minimize the impact of COVID-19 and assist in surviving. "Price flexibility of raw materials" may help small and medium enterprises to minimize loss due to its positive impact on production. "Financial assistance (loan, tax cut, cash handouts as a last resort) to the manufacturer" will be motivational drivers to run production and thus help survival in the global competition during COVID-19. The findings are also supported by the recent report by a leading newspaper that export earnings in leather footwear from July 2019 to June 2020 declined by 21.24%., with 70% of shipments canceled due to COVID-19 issues (Prothom Alo Report, May 18, 2020). Therefore, it is strongly indicated that financial drivers may help the footwear industry overcome the post-pandemic impacts.

5.2 Operations/Supply Chain (D2) Related Drivers

Among the "operations/supply chain (D2)" driver, "high capability of reconfigurability (D24)" received the paramount position in the global rank carrying the weight of 0.08378. It means the high reconfigurability of the supply chain positively influences minimizing the post-pandemic impact of COVID-19. It will assist in maintaining the balance between supply and demand and running the production by maintaining a physical distance. The industry with a high capability of reconfigurability has a high chance of reducing the alleviation of post-pandemic impacts of COVID-19. Therefore, operations managers can try reconfigure their supply chains to sustain and minimize the impacts. The driver "enhance the relationship with suppliers (D26)" acquired the second position in the global rank with a weight of 0.08136. This indicates that the footwear industry can reduce the impacts by building a good relationship with suppliers. In this regard, the collaborative supply chain framework may assist operations managers in running production. Otherwise, the supply will be stopped, which will create huge impacts on business and uncontrolled loss (Nadeem et al., 2019). The footwear industry needs various raw materials from multiple suppliers. Therefore, it is imperative to maintain good relations with suppliers to ensure continuous production.

The driver "high level of disruption risk management facility (D21)" attained the third position in this stream with a global weight of 0.06472. As COVID-19 is a distinctive kind of supply chain disruption, the footwear industry needs a high level of risk management facility, which may assist in reducing the impact. Without a high level of disruption management facility, it will be impossible to handle such unique disruption risks (Ethirajan et al., 2021). Accordingly, the drivers "high level of supply chain flexibility (D22)," "develop intertwined and agile supply networks (D23)," and "robustness in manufacturing activities (D23)" took the fourth, fifth, and sixth positions in this category with weights of 0.03684, 0.02593, and 0.01634, respectively. They all have a strong positive influence on minimizing the post-pandemic impact on the footwear sector of Bangladesh. The driver "high level of supply chain flexibility" can help change the production system and material sourcing and enhance the efficiency of the supply chain in the pandemic situation. Also, the driver "develop intertwined and agile supply networks" can help respond to the supply chain more effectively during and post-pandemic. Without an agile ISN, it is difficult to maintain the relationship between buyers and suppliers and minimize the impacts on the supply chain (Choi et al., 2019). Next, the driver "robustness in manufacturing activities" means resilience to the production system and process can help the footwear industry streamline and run production during the COVID-19 pandemic. All these drivers significantly positively influence the footwear supply chain regarding reducing post-pandemic impacts.

5.3 Technology (D3) Related Drivers

Among the technology (D3) related drivers, the driver "follow data-driven predictive supply chain (D32)" received the first position in this group with a weight of 0.05613. It means the data-driven predictive supply chain framework can enhance the supply chain efficiency during the pandemic by analyzing real-time data, thereby significantly helping to minimize the impact of COVID-19 in the footwear business. This driver has proven its importance in many countries. For example, Taiwan and South Korea were more robust during the pandemic because they used data-driven pandemic supply chains to help minimize the risk significantly. Next, the driver "high level of preparedness using AI (D35)" took the second position in this group carrying the weight of 0.04487. It may help predict the actual demand, crisis, and strategies for overcoming the worst situation in the context of COVID-19.

The drivers "IoT based communication platform (D31)," "innovation and design thinking plan (D36)," "application of big data analytics (D33)," and "flexible production technologies (D34)" received the third, fourth, fifth and sixth place in this stream carrying optimalweights of 0.02878, 0.01938, 0.01323, and 0.01090, individually. IoT-based communication platforms can help streamline communication among suppliers, manufacturers, and buyers. It is imperative to innovate and design a thinking plan to tackle the impact of COVID-19, as supply chain activities drastically changed during the pandemic. An innovative and design thinking plan can help make the new policy, streamlining the production facility efficiently. Next, applying big data analytics can help understand the global scenario and make decisions regarding footwear production and marketing. Flexible production technologies-like automation, including ERP, Robotics-can streamline production activities as COVID-19 is changing the concept of production and distribution. Hence, it will enhance supply chain activities as well as efficiency.

5.4 Marketing/Promotion (D4) Related Drivers

Good marketing or promotion policy related to the footwear business has a significant impact on the footwear business. As COVID-19 changed our traditional thinking and systems, it is imperative to think of a better marketing strategy to reduce the COVID-19 impacts. In this study, four drivers-"build marketing policy regarding supply chain collaboration (D43)," "faster transportation facility of finished goods (D44)," "motivate buyers by offering price discount (D41)," and "achieving high level of survivability adopting promotion activities (D42)" placed first, second, third and fourth in this group with optimal global weights of 0.02806, 0.02771, 0.01134, and 0.00645, respectively. To reduce the impact of COVID-19, all these drivers can contribute significantly. A strong supply chain collaborative marketing policy could help industry practitioners/operations managers diminish the impacts of COVID-19 and ensure faster transportation of finished goods by adopting tactical policies like launching e-commerce sites and building their own transportation facility. Offering a price discount in this pandemic situation can motivate buyers to be active in business, which will ultimately help reduce the post-pandemic impacts. Promotional activities of the footwear industry may help market survival as people are far away from the super shop and regular business activities are difficult. Therefore, effective promotional activities for solvability can act as a driver of post-pandemic impact reduction.

5.5 Government/Policy (D5) Related Drivers

The government of Bangladesh has declared some financial incentives for industry owners to reduce the impact of COVID-19 in the footwear business. Many regular shipments have been canceled due to the pandemic outbreak, which has created tremendous pressure on the footwear industry. Many buyers have stopped sourcing footwear from Bangladesh. Therefore, it is essential to understand government and policy-related drivers for reducing COVID-19 impacts in the footwear business. In this study, we identified six policy-related drivers to help the footwear industry tackle the effects of the COVID-19 pandemic. The findings revealed that the driver "set policy to ensure stable material supply (D52)," with a global weight of 0.07481, was placed first in this category. This indicates that the policy regarding materials sourcing facility can drive the operations managers to continue manufacturing. Next, the driver "develop health protocols to continue manufacturing (D53)" carrying the global weight of 0.07741 acquired the second position in this group. As COVID-19 is highly contagious, it is necessary to develop a working protocol to protect humans that will drive the manufacturing activities during this pandemic outbreak. Accordingly, the findings indicated that the drivers "maintain a balance between supply and demand (D51)," "improve start-up policy for creating jobs

(D54)," "employment management-hours based employment/create option, etc. (D56)," and "develop sustainable recovery policy (D54)" were ranked third, fourth, fifth and sixth with global optimal weights of 0.04809, 0.03666, 0.01870, and 0.01863, consequently. These drivers can improve supply chain efficiency in this critical pandemic time. It is impossible to reduce loss without proper maintenance between supply and demand. Balancing is crucial to maintaining business performance. Next, setting up policies for creating jobs may help reduce the impacts by creating job opportunities; hour-based employee opportunities may help the industry minimize loss.

5.6 Sensitivity Analysis

In this study, we conducted a sensitivity analysis to understand the stability of the ranking of drivers by changing the weight of the main paramount drivers and checking the impact on the other drivers. Many researchers examine the stability of ranking by varying the weight of top-ranked criteria from 0.1 to 0.9 and checking the variation of the ranking of the sub-criteria (Kaushik et al., 2020). In this study, we varied the weight of paramount driver "operations/supply chain (D2)" in the range of 0.1 to 0.9 and investigated the variation in ranking in the sub-drivers. The weight variation of driver "operations/supply chain (D2)" from 0.1 to 0.9 is shown in Table 6. Accordingly, the weights of other drivers are varied based on the weight change of the paramount driver.

Table 6: Weight variation of the main driver for sensitivity analysis

Main drivers	**Normal weight (0.3090)**	**Weights variations ranges of main drivers**								
		.100	**.200**	**.300**	**.400**	**.500**	**.600**	**.700**	**.800**	**.900**
D1	.1699	.2213	.1967	.1721	.1475	.1229	.0983	.0738	.0492	.0246
D2	.3090	.1000	.2000	.3000	.4000	.5000	.6000	.7000	.8000	.9000
D3	.1733	.2257	.2006	.1755	.1505	.1254	.1003	.0752	.0502	.0251
D4	.0736	.0958	.0852	.0745	.0639	.0532	.0426	.0319	.0213	.0106
D5	.2743	.3572	.3175	.2779	.2382	.1985	.1588	.1191	.0794	.0397
Total	1	1	1	1	1	1	1	1	1	1

According on the weight variation shown in Table 6, the weights of the sub-driver are calculated and shown in Table 7.

Table 7: Weight variation of sub-driver for sensitivity analysis

Sub-drivers	**Weights variations ranges of sub drivers**									
	Normal weights (.3090)	**.1000**	**.2000**	**.3000**	**.4000**	**.5000**	**.6000**	**.7000**	**.8000**	**.9000**
D11	.0617	.0804	.0714	.0625	.0536	.0446	.0357	.0268	.0179	.0089
D12	.0771	.1004	.0893	.0781	.0670	.0558	.0446	.0335	.0223	.0112

D13	.0311	.0405	.0360	.0315	.0270	.0225	.0180	.0135	.0090	.0045
D21	.0647	.0209	.0419	.0628	.0838	.1047	.1257	.1466	.1676	.1885
D22	.0368	.0119	.0238	.0358	.0477	.0596	.0715	.0835	.0954	.1073
D23	.0259	.0084	.0168	.0252	.0336	.0420	.0503	.0587	.0671	.0755
D24	.0838	.0271	.0542	.0813	.1085	.1356	.1627	.1898	.2169	.2440
D25	.0163	.0053	.0106	.0159	.0211	.0264	.0317	.0370	.0423	.0476
D26	.0814	.0263	.0527	.0790	.1053	.1317	.1580	.1843	.2107	.2370
D31	.0288	.0375	.0333	.0292	.0250	.0208	.0167	.0125	.0083	.0042
D32	.0561	.0731	.0650	.0569	.0487	.0406	.0325	.0244	.0162	.0081
D33	.0132	.0172	.0153	.0134	.0115	.0096	.0077	.0057	.0038	.0019
D34	.0109	.0142	.0126	.0110	.0095	.0079	.0063	.0047	.0032	.0016
D35	.0449	.0584	.0519	.0455	.0390	.0325	.0260	.0195	.0130	.0065
D36	.0194	.0252	.0224	.0196	.0168	.0140	.0112	.0084	.0056	.0028
D41	.0113	.0148	.0131	.0115	.0098	.0082	.0066	.0049	.0033	.0016
D42	.0064	.0084	.0075	.0065	.0056	.0047	.0037	.0028	.0019	.0009
D43	.0281	.0365	.0325	.0284	.0244	.0203	.0162	.0122	.0081	.0041
D44	.0277	.0361	.0321	.0281	.0241	.0200	.0160	.0120	.0080	.0040
D51	.0481	.0626	.0557	.0487	.0418	.0348	.0278	.0209	.0139	.0070
D52	.0748	.0974	.0866	.0758	.0650	.0541	.0433	.0325	.0217	.0108
D53	.0774	.1008	.0896	.0784	.0672	.0560	.0448	.0336	.0224	.0112
D54	.0186	.0243	.0216	.0189	.0162	.0135	.0108	.0081	.0054	.0027
D55	.0367	.0477	.0424	.0371	.0318	.0265	.0212	.0159	.0106	.0053
D56	.0187	.0244	.0216	.0189	.0162	.0135	.0108	.0081	.0054	.0027
Total	1	1	1	1	1	1	1	1	1	1

Based on the calculated weights of sub-driver, the final ranking was obtained and shown in Table 8 and Figure 1, confirming the results' consistency. It is observed from Table 8 and Figure 1 that, for the weight variation from 0.1 to 0.9, there are little variations in the ranking of sub-drivers. For example, for changing weight from a normal weight 0.3090 to 0.3, the ranking of drivers D22 and D55 changed to 12 and 11, respectively.

Finally, the ranking during sensitivity analysis based on weights obtained in Table 7, the ranking of sub-driver is made and presented in Table 8 and Figure 1.

Table 8: Final ranking of sub-driver during sensitivity analysis

Sub-drivers	Weights variations ranges of sub drivers									
	Normal weights (0.3090)	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
D11	7	4	4	7	7	8	9	10	10	10
D12	4	2	2	4	5	6	7	8	8	8
D13	13	9	12	13	14	15	15	15	15	15
D21	6	18	11	6	3	3	3	3	3	3
D22	11	22	16	12	9	4	4	4	4	4
D23	17	24	20	17	12	9	5	5	5	5

D24	1	13	7	1	1	1	1	1	1	1
D25	21	25	24	21	18	14	11	6	6	6
D26	2	14	8	2	2	2	2	2	2	2
D31	14	10	13	14	15	16	16	16	16	16
D32	8	5	5	8	8	10	10	11	11	11
D33	22	19	21	22	22	22	22	22	22	22
D34	24	21	23	24	24	24	24	24	24	24
D35	10	7	9	10	11	12	13	13	13	13
D36	18	15	17	18	19	19	19	19	19	19
D41	23	20	22	23	23	23	23	23	23	23
D42	25	23	25	25	25	25	25	25	25	25
D43	15	11	14	15	16	17	17	17	17	17
D44	16	12	15	16	17	18	18	18	18	18
D51	9	6	6	9	10	11	12	12	12	12
D52	5	3	3	5	6	7	8	9	9	9
D53	3	1	1	3	4	5	6	7	7	7
D54	20	17	19	20	21	21	21	21	21	21
D55	12	8	10	11	13	13	14	14	14	14
D56	19	16	18	19	20	20	20	20	20	20

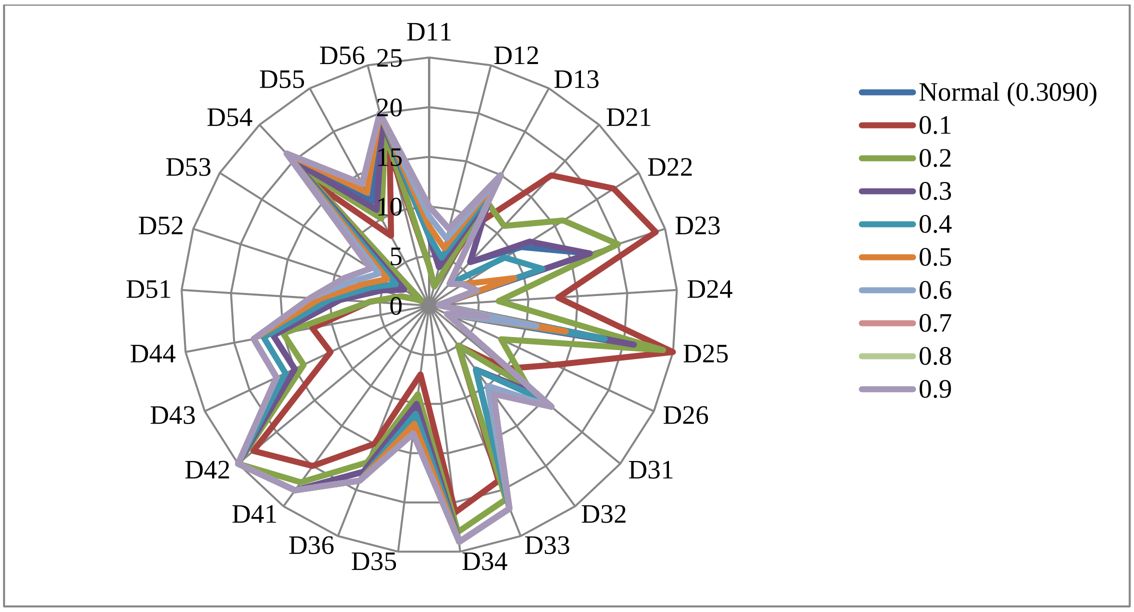

Figure 1: Graphical presentation sensitivity analysis

6. Implications and framework development

This study provides significant theoretical and practical implications for academics and practitioners to better understand and handle the effects of the COVID-19 pandemic. Previous studies investigated the impact of COVID-19 and suggested strategies to tackle the pandemic's effects in the contexts of food and beverage, food supply chain, the airline supply chain, and the GSCs (Chowdhury et al., 2020; Barman et al., 2021; Belhadi et al., 2021; Dubey et al., 2021). The findings of this study contribute to practice by providing a better understanding of each driver, which will assist operations managers in formulating better policies and strategies toward recovering the effect of COVID-19 in the footwear supply chain. This study advances the theoretical supply chain recovery literature under the pandemic outbreak condition in three ways. First, the offers to assess the drivers to defeat the effects of the pandemic outbreak in the domain of the footwear supply chain. This research is crucial for the footwear supply chain to improve its operational excellence and ensure a continuous manufacturing process. Second, findings contribute to stakeholder theory by providing insights into each driver that will help footwear supply chain stakeholders to decrease the impacts of the COVID-19 pandemic. Third, this study adds to supply chain resilience theory by delivering a clear concept of drivers and their impacts on the footwear supply chain, which will help decision-makers improve their supply chains' resilience and sustainability.

The following strategic research themes are proposed as implications of the study for conducting future research to overcome the impacts of the COVID-19 pandemic in various manufacturing industries.

6.1 Theme 1: Enhancing Manufacturing Network Diversification

Businesses and operations are becoming global, and it is becoming crucial for firms to make diversification of their plants all around the globe to compete in this rapidly evolving global economy (Canel and Khumawala, 2001; Norris et al., 2021). Also, operations/production management and manufacturing engineering have faced a rapid transformation in the concept of manufacturing systems from plant focus to international manufacturing networks (Cheng et al., 2015). Numonjonovich and Nodirjon (2021) opined that diversification is an important tool that eliminates imbalances in reproduction involving the redistribution of resources. The current study's findings revealed that operations/supply chain is the most significant and strong driver in minimizing the market loss and managing supply-demand relations. Also, it is critical to maintain production and operations without an agile manufacturing system (Xu et al., 2003). The high level of diversification gives a competitive advantage to domestic companies by helping firms to develop product differentiation and cost leadership. Thereby, firms can adopt diversification with improved market shares and enhanced integrated operations (Huo and Chaudhry, 2021).

Bobillo et al. (2010) conducted their study on 1500 manufacturing firms in five European countries to identify the relation between firm performance and international diversification. Their results found that the country's institutional factors affect international diversification strategies and firms' capabilities. Chang (2021) used a grey situation decision-making algorithm to detect the most appropriate country for manufacturing base movement for the footwear industry during the COVID-19 pandemic and focused on network diversification for sustainable operations. Another finding of the current study revealed the importance of technology as a crucial driver for the manufacturing footwear business to tackle the effect of the COVID-19 pandemic. In support of this, Huo and Chaudhry (2021) reported the usage of machine learning techniques and a framework for location decisions in the global network of the manufacturing sector. Thus, we propose the following propositions grounded on our findings and support literature.

P1: In the light of the COVID-19 pandemic, it is crucial to propose an AI technology-enabled framework to analyze the advantages of the manufacturing network diversification model.

P2: Future studies should focus on analytical model enhancement to make comparative studies between pre, and post COVID-19 periods to analyze the adaptability and efficiency of proposed models.

6.2 Theme 2: Multi-sourcing

Multi-sourcing mainly occurs when suppliers with similar abilities offer similar services to the customers (Cohen and Young, 2006). Adopting multi-sourcing by firms is encouraged by industry experts by forecasting general cost savings and strategic and operational risk reduction (Cohen and Young, 2006). Multi-sourcing is an obvious way to mitigate this risk. According to Wilhelm et al. (2016), firms outsource third parties and use their supply chain network collaborations with multi-level suppliers to comply with demand and supply. Likewise, our findings suggested that the driver "enhance the relationship with suppliers" is an important factor in overcoming the impact of COVID-19 in managing operations. In this regard, a collaborative supply chain and material sourcing can ensure optimum production during disruption. Therefore, operations managers should build good relationships to ensure transportation facilities with the support that can reduce the impacts of COVID-19 in the footwear business. Amiri-Aref et al. (2018) proposed a two-stage stochastic mathematical model for supply chain network profit maximization by focusing on multi-sourcing and uncertain demand. In another study, Ozsen et al. (2009) reported multi-sourcing as a more valuable option and discussed its impact by establishing a capacitated location-inventory model to reduce the transportation cost, location costs, and inventory costs. Thus, the findings of this study and previous literature motivate us to propose the following propositions.

P3: To compare different cases of multi-sourcing using several case studies to provide evidence for supply chain resiliency post-COVID-19 pandemic.

P4: To investigate the integration of multi-sourcing policies in light of a sudden upsurge in demand and develop an efficient heuristic approach to solve problems due to pandemics.

6.3 Theme 3: Enhancing Local Supply Network

Today, local markets and firms are extensively interlinked and form a complex network of value and supply chains (Otto et al., 2017; Upadhyay et al., 2021). The broad and distinct challenges that occurred due to the COVID-19 pandemic in supply networks required resilience strategies were only a few considered resiliencies from a network-level perspective (Azadegan and Dooley, 2021). The current study's findings revealed that a high level of disruption risk management facility significantly reduces disruptions caused by the COVID-19 pandemic. Hence, creating or enhancing an agile local supply network will enable a smooth flow of resources and manage manufacturing operations during sudden disruptions. Many companies prioritize manufacturing in a sustainable way and in less time which could be possible by gaining the advantage of keeping production activities limited to the local network (Macchion et al., 2015).

Sharma et al., (2020) focused on the local network to tackle COVID-19 disruptions and developed a framework using the Stepwise Weight Assessment Ratio Analysis framework to help create sustainable supply chains during and post COVID-19 pandemic. Sudden disruptions and uncertain situations have compelled supply chains to collaborate with several networks to reduce risk and uncertainty (Madsen and Petermans, 2020). Azadegan and Dooley (2021) asserted that for supply network resilience, existing literature focused on private or micro-level collaborations. In addition, Modgil et al., (2021) examined AI's role in enhancing supply chain resilience through distribution capabilities, risk sourcing, and developing visibility. Thus, we propose the following propositions based on our findings and support literature.

P5: To promote and enhance local supply networks through technological advancements to combat risks associated with pandemics.

P6: To create a resilient supply network model across different industry sectors to resolve disruption-related issues and better understand resilience.

6.4 Theme 4: Buffering Inventory and Capacity

Buffer capacity is an easy way to enhance resilience by underutilized production facilities or more safety stock requirements of inventory. A robust supply chain retains a large buffering capacity. However, a more resilient supply chain can endure large shocks but retain its original process and structure (Simmie and Martin, 2010). The buffering strategies aim to minimize the companies' exposure to risks and disruptions by creating capacity, inventory, cost buffers, and lead time (Manhart et al., 2020). According to Novak et al. (2021), a buffering strategy in a current pandemic is to stock up personal protection equipment to combat upcoming disruptions concerning the company's production capacity.

Our findings support these strategies as it revealed that the drivers "high level of disruption risk management facility" and "robustness in manufacturing activities" took third and fourth place according to their significance. As the COVID-19 pandemic is an exceptional kind of disruption risk for the supply chain. It can be handled by facilitating a high level of disruption risk management facility, which can help minimize the impacts of disruption. Thus, the findings of this study and previous literature motivate us to propose the following propositions.

P7: To explore how buffering strategies could impact flexibility in the supply chain during or post-pandemic.

P8: To identify the impact of different dimensions of buffering strategies on different dimensions of supply chain performance.

6.5 Theme 5: Harmonization

Harmonization prevents or eliminates differences in the technical matter of standards with the same scope (Richen and Steinhorst, 2005). The harmonization offers a clear understanding to compare different process variants' performance. Supply chain flexibility is an imperative concept for gaining a competitive benefit, and by using strategic supply chain networks, considerable advancements can be achieved in supply chain flexibility (Winkler, 2009). If the network is more regionalized, then plant technology needs to be more harmonized to ensure the smooth movement of products across the network. Likewise, the findings of this study revealed another two most important drivers "high capability of reconfigurability" and "enhance the relationship with suppliers". This indicates that harmonizing the technology and supply chain processes allow firms to overcome unexpected risks and disturbances caused by the pandemic, which could contribute to resiliency in the supply chain. Thus, we propose:

P9: To focus on harmonized plant technology and identify its advantages and barriers in designing a resilient supply chain during or post COVID-19 pandemic.

P10: To provide evidence of harmonization strategies by empirical projects and validating or testing the arguments.

6.6 Theme 6: Ecosystem Partnerships

The finding shows that technological drivers like "follow data-driven predictive supply chain" and "IoT based communication platform" are the important drivers to ensure the smooth running of supply chain processes during the COVID-19 pandemic. In addition, the "IoT based communication platform" driver can enable effective communication between manufacturers, suppliers, and customers. This will create a strong relationship between manufacturers and suppliers and help diversify the production and distribution processes in different countries. To its importance, Chen et al. (2007) used data envelopment analysis (DEA) model to assess the quality of information for manufacturers, retailers, suppliers, and distributors in a multi-echelon supply chain. Also, the probabilistic linear programming method can effectively enhance the partnerships among manufacturers and distributors in an uncertain environment in supply chains (Chang, 2021). Thus, the findings of this study and previous literature motivate us to propose the following propositions.

P11: To develop an AI-based supply chain model which can identify the ecosystem partnerships to help improve resiliency in the supply chain.

P12: To identify the barriers and drivers of ecosystem partnership among stakeholders in the supply chain during or post COVID-19 disruptions.

6.7 COVID-19 impacts mitigating strategic framework:

The above-mentioned six strategic themes can improve the supply chain resilience during and post COVID-19 periods. The in-depth investigation of these themes is essential to ensure the sustainability and resilience of the supply chain. The further explanation could be helpful for the supply chain managers to mitigate the disruption risks like the COVID-19 pandemic. Hence, a conceptual model, shown in Figure 2, has been developed based on the six themes, which could improve supply chain resilience. The conceptual model further helps mitigate the impacts of disruption risks by ensuring the supply chain activities.

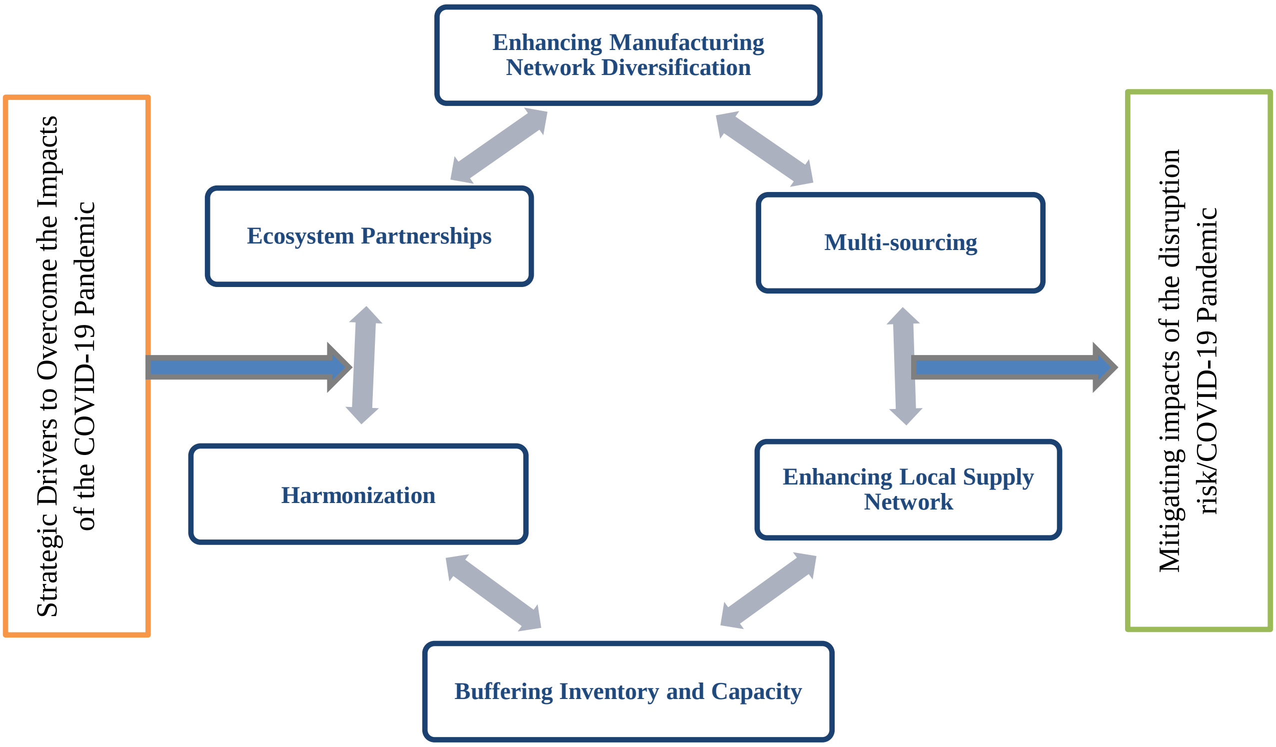

Figure 2: A conceptual framework to mitigate the impacts of the COVID-19 pandemic

7. Conclusions

The recent COVID-19 pandemic has informed researchers, policymakers, operations managers, industry owners, and practitioners that this outbreak destructively impacts the entire supply chain. Therefore, the study theoretically contributes to the operations management literature by advancing the insight of the drivers to reduce the impacts of the recent global pandemic outbreak of COVID-19. The study provides new and most demanding information by identifying and assessing a new set of drivers regarding the impacts of COVID-19 on the footwear supply chain. In this study, a practical decision-making tool comprising qualitative analysis and quantitative BWM was proposed to identify and examine the drivers for the footwear supply chain. We have identified twenty-five drivers under the five main groups of drivers using qualitative analysis based on domain experts' feedback. After that, the study extended by evaluating the importance of the identified drivers via novel BWM. Further study has been broadened by conductive sensitivity analysis to understand the stability of the results.

The findings implied that the footwear industry should pay more attention to the most significant drivers to minimize the impacts of COVID-19. The industry has a high capability of reconfiguring the supply chain network and has a better chance of minimizing the impacts of COVID-19. Similarly, a good relationship among suppliers and business partners may improve supply chain efficiency by reducing the post-pandemic impacts of COVID-19. Accordingly, effective health protocols, government support, and policy regarding materials supply stability will positively impact supply chain sustainability and resilience.

This study is one of few preliminary attempts to diminish the impact of the COVID-19 pandemic on supply chains. One of the key limitations of this study is that the study only finds the importance of the drivers. However, it is necessary to know the interrelationship among drivers to form the short- to long-term strategic policy for effective decisions.

The study can be extended using the different optimization and intelligent decision making tools. This study was primarily staged of COVID-19 research for the footwear supply chain. It can be extended by focusing on the key themes of the supply chains, methodological innovation or contribution, and theoretically grounded research by developing hypotheses.

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Appendix-A

Table 2: List of identified drivers and sub-drivers

Main-Drivers	ID	Sub-Drivers	Definition
Finance (D1)	D11	Price flexibility system of raw material	This driver can assist manufacturers in lowering the impacts of COVID-19 as it can help achieve sustainability when the product price is fistulated at the market.
	D12	Government support through incentives, subsidies, tax rebates, etc.	This driver can help supply chain practitioners to reduce the financial crisis due to COVID-19.
	D13	Financial assistance (loan, tax cut, cash handouts as a last resort) to manufacturer	Financial assistance will motivate the manufacturers to run their businesses during COVID-19. Further, this driver can give extra strength to sustain the world market.
Operations/supply chain (D2)	D21	High level of disruption risk management facility	A high level of disruption risk management facility means a high capacity to tackle the sudden risk that can help reduce the impacts of COVID-19.

	D22	High level of supply chain flexibility	The ability of a high level of supply chain flexibility may support the practitioners to modify structure of supply chain network as required for the COVID-19 crisis.
	D23	Develop intertwined and agile supply networks	It means that the supply chain system is very flexible and comfortable, which can smoothen the supply chain operations most easily.
	D24	High capability of reconfigurability	As COVID-19 is a special type of supply chain crisis, the high capability of reconfigurability can help to continue the supply chain operations.
	D25	Robustness in manufacturing activities	Gaining robustness in manufacturing activities can reduce the impact of COVID-19. This driver is essential for sustainable supply chain operations.
	D26	Enhance the relationship with suppliers	COVID-19 impacts supply chain performance dramatically due to the lack of sustainable suppliers. Therefore, a good relationship among suppliers can help minimize the effect of COVID-19 by ensuring the continuous supply of materials.
Technology (D3)	D31	IoT based communication platform	Social distancing is the key issue for minimizing the infectious disease of COVID-19. Therefore, IoT-based communication platforms may assist manufacturers in reducing the health risk for their employees.
	D32	Follow data driven predictive supply chain	Data driven predictive supply chain may help the manufacturer predict the upcoming market demand and changes due to COVID-19, which may assist supply chain practitioners in taking necessary action plans.
	D33	Application of Big data analytics	The application of big data analytics may reduce the impacts of COVID-19 as it can help analyze the big data to make an effective decision.
	D34	Flexible production technologies	Flexible production technologies can assist in reducing human control in the manufacturing system that could be the better option for supply chain at the time of COVID-19.
	D35	High level of preparedness using AI	Artificial intelligence assists manufacturing systems in reducing human control and thus will ultimately lower the effects of COVID-19 in supply chain.
	D36	Innovation and design thinking plan	This driver can help practitioners make the required plans and design the supply chain to continue the manufacturing process during the crisis period.
Marketing/Promotion (D4)	D41	Motivate buyers by offering price discount	Price discounts may motivate the buyers to continue their business activities during the COVID-19 crisis.
	D42	Achieving high level of survivability adopting promotion activities	Promotion activities may help business organizations to achieve a high level of survivability during the COVID-19 crisis.
	D43	Build marketing policy regarding supply chain collaboration	Building a strong marketing policy focusing COVID-19 crisis may assist in sustaining in the global competitive market.
	D44	Faster transportation facility of finished goods	With border closure due to COVID-19, it is essential to make the alternative trade policy to continue the transportation facility faster for

			finished goods, which may assist in reducing the impacts of COVID-19.
Government/policy (D5)	D51	Maintain balanced between supply and demand	Based on the market demand, manufacturers should focus on the manufacturing process that will help reduce business losses.
	D52	Set policy to ensure stable material supply	Strong policy considering the COVID-19 crisis may help continue the materials supply, which is the crucial driving factor for a continuous manufacturing system.
	D53	Develop health protocols to continue manufacturing	As COVID-19 is a serious infectious disease, developing health protocol may help reduce the death rate and avoid the risk of infection at the manufacturing site.
	D54	Develop a sustainable recovery policy	Developing a recovery policy is an essential driver for the manufacturers to reduce or minimize the impacts of COVID-19.
	D55	Improve Start-up policy for creating jobs	Start-up policy may help create job opportunities for unemployment during the COVID-19 period. This driver can assist enhance the sustainability of human resource management, which can reduce the impact of COVID-19 on human resources.
	D56	Employment Management-hours based employment/ create option etc.	This driver can give an idea to handle the employees during the COVID-19 crisis.

Appendix-B

Table B1: Determined best and worst drivers and sub-drivers with the help of six experts

Drivers and Sub-drivers	Best drivers and sub-drivers indicated by experts	Worst drivers and sub-drivers indicated by experts
Finance (D1)	E5	E7
D11	E1, E10	E7
D12	E3, E9, E5	
D13	E7	E1, E3, E9, E10, E5
Operations/supply chain (D2)	E9, E10	
D21	E1	
D22		
D23		E3
D24	E9, E7, E5	
D25		E1, E9, E7, E10, E5
D26	E3, E10	
Technology (D3)	E7	E9
D31		
D32	E1, E3, E7, E5	
D33		E9, E7, E5
D34		E1, E3, E10
D35	E9, E10	
D36		
Marketing/Promotion (D4)		E1, E3, E10, E5
D41		E3
D42		E1, E9, E7, E10, E5
D43	E1, E3, E10	
D44	E9, E7, E5	
Government/policy (D5)	E1, E3	
D51		
D52	E1, E3, E5	
D53	E9, E7, E10	

D54		E3, E7, E10
D55		
D56		E1, E9, E5

Table B2: The comparison matrix of best satategic sub-driver over the other and all the other satategic sub-drivers over the worst and the computed optimal weight for driver Finance (D1)

Expert Code		D11	D12	D13
E1	Best sub-driver (D11)	1	2	6
	Worst sub-driver (D13)	6	5	1
	Optimal weights (ξ^L =0.0833)	0.5833	0.3333	0.0833
E3	Best sub-driver (D12)	3	1	7
	Worst sub-driver (D13)	5	7	1
	Optimal weights (ξ^L =0.1231)	0.2615	0.6615	0.0769
E9	Best sub-driver (D12)	3	1	5
	Worst sub-driver (D13)	2	5	1
	Optimal weights (ξ^L =0.0250)	0.2615	0.6615	0.0769
E7	Best sub-driver (D13)	4	3	1
	Worst sub-driver (D11)	1	2	4
	Optimal weights (ξ^L =0.0571)	0.1429	0.2286	0.6286
E10	Best sub-driver (D11)	1	4	7
	Worst sub-driver (D13)	7	2	1
	Optimal weights (ξ^L =0.0167)	0.7167	0.1833	0.1000
E5	Best sub-driver (D12)	3	1	7
	Worst sub-driver (D13)	4	7	1
	Optimal weights (ξ^L =0.0833)	0.2500	0.6667	0.0833
Average optimal weights (ξ^L =0.0648)		0.3632	0.4539	0.1829

Table B3: The comparison matrix of best satategic sub-driver over the other and all the other satategic sub-drivers over the worst and the computed optimal weight for driver Operations/supply chain (D2)

Expert Code		D21	D22	D23	D24	D25	D26
E1	Best sub-driver (D21)	1	3	4	6	9	2
	Worst sub-driver (D25)	9	4	3	2	1	6
	Optimal weights (ξ^L =0.0314)	0.4084	0.1466	0.1099	0.0733	0.0419	0.2199
E3	Best sub-driver (D26)	3	4	7	2	5	1
	Worst sub-driver (D23)	5	3	1	4	2	7
	Optimal weights (ξ^L =0.0705)	0.1498	0.1124	0.0441	0.2248	0.0899	0.3790
E9	Best sub-driver (D24)	2	5	4	1	7	3
	Worst sub-driver (D25)	5	2	3	7	1	4
	Optimal weights (ξ^L =0.0487)	0.2190	0.0876	0.1095	0.3893	0.0487	0.1460
E7	Best sub-driver (D24)	3	4	7	1	9	2
	Worst sub-driver (D25)	4	3	2	9	1	7
	Optimal weights (ξ^L =0.0493)	0.1512	0.1134	0.0648	0.4043	0.0394	0.2268
E10	Best sub-driver (D26)	2	4	5	3	7	1
	Worst sub-driver (D25)	5	3	2	4	1	7
	Optimal weights (ξ^L =0.0487)	0.2190	0.1095	0.0876	0.1460	0.0487	0.3893
E5	Best sub-driver (D24)	4	3	5	1	7	2
	Worst sub-driver (D25)	3	4	2	7	1	5
	Optimal weights (ξ^L =0.0487)	0.1095	0.1460	0.0876	0.3893	0.0487	0.2190
Average Optimal weights (ξ^L =0.0495)		0.2095	0.1192	0.0839	0.2712	0.0529	0.2633

Table B4: The comparison matrix of best satategic sub-driver over the other and all the other satategic sub-drivers over the worst and the computed optimal weight for Technology (D3)

Expert Code		D31	D32	D33	D34	D35	D36
E1	Best sub-driver (D32)	3	1	6	9	2	4
	Worst sub-driver (D34)	4	9	2	1	6	3
	Optimal weights (ξ^L =0.0314)	0.1466	0.4084	0.0733	0.0419	0.2199	0.1099
E3	Best sub-driver (D32)	2	1	4	7	3	5
	Worst sub-driver (D34)	5	7	3	1	4	2
	Optimal weights (ξ^L 0.0487)	0.2190	0.3893	0.1095	0.0487	0.1460	0.0876
E9	Best sub-driver (D35)	2	3	9	5	1	4
	Worst sub-driver (D33)	5	4	1	2	9	3
	Optimal weights (ξ^L =0.0253)	0.2153	0.1435	0.0422	0.0861	0.4052	0.1076
E7	Best sub-driver (D32)	4	1	6	7	3	2
	Worst sub-driver (D34)	3	7	2	1	4	6
	Optimal weights (ξ^L =0.0592)	0.1124	0.3905	0.0750	0.0473	0.1499	0.2249
E10	Best sub-driver (D35)	3	2	4	9	1	7
	Worst sub-driver (D34)	5	7	3	1	9	2
	Optimal weights (ξ^L =0.0493)	0.1512	0.2268	0.1134	0.0394	0.4043	0.0648
E5	Best sub-driver (D32)	3	1	7	4	2	6
	Worst sub-driver (D33)	5	7	1	2	6	3
	Optimal weights (ξ^L =0.0716)	0.1521	0.3848	0.0447	0.1141	0.2282	0.0761
Average optimal weights (ξ^L =0.0476)		0.1661	0.3239	0.0763	0.0629	0.2589	0.1118

Table B5: The comparison matrix of best satategic sub-driver over the other and all the other satategic sub-drivers over the worst and the computed optimal weight for driver Marketing/Promotion (D4)

Expert Code		D41	D42	D43	D44
E1	Best sub-driver (D43)	4	7	1	3
	Worst sub-driver (D42)	3	1	7	4
	Optimal weights (ξ^L =0.0702)	0.1579	0.0702	0.5614	0.2105
E3	Best sub-driver (D43)	7	3	1	2
	Worst sub-driver (D41)	1	2	8	3
	Optimal weights (ξ^L =0.0345)	0.0690	0.1724	0.5172	0.2414
E9	Best sub-driver (D44)	3	7	2	1
	Worst sub-driver (D42)	2	1	3	7
	Optimal weights (ξ^L =0.0189)	0.1698	0.0755	0.2453	0.5094
E7	Best sub-driver (D44)	2	6	4	1
	Worst sub-driver (D42)	4	1	2	7
	Optimal weights (ξ^L =0.0392)	0.2745	0.0784	0.1373	0.5098
E10	Best sub-driver (D43)	4	9	1	2
	Worst sub-driver (D42)	2	1	9	4
	Optimal weights (ξ^L =0.0154)	0.1385	0.0615	0.5385	0.2615
E5	Best sub-driver (D44)	5	7	2	1
	Worst sub-driver (D42)	2	1	5	7
	Optimal weights (ξ^L =0.0510)	0.1156	0.0680	0.2891	0.5272
Average optimal weights (ξ^L =0.0382)		0.1542	0.0877	0.3815	0.3766

Table B6: The comparison matrix of best satategic sub-driver over the other and all the other satategic sub-drivers over the worst and the computed optimal weight for driver Government/policy (D5)

Expert Code		D51	D52	D53	D54	D55	D56
E1	Best sub-driver (D52)	3	1	2	6	4	7
	Worst sub-driver (D56)	5	7	6	2	3	1
	Optimal weights (ξ^L =0.0716)	0.1521	0.3848	0.2282	0.0761	0.1141	0.0447
E3	Best sub-driver (D52)	2	1	3	7	5	6
	Worst sub-driver (D54)	6	7	5	1	2	3
	Optimal weights (ξ^L =0.0733)	0.2335	0.3938	0.1557	0.0458	0.0934	0.0778
E9	Best sub-driver (D53)	3	2	1	4	7	9
	Worst sub-driver (D56)	4	5	9	3	2	1
	Optimal weights (ξ^L =0.0260)	0.1471	0.2207	0.4155	0.1104	0.0631	0.0433
E7	Best sub-driver (D53)	2	3	1	7	5	4
	Worst sub-driver (D54)	6	5	7	1	2	3
	Optimal weights (ξ^L =0.0705)	0.2248	0.1498	0.3790	0.0441	0.0899	0.1124
E10	Best sub-driver (D53)	3	4	1	9	2	5
	Worst sub-driver (D54)	4	3	9	1	6	2
	Optimal weights (ξ^L =0.0310)	0.1445	0.1084	0.4025	0.0413	0.2167	0.0867
E5	Best sub-driver (D52)	3	1	4	5	2	9
	Worst sub-driver (D56)	5	7	3	2	6	1
	Optimal weights (ξ^L =0.0705)	0.1498	0.3790	0.1124	0.0899	0.2248	0.0441
Average optimal weights (ξ^L =0.0571		0.1753	0.2727	0.2822	0.0679	0.1337	0.0682