Social Sustainability Challenges Towards Flexible Supply Chain Management: Post-COVID-19 Perspective

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Received: 9 July 2021 / Accepted: 8 September 2021 / Published online: 3 November 2021
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Abstract The COVID-19 pandemic has severely impacted the global social sustainability of the supply chains, pushing them towards a more flexible management approach. However, there is a paucity of literature that focuses on social sustainability issues for emerging economies. In the post-COVID-19 period, firms around the world will face several critical challenges to social sustainability, which will hinder achieving sustainable development goals (SDGs). Against this backdrop, this study identifies the pressing challenges to social sustainability in the post-COVID-19 context by a literature review and opinions from an expert panel, focusing on the footwear supply chain. In this paper, the best–worst method is applied to compute the criticality of social sustainability challenges towards the flexibility of the supply chains. The study findings reveal that among the nine identified critical challenges, “high level of layoffs”, “health protocol development”, “complexity in ensuring workplace safety”, “facing trouble in mental health”, and “lack of government enforcement and regulations for social issues” are reported as the top five challenges, respectively. Furthermore, this study suggests several flexible managerial guidelines, which will help practitioners and policymakers to achieve SDGs considering the COVID-19 pandemic.

Keywords Best–worst method · COVID-19 · Flexibility · Footwear supply chain · Social sustainability · Sustainable development goals

Introduction

In this twenty-first century, the most disastrous pandemic is COVID-19, which outburst in Wuhan, China, in December 2019 and has since spread to over 220 countries worldwide (Worldometer, 2021). According to a Worldometer study, there have been over 199 million confirmed cases of COVID-19, including about 4.24 million deaths, till 2nd August 2021. This life-threatening viral disease has not only changed our daily life activities but also altered the flexible business environment for many organizations around the globe (Chowdhury et al., 2021; D’Adamo & Lupi, 2021; Govindan et al., 2020; Shahed et al., 2021). According to Fortune, the COVID-19 has affected the supply chains (SCs) of 94% of Fortune 1000 organizations (Fortune, 2020). Due to the COVID-19 pandemic, the impact on global business resulted in a drop of 5.3% in 2020 (WTO, 2021). This pandemic hits the global poverty line severely resulting in 420–580 million people in poverty line (Sumner et al., 2020). Meanwhile, the International Labor Organization (ILO) estimates that 436 million businesses are at high risk of significant disruption and the COVID-19 crisis could result in the loss of up to 305 million full-time employment (ILO, 2020). This pandemic is exacerbating the world’s livelihood and employee’s well-being and thus, it has been emerged as a global threat towards achieving the United Nation’s Sustainable...
Development Goals (SDGs), more importantly, SDG-3 that focuses on “ensure healthy lives and promote wellbeing for all at all ages” (Zhou et al., 2020). More adversely, this pandemic can lead to several critical challenges in flexible supply chain management (FSCM), such as increased lay off (Bauer & Weber, 2020; ILO, 2020), delay and reduction in wages (Lipschutz, 2004), social security (Majumdar et al., 2020), poverty (He & Harris, 2020), mental health (Filho et al., 2020; Zhang & Ma, 2020), and potential health risks at workplaces (Kumar et al., 2020). Hence, these challenges need to be addressed in the way of achieving social sustainability (SS). While many businesses have restarted their activities with appropriate safeguards, those have not yet done so, should analyse their SCs now and investigate where they may need to take necessary flexible strategies to ensure employees’ social security in the post-COVID-19 situations. In such a challenging time, ensuring SS has become a wake-up call that deserves more attention from researchers and practitioners.

The increasing tension of the social security of employees urges SS at the focal point of the FSCM debate (New, 2015). While many researchers explored the concept of sustainability in supply chain management (SCM) from economic and environmental perspectives in the light of the COVID-19 pandemic, the social philosophy remained beneath the surface (Abid et al., 2020; Dubey et al., 2015). Ensuring SS increases the operational performance of an organization, which also favours organizational economic growth (Schönborn et al., 2019). Now, many companies around the world have begun to move on a recovery mode and started planning to address the social security of employees in the post-COVID period. Meanwhile, flexibility in decision making process has gained an important strategic approach in SCM to make a firm’s SCs more robust and resilient (Akhtar & Sushil, 2018; Settembre–Blundo et al., 2021). Therefore, SCM has come out as a noteworthy area to explore the critical challenges to SS towards FSCM in the post-COVID-19 period.

Because of the rapid growth and economic contribution of Bangladesh’s footwear industry, it has been designated as an emerging market. Bangladesh has been identified as a favourable outsourcing country for footwear than its competitors due to the availability of raw materials and low labour wages (Moktadir et al., 2018a). Currently, Bangladesh exports leather and non-leather footwear to many countries such as China, Italy, the USA, the UK, Germany, Sweden, Taiwan, and Japan. Many world-leading buyers, namely Timberland, Puma, Decathlon, H & M, and Hugo Boss, are sourcing footwear from Bangladesh. In the last fiscal year 2019–20, though the footwear industry was the third export earning sector in Bangladesh, it registered a drop of 21.24% in export volume than that of the previous year, generating 478.75 million US dollars (World footwear, 2020a). Experts claimed that this export drop was largely happened due to the COVID-19 pandemic and non-compliance issues in this sector (Islam et al., 2020). Social compliance issues such as non-standard wages, long working hours, poor working conditions, child labour, workplace safety, and gender inequality are common phenomena in the Bangladeshi footwear industry (Munny et al., 2019). These non-compliance issues are getting worsened by the COVID-19 pandemic. Since, nowadays, global footwear brands are more concerned about SS in their SCs, there is no alternative way for Bangladesh, but SS can be an essential factor for this industry’s growth. Besides, during this pandemic, many footwear factories in this country face challenges to adopting social compliance issues that should be addressed. Therefore, the footwear supply chain (FSC) has been identified as an emerging area by the authors to explore the SS challenges in the post-COVID period, guiding the practitioners to prepare themselves to restore social compliance issues towards FSCM and to achieve several SDGs. Also, flexible systems management may help achieve sustainability of the SCs of manufacturing organizations including the footwear industry (Shukla et al., 2019; Sushil, 2015, 2018).

Most of the previous SC literature focused on environmental and economic sustainability from the COVID-19 perspective (Amankwah-Amoah, 2020; Appolloni et al., 2021; D’Adamo et al., 2020; Ozili & Arun, 2020; Somani et al., 2020; Yu & Aviso, 2020; Zambrano-Monserrat et al., 2020). Gerbeti (2021) discussed several flexible proposals for controlling industrial emissions in the way of achieving environmental sustainability. Ikram (2021) developed a sustainable energy development grey model for predicting renewable and non-renewable energy production and consumption. Settembre-Blundo et al. (2021) developed a risk management tool focusing on business sustainability, which can measure the progress of achieving SDGs. Until now, very few studies narrowly focused on SS. Among these studies, Kumar et al. (2020) suggested improving the present situation in the post-pandemic production system with proper concentrations on social distancing at work, employees’ welfare, mental wellness, and health screening procedures, workforce compensation, and benefits, and the implementation of new human resource policies by any manufacturing organizations. Majumdar et al. (2020) investigated the reasons behind the absence of SS in their study from the perspective of the clothing SC in Bangladesh. They found that the power dominance of clothing brands, unauthorized subcontracting of clothing manufacturing, and the use of contract labour are the main reasons for breaching the ‘code of conduct’ of social compliance. Sharma et al. (2020) mentioned in their study that an organization should not only focus on their employees’ health and well-being but also focus on the
organization’s suppliers’ health and well-being to control the COVID-19 impacts on SC. A study conducted by Bauer and Weber (2020) investigated that the rate of lay off has increased during the COVID-19 pandemic. They found that 60% of employees in Germany got into unemployment due to the shutdown measures in April 2020. Popkova et al. (2021) emphasized the role of corporate social responsibility (CSR) to tackle the economic crisis, emanated from the COVID-19 pandemic. In another study conducted by He and Harris (2020), argued that this pandemic has brought out an excellent opportunity to combat emergency global social and environmental challenges by businessmen, adopting genuine and authentic CSR. Meanwhile, Elias (2021) investigated the successful flexible strategies to combat the 1st wave of COVID-19 in Kerala, India. Paul and Chowdhury (2020) proposed some strategies to deal with SC disruption considering a case of a high-demand item, i.e. toilet paper in the context of COVID-19. Pérez Vergara et al. (2021) conducted a study on multi-product business inventory strategies to ensure adequate service levels for biosafety products in the context of COVID-19.

The pervasive literature review shows that very few studies were conducted that dealt with SS in SCM. However, we did not find any study that focused on the critical challenges to SS for the post-COVID-19 context. Most importantly, previous literature did not explore the SS challenges towards FSCM in the context of an emerging economy (i.e. Bangladeshi footwear industry) from the perspective of the post-COVID-19 pandemic. Therefore, we consider the FSC to investigate the critical challenges to SS in the post-COVID-19 context. In such an awful situation emanated by COVID-19, like many other industries, the footwear industry also faces a series of common questions to ask, which are taken as research questions in our study as follows:

1. What are the critical challenges of SS in the post-COVID-19?
2. How to assess the importance of SS challenges towards FSCM?
3. How does a firm can cope with SS challenges in the post-COVID-19 period?

Given the backdrop of these questions, the objectives of this study are set as follows:

(a) To unveil the critical challenges to SS towards FSCM in the post-COVID-19 pandemic.
(b) To prioritize the critical challenges to SS using the best–worst method (BWM).
(c) To propose some flexible managerial guidelines needed in the post-COVID-19 era for ameliorating current SS conditions and achieving several SDGs.

Several multi-criteria decision-making (MCDM) tools have gained popularity among researchers in the SCM field whereby the degree of importance of several factors is identified in a decision-making process (Kumar et al., 2019). Practitioners use MCDM tools in developing a strategic plan to find the most important factors among the many factors. Among the various MCDM tools, the BWM is a powerful multi-criteria decision support tool that was developed by professor Rezaei in 2015 (Rezaei, 2015). This method is receiving special attention to academicians and researchers over other MCDM methods because (1) it is a unique, effective, and simple method for analysing decision-making problems within a concise time, (2) it needs less pair-wise comparison matrices than others established decision support tools, and (3) it can give consistent and reliable results with a simple calculation. Identification of SS challenges towards the FSCM system is a multi-criteria problem where experts might face ambiguity to select the best criterion. The BWM has overcome this problem along with the above-mentioned advantages (Faizi et al., 2021). Therefore, this study proposes a novel application of the BWM to identify the critical challenges to SS towards FSCM in the post-COVID-19 world.

This study has threefold contributions: First, this study identifies the critical challenges to SS in the FSC towards FSCM due to SC disruptions emanated from the COVID-19 pandemic. Secondly, the research focuses on utilizing the BWM as a decision support tool to assess the importance of each critical challenge. Thirdly, this study offers possible ways to alleviate these vital challenges on the way to achieving several SDGs.

The rest of the paper is arranged as follows: second section includes literature review, research methodology is discussed in third section, fourth section introduces a real-life case application of the proposed methodology, fifth section presents results and discussion, and sixth section summarizes the implications of the study. Finally, the conclusions and recommendations for future research are presented in seventh section.

**Literature Review**

This section discusses the impact of COVID-19 on supply chain management, social sustainability and the previous contributions, challenges to social sustainability in the post-COVID-19 context, application of MCDM tools in supply chain management, and research gaps and highlights, respectively.
Impact of COVID-19 on Supply Chain Management

The contemporary world has been facing severe challenges by the unprecedented disease, the COVID-19 (Lin et al., 2015; Ho et al., 2015). It is eminent that the COVID-19 pandemic has displayed us the severe social, political, environmental, and economic consequences in SCM (Kumar et al., 2020). The business world has been facing various types of SC disruptions from several disasters, but now, the effect of the COVID-19 outbreak on the global SCs has become so difficult to measure (Chowdhury et al., 2020). According to the World Economic Forum (2020), domestic and international trade transactions registered a week-on-week drop of 56% since mid-February of 2020. The US, the UK, and other European countries underwent a similar trend in trade transactions with an initial drop of 26% at the beginning of April, which ended up with a 17% drop in late April 2020. Meanwhile, according to the Bangladesh Garment Manufacturers and Exporters Association (BGMEA), Ready Made Garments (RMG), the first export earning sector in Bangladesh lost orders of about 1.5 billion USD by many international buyers (Lightcastle, 2020). Since the global economy has contracted due to the effect of COVID-19 pandemic, these effects are expected to be felt more strongly in major G20 economies, which are major importers of Bangladesh. According to a report published by World Footwear (2020b), there was a predicted drop in global footwear consumption of 22.5% in 2020 due to the COVID-19 effect. As a result of the COVID-19 impact, the FSC has been not only facing an economic downturn but also facing several social sustainability issues.

The global SC perspective is not constrained by geography; it spreads beyond the geographic borders of a country. Therefore, if one country is affected, it disrupts the total SC functions among the total SC members. Researchers have introduced several strategies regarding the SC resilience model to tackle any SC disruption in the last two decades. However, the existing SC model experienced more vulnerabilities, and about 35% of the manufacturers from the National Association of Manufacturers (NAM) claimed that their SCs network has been disrupted by the COVID-19 pandemic (Kumar et al., 2020). Sadly, the COVID-19 outbreak has clarified beyond a question that traditional SC strategies, such as robustness, surplus inventory, redundant capacity, agility, and flexibility, are not able to tackle such kind of SC disruption (Heckmann et al., 2015; Ho et al., 2015). It is eminent that the COVID-19 pandemic has displayed us the severe social, political, financial, and environmental consequences in SCM (Kumar et al., 2020).

Social Sustainability and the Previous Contributions

“Sustainability is the way of meeting today’s needs without compromising the future generations’ needs” (Keeble, 1988). Sustainability has three dimensions, namely economic, environmental, and social. SS is defined as an “ethical code of conduct for human survival and outgrowth that needs to be accomplished in a mutually inclusive and prudent way” (Sharma & Ruud, 2003). Other researchers defined SS as the management of product and process attributes that ensure human safety, welfare, and community development (Klassen & Vereecke, 2012; Wood, 1991). Sarkis et al. (2010) defined SS as the management of social resources that are connected with social values, social personal relationships, organizations, and people’s skills and abilities. SS encompasses employees’ wellbeing, fair treatment (Abid et al., 2020), philanthropy (Mani et al., 2018), cultural diversity (Meuleman, 2013), social equity (Bansal, 2005), and formal education (Sarkis et al., 2010). Meanwhile, Labuschagne and Brent (2005) classified the dimensions of SS into four areas, namely internal human capital, external population, stakeholder engagement, and macro social performance problems.

A study conducted by Filho et al. (2020) discussed how the COVID-19 pandemic jeopardizes achieving SDGs. They mentioned this pandemic has increased the global socio-economic pressures that are escalating poverty and worsening social wellbeing around the world and consequently, making it more challenging to achieve sustainability. Majumdar et al. (2020) investigated the reasons for lacking SS practices in the clothing industry and suggested appropriate ways to achieving sustainability in the context of COVID-19. They proposed a new sourcing model where disruption risk-sharing contracts between suppliers and buyers were mandated, and community development initiatives were prioritized. They suggested buyers should outsource their goods from those suppliers who consider the social safety benefits for employees and who have no contract labour. Basch et al. (2020) pointed out that mass media should promote news regarding enhance health safety rather than telecasting more negative news that creates negative emotions among humans, to achieve health sustainability. Petrudi et al. (2021) identified six SS innovation criteria in their study in the context of the COVID-19 pandemic where they found “safety and health practices”, “remote working conditions”, and “localization” are the most essential SS innovation criteria. A study performed by Sarkis et al. (2020) primarily focused on environmental sustainability dimensions and covered some major social issues from the COVID-19 perspective. Abid et al. (2020) investigated the impact of fairness perception on employee’s wellbeing. The study found that fairness perception positively correlates with employee’s
wellbeing, civility, and thriving at work towards achieving SS. Paying attention to the COVID-19 pandemic, Queiroz et al. (2020) proposed a framework for SC and operations management, which comprises six perspectives, i.e. “adaptation”, “digitalization”, “preparedness”, “recovery”, “ripple effect”, and “sustainability”. A literature review conducted by Govindan, et al. (2021) recorded forty barriers of SS under seven categories and pointed out thirty-nine drivers of SS under six categories in achieving SS. Mani et al. (2020) pointed out that investment and a firm’s size have a positive impact on practising SS. D’Eusanio et al. (2019) developed an SS assessment toolbox for decision-makers whereby they can measure a company’s progress towards SS. Mani et al. (2016) investigated six dimensions of supply chain social sustainability from the perspective of a developing country, namely ethics, philanthropy, health and welfare, human rights, safety, and equity, respectively. In another study conducted by Mani et al. (2018), found five dimensions of SS under eighteen validated social measures to design socially sustainable SC from the perspective of an emerging economy. The listed dimensions were “health and safety”, “societal responsibility”, “human rights”, “diversity”, and “product responsibility”. They also mentioned that collaborative efforts among SC members can minimize disruption risks and can amplify the performance and reputation of an emerging economy. Considering the Bangladeshi footwear industry as a case study, Moktadir et al. (2018) identified twenty drivers of CSR under four perspectives where the financial driver was ranked as the first position. In addition, Munny et al. (2019) found nineteen enablers of SS whereas “workplace health and safety practices”, “wages and benefits”, and “customer requirements” were listed as the most critical SS enablers in the context of the FSC.

Challenges to Social Sustainability in the Post-COVID-19 Context

The post-COVID situation will be more challenging to industry managers to recover their disrupted SC and to meet the SDGs by 2030, which main philosophy is to “leave no one behind”. The post-COVID-19 period will compel all firms to practice the social issues of sustainability in their SCM to achieve sustainability. Therefore, manufacturing firms should take a rounded approach to tackle all the social problems emanated from the COVID-19 pandemic like increased lay off, health protocol development, workplace safety, and socio-cultural patterns. The United Nations (UN) has already urged all stakeholders to build a more inclusive society and sustainable economies and introduced a new strategic plan to lessen the socio-economic downgrading conditions by the COVID-19 pandemic. Sarkis et al. (2020) mentioned in their study that the new-normal world will require new public policy, financial investment, complex thinking, new behaviour, and thoughtful action to restore the world to a livable place again. A whole-hearted effort by the government, practitioners, employees and all other stakeholders can jointly make a company’s SC more sustainable to protect any future disruption like COVID-19.

Application of MCDM Tools in Supply Chain Management

SC managers often face problems in the decision-making process where they need to make a priority among multiple decision criteria, which is known as a multi-criteria decision problem. Many researchers developed several MCDM tools to solve this problem in a decision-making process, namely analytical hierarchy process (AHP) (Saaty, 1987), measuring attractiveness by a categorical-based evaluation technique (MACBETH) (Costa & Vansnick, 1997), interpretive structural modeling (ISM) (Hwang & Yoon, 1981), simple multi-attribute rating technique (SMART) (Edwards, 1977), weighted sum method (WSM) (Zadeh, 1963), conjoint analysis (CA) (Green & Rao, 1971), multi-objective optimization ratio analysis (MOORA) (Brauers & Zavadskas, 2006), discrete choice experiments (DCE) (Louviere & Woodworth, 1982, 1983), analytical network process (ANP) (Saaty, 1996), technique for order preference by similarity to ideal solution (TOPSIS) (Hwang & Yoon, 1981), level-based weight assessment (LBWA) (Žižović & Pamucˇar, 2019), full consistency method (FUCOM) (Pamucˇar et al., 2018), etc. We have found several applications of MCDM tools in the SCM field in the previous literature. For example, Kumar et al. (2019) applied intuitionistic fuzzy-based TOPSIS method to measure and compare the innovative performance of manufacturing firms in India. Sushil (2017) used the interpretive ranking process along with total interpretive structural modeling (TISM) to evaluate the flexibility initiatives of an organization. Ali et al. (2021) evaluated the efficacy of complex interval-valued Pythagorean fuzzy set (CIVFPS) in their study and they found this method provides consistent and reliable results. Biswas (2020) evaluated the performance of Indian health care SC where pivot pairwise relative criteria importance assessment (PIPRECIA) method was used to find the criteria weights and then multi-attributive border approximation area comparison (MABAC), combined compromise solution (CoCoSo), and measurement of alternatives and ranking according to compromise solution (MARCOS), were used to find the rank of alternatives. Ahmed et al. (2021) applied Pareto analysis and rough-decision making trial and evaluation laboratory (rough-DEMATEL) method to identify the
challenges in the education sector of Bangladesh due to COVID-19 and proposed 19 flexible strategies to combat these challenges. Sarker et al. (2021) developed a sustainability performance assessment model for the leather industry integrating several MCDM tools, i.e. fuzzy AHP, simple additive weighting (SAW), TOPSIS, and fuzzy multi-criteria optimization and compromise solution (VIKOR).

Research Framework

The identification and prioritization of the critical challenges to SS in the post-COVID-19 period is a multi-criteria problem. A panel of industry experts was formed to identify the pressing challenges. BWM, an MCDM tool, was used to rank the SS challenges. Furthermore, some managerial flexible strategies are proposed to tackle these challenges. The research framework of this study is depicted in Fig. 1.

Best–Worst Method (BWM)

In this method, experts select the best criterion and the worst criterion and then formulate two preference vectors by comparing criteria best to other and other to worst using a 1–9 point rating scale (Moktadir et al., 2020). Previous literature showed the various successful application of the BWM in the SCM decision-making process. For example, Sharma et al. (2021) used the BWM to identify and analyse essential barriers of big data analytics in SCs. Moktadir et al. (2021) identified the most critical risk factors for sustainable supply chain management (SSCM) in the leather industry using the BWM. Sahebi et al. (2020) applied the BWM to rank the blockchain barriers in humanitarian SC. With the BWM, Gupta et al. (2020) ranked several strategies for SC sustainability innovation. Munim et al. (2020) applied the BWM to select an appropriate governance model for green port management and they reported that the BWM is a more reliable decision-making tool than ANP. Fartaj et al. (2020) used the BWM to identify the critical transportation disruption factors. Grida et al. (2020) applied the BWM to rank the COVID-19 prevention policies in SCM. Some other notable applications of the BWM method comprise assessment of environmental sustainability indicators (Suhi et al., 2019), identification of critical success factors of energy-efficient SC (Moktadir et al., 2019), and prioritization of sustainable manufacturing barriers (Malek & Desai, 2019). These successful applications and several advantageous features of BWM against other MCDM tools, as shown in Table 1, motivated us to apply the BWM in this study to explore the critical challenges to SS towards FSCM in the context of the post-COVID-19 period.

Methodology

In this section, the research framework and the applied best–worst method (BWM) are described sequentially.

Nowadays, SS has gained significant momentum in the SC of the manufacturing industries because of stakeholders’ consciousness regarding factory working conditions (McCarthy et al., 2010) and human resource policy. Implementation of the social responsibilities of a company largely influences its SC activities, operational performance, supplier performance, and customers’ satisfaction that drive the financial success of a company (Mani et al., 2020). Though SS has become an inevitable stepping-stone for a company’s success, it has not gained so much attention like environmental and economic sustainability in the previous literature (D’Adamo et al., 2019; D’Eusiano et al., 2019; Gupta & Gupta, 2021; Kala et al., 2020; Somani et al., 2020). Most importantly, no study found the critical challenges to SS in the post-COVID-19 context. Moreover, we found several conceptual frameworks of SS where authors did not identify the degree of importance of the critical challenges. Also, we found very few studies that explored the SS challenges through the viewpoint of an emerging economy. To fill these research gaps, this study not only finds the critical challenges of SS but also investigates their degree of importance using the BWM in the context of the post-COVID-19 pandemic from an emerging economy perspective, i.e. the Bangladeshi footwear industry. Also, this study formulates several managerial guidelines to combat the SS challenges in the way of achieving several SDGs. Thus, this study will undoubtedly guide practitioners to take flexible strategic steps to combat the SS risks in post-COVID-19 situations.
Step 1  Selection of a set of challenges to SS in the post-COVID-19 pandemic.

With the help of an expert panel, a set of challenges \( \{pc_1, pc_2, \ldots, pc_n\} \) to SS in the post-COVID-19 context is selected.

Step 2  Identification of the best and worst challenges to SS in post-COVID-19.

Here, the decision-makers identify the best and worst challenges to SS in the post-COVID-19 pandemic. Interestingly, no comparison is needed for this job.

Step 3  Identification of the order of preference of the best challenge to other challenges to SS in post-COVID-19.

Here, a rating scale of 1–9 is used to formulate the comparison matrices among challenges to SS in the post-COVID-19 pandemic for \( m \)th decision-makers. In this regard, point 1 represents equal importance, whereas point 9 denotes a higher priority. The Best-to-Others (BO) vector for the \( m \)th decision-makers is established as follows:

\[
A_B^m = (a_{B1}^m, a_{B2}^m, \ldots, a_{Bn}^m)
\]

where \( a_{Bj}^m \) represents the significance of the best challenge \( B \), compared to challenges \( j \).

Step 4  Identification of the order of preference of other to the best challenge to SS in post-COVID-19.

Here, a rating scale of 1–9 is used to formulate the comparison matrices among others to the worst challenge to SS in the post-pandemic period for the \( m \)th decision-makers. The others-to-worst (OW) vector for the \( m \)th decision-makers is established as follows:

\[
A_W^m = (a_{W1}^m, a_{W2}^m, \ldots, a_{Wn}^m)^T
\]

where \( a_{jW}^m \) represents the importance of challenges \( j \), over the worst challenge \( W \).
Step 5 Calculating the optimal weights of challenges to SS in the post-pandemic period.

In this step, the weights of challenges \((w^*_m, w^*_2, ..., w^*_n)\) to SS in the post-pandemic period are computed such that the maximum absolute difference for all \(j\) is minimized for the following set: \(\{|w^*_m - a^*_jw^*_j|, |w^*_m - a^*_jw^*_j|\}\). The problem is translated and denoted as follows:

\[
\min \{ |w^*_m - a^*_jw^*_j|, |w^*_m - a^*_jw^*_j| \}
\]

Subject to
\[
\sum_j w^*_j = 1
\]
\[
w^*_j \geq 0 \text{ for all } j
\]

Model (1) is altered to a linear programming problem, which is expressed as follows:

\[
\min \xi^L
\]

subject to,
\[
|w^*_B - a^*_jw^*_j| \leq \xi^L \text{ for all } j
\]
\[
|w^*_m - a^*_jw^*_j| \leq \xi^L \text{ for all } j
\]
\[
\sum_j w^*_j = 1
\]
\[
w^*_j \geq 0 \text{ for all } j
\]

By solving model (2), the optimized weightings \((w^*_1, w^*_2, ..., w^*_n)\) are determined while minimizing the value of \(\xi^L\). It is noted that the closer the value of \(\xi^L\) to zero represents higher consistency in the results, and vice versa. The value of \(\xi^L\) is the optimal objective function of the constructed linear programming model, which helps to compute the consistency ratio of the constructed comparison matrix explained as

\[
\text{CR} = \frac{C_I}{\xi^L}, \text{ where } C_I \in [0, 1].
\]

The consistency index for different values of \(PC_{BW}\) is given in Table 2. It is also noted that the closer the value of CR to zero indicates the better consistency of the system.

### Table 2 Consistency index for BWM

| \(PC_{BW}\) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-------------|---|---|---|---|---|---|---|---|---|
| CI          | 0 | 0.44 | 1.0 | 1.63 | 2.3 | 3.0 | 3.73 | 4.47 | 5.23 |

A Real-Life Case Application

The critical challenges of ensuring SS and achieving SDGs in the post-COVID-19 period will be a burning issue for every industry around the world. This study takes the footwear industry as a real-life case study to focus on SS. In Bangladesh, the footwear industry has been marked as an emerging economy where sustainability issues should be addressed appropriately to further escalate this sector.

Identification of a Set of Challenges to SS in the Post-COVID-19 Pandemic

In this step, a set of critical challenges to SS in the post-COVID-19 context were listed by an extant literature review. Then, Google forms was designed to collect responses from the footwear industry’s experts on the critical challenges to SS. The data collection form was sent to the e-mail addresses of fifty industry experts following the purposive sampling approach. The minimum criteria for experts' selection were 4 years of working experience in the SCM field along with a Bachelor's degree. The data collection period was from 2nd January to 28th February 2021. During the data collection period, several phone calls and e-mail reminders were executed to get experts’ feedback. In the data collection form, there was an option of Yes/No for selecting the critical challenges to SS by the respondents. Additionally, there was an option to add further challenges. After collecting the responses, we paraphrased the new challenges proposed by the industry experts and set a threshold value to screen out the most critical challenges. Finally, we considered eight critical challenges based on the threshold value. The challenges are listed in Table 3 with a brief definition.

This study followed the purposive sampling technique to get the responses from industry experts. In this sampling technique, researchers choose respondents randomly based on respondents’ knowledge, expertise, and experience in the desired field (Guarte & Barrios, 2006). We found several previous studies that followed the purposive sampling technique to explore any problem from an industry standpoint (Masudin et al., 2021; Sarker et al., 2021). We finally got responses from eight experts from the invited fifty experts. Rezaei et al. (2018) reported that 4–10 respondents are enough to get credible results from the
In this regard, this study meets the sample requirements for the BWM. The details of the expert panel are described in Table 4.

Identification of the Best and the Worst Challenges to SS in the Post COVID-19 Pandemic

In this step, eight industry experts (decision-makers) were asked to find the most significant (best) and the least significant (worst) challenge among the defined nine challenges. In this regard, a second-round survey was conducted using google forms. The results of this step are depicted in Table 5.

Table 3 Critical challenges to SS in FSC in the post COVID-19 scenario

| Code | Name of challenge                                      | Definition                                                                                                                                  | Reference                      |
|------|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| PC1  | Complexity in ensuring workplace safety               | Lack of capabilities to maintain a clean, safe, and hygienic factory environment                                                           | Kumar et al. (2020), Sharma et al. (2020) and Tonne (2021) |
| PC2  | Health protocol development                           | Providing proper guidelines for ensuring employees’ health wellbeing                                                                      | Proposed in this article       |
| PC3  | Lack of training facility on health hygiene           | Absence of training, education, and awareness programs for better health of employees                                                      | Proposed in this article       |
| PC4  | Unavailability of primary medical services            | Lack of ensuring essential medical services for employees (e.g., monthly medical check-up)                                              | Kumar et al. (2020)            |
| PC5  | High level of lay off                                 | The degree of temporary or permanent job cut down due to the shortage of work                                                              | Bauer and Weber (2020)         |
| PC6  | Facing trouble in mental health                       | The problem of employees in dealing with their thoughts, emotions and/or behaviors                                                          | Bu et al. (2020)               |
| PC7  | Lack of government enforcement and regulations for social issues | The preparation of guidelines for social compliance issues and their lack of supervision and control in implementation by the government | Proposed in this article       |
| PC8  | Problem in socio-cultural patterns and practices      | Changes in socio-cultural condition and culture (e.g., inequality due to poverty)                                                          | Fenner and Cernev (2021)       |
| PC9  | New normal community needs                            | The emergence of a new pattern of lifestyles (e.g., remote working)                                                                          | Proposed in this article       |

Table 4 Profile of industry experts from footwear companies

| Experts (E) | Years of experience | Area of expertise/department                  | Education | Number of employees in working company | Presence of social compliance certification | Age of working company (Years) | Designation                              |
|-------------|---------------------|-----------------------------------------------|-----------|----------------------------------------|---------------------------------------------|-------------------------------|----------------------------------------|
| E-1         | 4–6                 | Production and operations management          | Bachelor  | 101–1000                               | Yes                                         | 126                           | Executive officer                      |
| E-2         | 4–6                 | Production and operations management          | Master’s  | 101–1000                               | Yes                                         | 44                            | Sole expert and compound developer     |
| E-3         | 7–10                | Merchandising                                 | Master’s  | 1–100                                  | Yes                                         | 98                            | Quality compliance analyst             |
| E-4         | 7–10                | Quality assurance/control                     | Master’s  | Above 1000                             | Yes                                         | 29                            | Deputy manager                         |
| E-5         | 4–6                 | Product conception and development            | Bachelor  | Above 1000                             | Yes                                         | 44                            | Footwear Product Engineer              |
| E-6         | 4–6                 | Supply chain management                       | Master’s  | 101–1000                               | Yes                                         | 7                             | Deputy manager                         |
| E-7         | 4–6                 | Quality assurance/control                     | Bachelor  | Above 1000                             | Yes                                         | 44                            | Quality production leader              |
| E-8         | 4–6                 | Footwear development and industrialization    | Bachelor  | 1–100                                  | Yes                                         | 45                            | Development and industrialization leader |
Table 5 Best and worst challenges to SS in the post-COVID-19 context identified by experts

| Code | Name of challenge                                              | Best (most significant) challenge mentioned by experts | Worst (least significant) challenge mentioned by experts |
|------|---------------------------------------------------------------|-------------------------------------------------------|--------------------------------------------------------|
| PC₁  | Complexity in ensuring workplace safety                      | E2, E7                                                |                                                        |
| PC₂  | Health protocol development                                   | E4                                                   |                                                        |
| PC₃  | Lack of training facility on health hygiene                   |                                                        | E1, E6                                                |
| PC₄  | Unavailability of primary medical services                    |                                                        |                                                        |
| PC₅  | High level of lay off                                        | E1, E3, E5, E6, E8                                   |                                                        |
| PC₆  | Facing trouble in mental health                               |                                                        |                                                        |
| PC₇  | Lack of government enforcement and regulations for social issues |                                                        |                                                        |
| PC₈  | Problem in socio-cultural patterns and practices              |                                                        |                                                        |
| PC₉  | New normal community needs                                   | E2, E4, E5, E7, E8                                   |                                                        |

Identification of the Priority of the Best Challenge to Other Challenges to SS in the Post-COVID-19 Pandemic

In this step, the decision-makers were asked to provide their responses regarding the best challenge over the other challenges based on a 1–9 point rating scale. Table 6 represents the rating of the best challenge over the other challenges by industry Expert-1. The best challenge of SS in FSC in the post-pandemic period over the other challenges by Experts-2–8 are attached in “Appendix” (see Table 10).

Identification of the Priority of Other Challenges to the Worst Challenge to SS in the Post-COVID-19 Pandemic

In this step, the decision-makers provided their responses on other challenges over the worst challenge based on a 1–9 point rating scale. Table 7 represents the rating of other challenges over the worst challenge by industry Expert-1. The comparisons of other challenges of SS in FSC in the post-COVID-19 pandemic to the worst challenges constructed by Experts-2–8 are attached in “Appendix” (see Table 11).

Calculating Optimal Weights \( (w_{PC}^m, w_{PC}^m, ..., w_{PC}^m) \) of SS Challenges in the Post-COVID-19 Pandemic

Here, the optimal weights of all SS challenges are calculated by fulfilling the constraints and the optimization model given in Eq. (2) for every decision-makers. The optimization model for Expert-1 is depicted below:

\[
\text{Min}_{\L} \sum_{i=1}^{n} \sum_{j=1}^{n} \left( w_{PCi}^m - w_{PCj}^m \right) \leq \xi \frac{l}{2}; \sum_{i=1}^{n} w_{PCi}^m = 1; \quad w_{PCi}^m \geq 0
\]

By solving the above-mentioned model in an Excel solver, the optimal weights of all SS challenges were obtained and are presented in Table 8. Similarly, the optimal weights of the SS challenges in FSC with Experts-2–8 are calculated and the results are attached in

Table 6 Best challenge over other challenges by Expert-1

| Best to others | PC₁ | PC₂ | PC₃ | PC₄ | PC₅ | PC₆ | PC₇ | PC₈ | PC₉ |
|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| PC₅           | 2   | 3   | 9   | 8   | 1   | 4   | 5   | 7   | 6   |
Appendix” (see Table 12). Later, the average weights (arithmetic mean), standard deviation, and average consistency were observed for the obtained data from the eight experts, which is depicted in Table 9. The closer the value of the objective function of the constructed linear programming model to zero indicates that the results are highly reliable and consistent. Our study findings show that the average value of the objective function is 0.0923, which is very close to zero. Therefore, it can be concluded that our results are more reliable and consistent. Besides, the computed lower standard deviation indicates the homogeneity of the responses of the eight experts. The overall weights of the critical SS challenges are also depicted in Fig. 2.

Results and Discussion

Table 9 represents the ultimate results of the SS critical challenges towards FSCM in the context of the post-COVID-19 pandemic. The prioritization of the critical challenges is established based on their calculated weights using the BWM. The ranking of the critical challenges is “high level of lay off”, “health protocol development”, “complexity in ensuring workplace safety”, “facing trouble in mental health”, “lack of government enforcement and regulations for social issues”, “unavailability of primary medical services”, “lack of training facility on health hygiene”, and “new normal community needs”, “problem in socio-cultural patterns and practices”, respectively.

“High level of lay off” is the most critical challenge to SS in the post-COVID-19 period with the highest optimal weight of 0.2189, which denotes that job security is the most important issue to ensure SS in the post-COVID-19 world. On 23rd March 2019, a lockdown policy has been initiated by the government of Bangladesh to detain the spread of the contagious COVID-19 virus. When writing this article, during April 2021, the second wave of COVID-19 has emerged more deadly than that of the previous wave. However, the government of Bangladesh is strictly

Table 7 Other challenges over the worst challenge constructed by Expert-1

| Others to the worst challenge | PC3 |
|------------------------------|-----|
| PC1                          | 8   |
| PC2                          | 6   |
| PC3                          | 1   |
| PC4                          | 3   |
| PC5                          | 9   |
| PC6                          | 7   |
| PC7                          | 4   |
| PC8                          | 2   |
| PC9                          | 5   |

Table 8 Optimal weights of the critical SS challenges by Expert-1

| Code of challenge | Optimal weight |
|------------------|----------------|
| PC1              | 0.1941         |
| PC2              | 0.1294         |
| PC3              | 0.0253         |
| PC4              | 0.0485         |
| PC5              | 0.3080         |
| PC6              | 0.0970         |
| PC7              | 0.0776         |
| PC8              | 0.0554         |
| PC9              | 0.0647         |
| L*               | 0.08015        |

Table 9 Average weights of the critical SS challenges from the eight experts

| Code | Name of critical challenge                                      | Average weight | Deviation | Consistency | Rank |
|------|-----------------------------------------------------------------|----------------|-----------|-------------|------|
| PC1  | Complexity in ensuring workplace safety                        | 0.1860         | 0.0544    | 0.0923      | 3    |
| PC2  | Health protocol development                                    | 0.1943         | 0.0413    | 2           |      |
| PC3  | Lack of training facility on health hygiene                    | 0.0697         | 0.0229    | 7           |      |
| PC4  | Unavailability of primary medical services                     | 0.0717         | 0.1138    | 6           |      |
| PC5  | High level of lay off                                          | 0.2189         | 0.0452    | 1           |      |
| PC6  | Facing trouble in mental health                                | 0.0927         | 0.0198    | 4           |      |
| PC7  | Lack of government enforcement and regulations for social issues| 0.0731         | 0.0198    | 5           |      |
| PC8  | Problem in socio-cultural patterns and practices                | 0.0375         | 0.0216    | 9           |      |
| PC9  | New normal community needs                                     | 0.0561         | 0.0162    | 8           |      |
monitoring the lockdown measures to control the severe impact of this pandemic. Due to the COVID-19 effect, like other industries, the footwear industry of Bangladesh has been facing cancellation of buyers’ orders, supply chain disruption, and supply–demand shock. As a result, many practitioners of the footwear industry are downsizing employees’ jobs, as an alternate way, to minimize the financial loss of a company. Dhaka Tribune (2021) reported that the pandemic has affected 77% of Bangladesh’s clothing and footwear industries, which are the most export-earning sectors of this country. A survey conducted by the Bangladesh Institute of Development Studies from 5th May to 29th May 2020, reported that around 13% of employees lost their jobs, due to the COVID-19 effect in Bangladesh (Dhaka Tribune, 2021). Due to the loss of their jobs, employees are struggling to meet their family and social needs, which are ultimately affecting the SS status of the FSC. In the post-COVID-19 period, many footwear companies like other manufacturing firms will restructure their SCs that will decline the job market, resulting in a threat to restart employees’ jobs who have already lost their jobs during this pandemic. A previous study conducted by McCloskey et al. (2020) claimed that “high level of lay off” is one of the biggest challenges emanated from the COVID-19 pandemic, however, they did not discuss this challenge for FSCM in the post-pandemic period for ensuring SS, as our study reported.

“Health protocol development” is identified as another influential critical challenge to SS for FSCM, with the optimal weight of 0.1943. Industry managers should develop and execute a health protocol to prevent, screen, and/or management of the pandemic condition. Though the mass vaccination program has started in Bangladesh on 7 February 2021, it will take a long time to vaccinate the mass people of this country. Therefore, preventive flexible strategies, such as effective health protocol development are necessary to control this pandemic. This study suggests, in the post-COVID-19 period, practitioners should implement a health protocol to limit the advancement of this viral disease. There was no previous literature that identified the health protocol development, as a part of FSCM strategy, for ensuring SS in the post-pandemic period.

“Complexity in ensuring workplace safety” is the next critical challenge, with the optimal weight of 0.1860 for ensuring SS for FSCM. The post-pandemic period will require personal safety practices (e.g. physical distancing, face coverings, gloves, and hand hygiene) to ensure a safe workplace. Previous studies, such as Kumar et al. (2020) mentioned that the post-pandemic production system should monitor workplace safety to ensure employees’ health wellbeing and Sharma et al. (2020) discussed that even industry managers should focus on their suppliers’ workplace environment to ensure SS in their SCs. Though few previous studies discussed the aforementioned challenge as an essential factor for ensuring SS in SCM, they did not highlight its importance as a strategy for FSCM in the post-pandemic period.

Our study finds “Facing trouble in mental health” as another critical challenge to SS in the post-pandemic period, with the optimal weight of 0.0927. Due to fear, lockdown, salary cut down, and lay off emanated from COVID-19, employees are being put under pressure, which troubles their mental health. Bu et al. (2020) and Kumar et al. (2020) found that employees’ mental health has been strongly affected by this pandemic. However, previous studies did not point out how this challenge could affect SS. If employees are unsatisfied with his/her working environment or feel traumatized while working, ultimately, it will not only hamper SS but also lessen their working efficiency. Our study finds this challenge as an essential driver for achieving SS in the post-COVID-19 pandemic period.

In this study, “Lack of government enforcement and regulations for the social issue” is identified as another influential challenge to SS as a part of FSCM strategy in the post-pandemic period. Though the footwear industry is an emerging economy of Bangladesh, social compliance issues are not strictly followed in this industry, excluding...
some leading factories. Though the government has imposed several guidelines for the industries of Bangladesh during the COVID-19 period, they are not strictly following these guidelines. Therefore, the government of Bangladesh should closely monitor the social issues of this industry. We have found this challenge as a novel driver for ensuring SS, which was not found in any other previous studies.

This study finds another important challenge to SS as a part of FSCM strategy in the post-COVID context, namely “Unavailability of primary medical services”. As a part of ensuring workplace safety and employees’ health security, companies should have primary medical services (e.g. measuring body temperature, checking oxygen saturation, and blood pressure monitoring). The COVID-19 pandemic has pointed out the importance of these primary medical services to continue SC functions in the post-pandemic period. Several footwear companies in Bangladesh lack primary medical services. No other previous SCM research found this challenge to SS issues in the literature.

“Lack of training facility on health hygiene” is identified as another critical challenge to SS in our study. Since COVID-19 is a viral disease, personal protection is a prerequisite condition to be safe. Practitioners of the footwear industry should not only develop the health protocol but also train their workforces on how to keep them clean and safe. To draw a comparison, we found no other previous literature that included this challenge to SS.

In the post-pandemic period, the world will not be the same as it was before; we will get a new normal world where a big challenge needs to be addressed as “new normal community needs”, which has been recognized as a critical challenge to SS as a part of FSCM approach in our study. The COVID-19 pandemic predominantly affects the lifestyles of employees, e.g. online meetings, remote working, and physical activity. Moreover, throughout the pandemic, people were more interested in online shopping. Our study finds “New normal community needs” as a newly found critical challenge to SS in the post-COVID-19 period.

This study finds another challenge to SS of the FSC that is “problem in socio-cultural patterns and practices”. Sadly, due to COVID-19, people all around the world are being deprived of the most basic of human needs (e.g. food and education). As the pandemic forwards, the issues regarding socio-cultural patterns as of social and economic inequity are exacerbating. Several companies have come forward to help communities with such good practices as providing food, masks, and hand sanitizers during this pandemic. However, in the post-pandemic period, reducing inequalities among communities will be an essential challenge for ensuring SS in SCM. Among the previous studies, Fenner and Cernev (2021) discussed that reducing inequalities will be a great challenge for ensuring SDGs in the post-COVID-19 period; in contrast with that study, we find “problem in socio-cultural patterns and practices” as a critical challenge to SS for implementing FSCM strategies in the post-pandemic period.

Implications of the Study

The implications of this study can be categorized into two sections, i.e. theoretical and practical implications. Theoretical implications highlight the application of this research based on the applied framework. On the contrary, the real-world applications of this study in policy formulating are discussed under practical implications.

Theoretical Implications

To our knowledge, this is a new study in identifying the critical challenges to SS for implementing FSCM strategies in the post-COVID-19 context. As a result of this study, practitioners and policymakers will gain awareness about the SS problems in the post-COVID era, which will ensure the flexibility of the FSC. This study introduces four new critical challenges, i.e. “health protocol development”, “lack of training facility on health hygiene”, “lack of government enforcement and regulations for social issues”, “new normal community needs” among the identified total nine challenges, which were not found in any other previous literature. This study adopts the real-life application of the BWM to find out the relative importance of each challenge by computing their weights where we find consistent results by less pair-wise comparisons. Thus, we find the suitability of the BWM that can be further applied in such MCDM problems. The obtained ranking of the challenges will help practitioners and policymakers to understand the severity of each SS challenge, which will aid them in prioritizing and preparing themselves to address these challenges by undertaking flexible strategies. Furthermore, the relative weight of each challenge can be used as a reference for future research to explore the performance of SS of any company and manufacturing firm.

Practical Implications

This research will guide not only the footwear industry managers but also the other industry managers in formulating flexible strategic policies to ensure SS within their SCs. Also, from this study, other developing countries can learn about the critical challenges to SS in the post-COVID-19 period. In this study, we recommend the following flexible strategic approaches based on the identified
critical challenges that will not only ameliorate the social issues exacerbated by COVID-19 but also help in achieving several SDGs in the FSC.

- Assurance of job security and new employment opportunities During this pandemic, employees face temporary/permanent job cut down, which pushes them into a new miserable situation. Companies should not lay off employees; instead, they might cut a portion of wages, reducing the working hours of employees and through proper negotiations with trade unions to compensate for any economic losses of companies. Strong trade unions can negotiate with industry managers to protect any kind of lay off. Therefore, the presence of strong trade unions should be ensured in each company. Employees would need more secured jobs in the post-pandemic world, which should be ensured by employers. Companies should also concentrate on creating more job openings to rehire laid off staff. Industry managers may create more low wages jobs rather than high-paid salaries, which will increase more employment opportunities. Job security and more employment opportunities will help directly in achieving the SDG-8 ("Decent work and economic growth") and also play a pivotal role in attaining SDG-1 ("No poverty") and SDG-2 ("Zero hunger") by any business entity.

- Government regulations and strict enforcement Government may play an essential role in ensuring SS by establishing strict guidelines and enforcing them. Developing countries, like Bangladesh, are facing a lack of this approach. The government of Bangladesh has taken an initiative to provide cash incentives on exporting leather, leather products, and footwear. However, the government can also provide a benefits package to companies who follow social compliance issues, which will encourage practitioners to adopt social compliance issues strictly.

- Ensuring workplace safety and health wellbeing Workplace safety not only protects the health and wellbeing of workers but also boosts a company’s productivity. Practitioners should establish a health protocol to fight against viral diseases like COVID-19, train workers to keep the workplace healthy and clean and ensure that their employees have access to primary medical care. Furthermore, businesses should provide social opportunities (such as games and cultural programs) to enhance their mental health conditions. The policy as mentioned earlier will help any industries in achieving SDG-3 ("Good health and wellbeing").

- Company new policy development focusing on new normal community needs Companies should update their workstations in the post-COVID-19 era to create a safe workplace, which will consider physical distancing. Industry managers should reinvestigate the efficacy of distant, flexible, and blended working in the post-COVID 19 periods. Meanwhile, customers will be less interested in physical shopping in the near future due to safety concerns. Therefore, retail companies should be proactive to open an online sales channel to expand their businesses.

Conclusions and Recommendations for Future Research

The COVID-19 pandemic has demonstrated the vulnerability of global SC sustainability. During this pandemic, emerging economies have been severely impacted. As such, Bangladesh’s footwear industry has been subjected to the same social vulnerabilities as the economic downturn. We discovered that SS problems were not articulated nearly as much as the financial crisis caused by the pandemic. Therefore, this study was taken to observe the critical challenges to SS for FSCM in the context of FSC. This study contributes to the recent research articles in several ways. First, this is the first study that examines the critical challenges to SS in the post-COVID-19 era for formulating FSCM strategies. Secondly, this research identifies a total of nine critical challenges, four of which are new to any other study, namely “health protocol development”, “lack of training facility on health hygiene”, “lack of government enforcement and regulations for social issues”, and “new normal community needs”. Thirdly, this research uses the BWM to determine the degree of criticality of SS challenges, which needs fewer pair-wise comparison matrices, and the findings are consistent. Finally, in the post-COVID-19 era, we provide some flexible managerial guidelines whereby the footwear industry and the other industries may contribute to the achievement of SDG-1, 2, 3, and 8 along with their SCs.

This research has several drawbacks, even though it has many contributions. Only eight experts from eight footwear companies in Bangladesh are considered in this study. Any potential research could include more experts from different countries to obtain a deeper understanding of the critical challenges to SS and to strengthen the validity of the findings. Moreover, the applied BWM is incapable of dealing with uncertainty and ambiguity in decision-making processes, which can be handled by integrating fuzzy, rough, or Z numbers into this method (Petrudi et al., 2021). Also, for group decision-making, in the future Bayesian
BWM can be applied in different industrial cases. There might have causal relationships among the identified challenges, which could not be explored by the BWM. Other MCDM tools, such as FANP, ISM, and rough-DEMATEL can be applied in any future research to investigate the causal relationships among the identified challenges. In addition, the new methods named FUCOM and LBWA models can be used in any future studies to compare the efficiency of these models with the BWM for criteria evaluation. Though our study findings can be generalized for other similar industries for developing economies, the findings might be different for other industries, because the challenges to SS largely depend on the nature of an industry and the context of a country, thus future research might look at the critical challenges to SS for other sectors of different countries and compare them to the findings of this study. In our study, we find only nine critical challenges to SS in the post-COVID-19 pandemic, any future studies can include more SS challenges under several categories and sub-categories.

The proposed model applied in this study could be used to investigate the challenges to SDGs posed by the COVID-19 pandemic in the future. The study’s SS challenge indexes, along with their respective weights, might be used to evaluate any firm’s SS performance in any future studies. Since the COVID-19 pandemic has also shaken the economic sustainability of companies over the world, the given model could be used in the future to explore the critical challenges to economic sustainability in the context of the COVID-19 pandemic for any industry’s SC activities.

Appendix

See Tables 10, 11 and 12.

Table 10  Best challenge over other challenges by Experts-2–8

| Best to others | $PC_1$ | $PC_2$ | $PC_3$ | $PC_4$ | $PC_5$ | $PC_6$ | $PC_7$ | $PC_8$ | $PC_9$ |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| E-2           |     1  |     2  |     6  |     8  |     3  |     5  |     4  |     9  |     7  |
| E-3           |     3  |     2  |     7  |     6  |     1  |     5  |     4  |     8  |     9  |
| E-4           |     2  |     1  |     3  |     8  |     7  |     4  |     6  |     9  |     5  |
| E-5           |     3  |     2  |     8  |     4  |     1  |     7  |     5  |     9  |     6  |
| E-6           |     4  |     3  |     9  |     6  |     1  |     2  |     8  |     5  |     7  |
| E-7           |     1  |     2  |     3  |     4  |     6  |     5  |     8  |     9  |     7  |
| E-8           |     3  |     2  |     5  |     4  |     1  |     7  |     6  |     9  |     8  |

Table 11  Other challenges over the worst challenge constructed by Experts-2–8

| Others to worst | E-2 | E-3 | E-4 | E-5 | E-6 | E-7 | E-8 |
|-----------------|-----|-----|-----|-----|-----|-----|-----|
|                 | $PC_8$ | $PC_9$ | $PC_8$ | $PC_8$ | $PC_8$ | $PC_8$ | $PC_8$ | $PC_8$ |
| $PC_1$          |     9  |     5  |     7  |     4  |     4  |     9  |     4  |
| $PC_2$          |     6  |     7  |     9  |     7  |     7  |     8  |     6  |
| $PC_3$          |     4  |     2  |     8  |     2  |     1  |     7  |     5  |
| $PC_4$          |     8  |     3  |     2  |     8  |     5  |     6  |     7  |
| $PC_5$          |     7  |     9  |     4  |     9  |     9  |     5  |     9  |
| $PC_6$          |     5  |     8  |     5  |     3  |     6  |     4  |     8  |
| $PC_7$          |     6  |     6  |     6  |     5  |     2  |     3  |     3  |
| $PC_8$          |     1  |     4  |     1  |     1  |     8  |     1  |     1  |
| $PC_9$          |     3  |     1  |     3  |     6  |     3  |     2  |     2  |
Table 12 Optimal weights of critical challenges by Experts-2–8

| Code of challenge | E-2 Optimal weight | E-3 | E-4 | E-5 | E-6 | E-7 | E-8 |
|-------------------|--------------------|-----|-----|-----|-----|-----|-----|
| $PC_1$            | 0.2908             | 0.1320 | 0.1948 | 0.1308 | 0.0990 | 0.3133 | 0.1333 |
| $PC_2$            | 0.2006             | 0.1980 | 0.3061 | 0.1962 | 0.1320 | 0.1920 | 0.1999 |
| $PC_3$            | 0.0669             | 0.0566 | 0.1299 | 0.0491 | 0.0222 | 0.1280 | 0.0800 |
| $PC_4$            | 0.0501             | 0.0660 | 0.0487 | 0.0981 | 0.0660 | 0.0960 | 0.1000 |
| $PC_5$            | 0.1337             | 0.2977 | 0.0557 | 0.3022 | 0.2977 | 0.0640 | 0.2925 |
| $PC_6$            | 0.0802             | 0.0792 | 0.0974 | 0.0561 | 0.1980 | 0.0768 | 0.0571 |
| $PC_7$            | 0.1003             | 0.0990 | 0.0649 | 0.0785 | 0.0495 | 0.0480 | 0.0666 |
| $PC_8$            | 0.0201             | 0.0495 | 0.0247 | 0.0235 | 0.0792 | 0.0270 | 0.0206 |
| $PC_9$            | 0.0573             | 0.0222 | 0.0779 | 0.0654 | 0.0566 | 0.0549 | 0.0500 |
| $\zeta_{1}^{L^*}$ | 0.1103             | 0.0982 | 0.0835 | 0.0903 | 0.0982 | 0.0707 | 0.1074 |

Funding  Research of Prof. Dr. Ernesto D.R. Santibanez Gonzalez was partially funded by FONDECYT, Award Number 1190559.

Declarations

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

References

Abid, G., Ahmed, S., Elahi, N. S., & Ilyas, S. (2020). Antecedents and mechanisms of employee well-being for social sustainability: A sequential mediation. Sustainable Production and Consumption, 24, 79–89. https://doi.org/10.1016/j.spc.2020.06.011

Ahmed, S., Taqi, H. M. M., Farabi, Y. I., Sarker, M., Ali, S. M., & Sankaranarayanan, B. (2021). Evaluation of Flexible Strategies to Manage the COVID-19 Pandemic in the Education Sector. Global Journal of Flexible Systems Management, 2021, 1–25. https://doi.org/10.1007/S40171-021-00267-9

Akhtar, M., & Sushil. (2018). Managing strategic performance in a dynamic business environment: A study of two Indian oil companies. Global Business and Organizational Excellence, 37, 47–62. https://doi.org/10.1002/JOE.21876

Ali, Z., Mahmood, T., Ullah, K., & Khan, Q. (2021). Einstein geometric aggregation operators using a novel complex interval-valued pythagorean fuzzy setting with application in green supplier chain management. Reports in Mechanical Engineering, 2(1), 105–134. https://doi.org/10.31181/rme2001020105

Amankwah-Amoah, J. (2020). Stepping up and stepping out of COVID-19: New challenges for environmental sustainability policies in the global airline industry. Journal of Cleaner Production, 271, 123000. https://doi.org/10.1016/j.jclepro.2020.123000

Appolloni, A., D’Adamo, I., Gastaldi, M., Santibanez-Gonzalez, E. D. R., & Settembre-Blundo, D. (2021). Growing e-waste management risk awareness points towards new recycling scenarios: The view of the Big Four’s youngest consultants. Environmental Technology & Innovation, 23, 101716. https://doi.org/10.1016/j.eti.2021.101716

Bansal, P. (2005). Evolving sustainably: A longitudinal study of corporate sustainable development. Strategic Management Journal, 26(3), 197–218. https://doi.org/10.1002/smj.441

Basch, C. H., Hillyer, G. C., Erwin, Z. M., Mohlman, J., Cosgrove, A., & Quinones, N. (2020). News coverage of the COVID-19 pandemic: Missed opportunities to promote health sustaining behaviors. Infection, Disease & Health, 25(3), 205–209. https://doi.org/10.1016/j.idh.2020.05.001

Bauer, A., & Weber, E. (2020). COVID-19: How much unemployment was caused by the shutdown in Germany? Applied Economics Letters. https://doi.org/10.1080/13504851.2020.1789544

Biswa, S. (2020). Measuring performance of healthcare supply chains in India: A comparative analysis of multi-criteria decision making methods. Decision Making: Applications in Management and Engineering, 3(2), 162–189. https://doi.org/10.31181/dmae2003162b

Brauers, W. K., & Zavadskas, E. K. (2006). The MOORA method and its application to privatization in a transition economy. Control and Cybernetics, 35(2), 445–469.

Bu, F., Steptoe, A., Mak, H. W., & Fancourt, D. (2020). Time-use and mental health during the COVID-19 pandemic: A panel analysis of 55,204 adults followed across 11 weeks of lockdown in the UK. MedRxiv. https://doi.org/10.1101/2020.08.18.20177345

Chowdhury, M. T., Sarkar, A., Paul, S. K., & Moktadir, M. A. (2020). A case study on strategies to deal with the impacts of COVID-19 pandemic in the food and beverage industry. Operations Management Research. https://doi.org/10.1007/s12063-020-00166-9

Chowdhury, P., Paul, S. K., Kaisar, S., & Moktadir, M. A. (2021). COVID-19 pandemic related supply chain studies: A systematic review. Transportation Research Part E: Logistics and Transportation Review. https://doi.org/10.1016/j.trce.2021.102271

Costa, C. A. B. E., & Vansnick, J. (1997). Applications of the MACBETH approach in the framework of an additive aggregation model. Journal of Multi-criteria Decision Analysis, 6(July 1995), 107–114.

D’Adamo, I., Falcone, P. M., Gastaldi, M., & Morone, P. (2019). A Social analysis of the olive oil sector: The role of family business. Resources, 8, 151. https://doi.org/10.3390/RESOURCES8030151

D’Adamo, I., Gastaldi, M., & Morone, P. (2020). The post COVID-19 green recovery in practice: Assessing the profitability of a policy...
proposal on residential photovoltaic plants. *Energy Policy*, 147, 111910. https://doi.org/10.1016/J.ENPOL.2020.111910

D'Adamo, I., & Lupi, G. (2021). Sustainability and resilience after COVID-19: A circular premium in the fashion industry. *Sustainability, 13*, 1861. https://doi.org/10.3390/SU13041861

D’Eusanio, M., Zamagni, A., & Petti, L. (2019). Social sustainability and supply chain management: Methods and tools. *Journal of Cleaner Production, 235*, 178–189. https://doi.org/10.1016/j.jclepro.2019.06.323

Dhaka Tribune. (2021). COVID-19 pandemic affects 77% of apparel and footwear industries in Bangladesh. Retrieved April 17, 2021, from https://www.textiletoday.com.bd/covid-19-pan demic-affects-77-apparel-footwear-industries-bangladesh/

Dubey, R., Gunasekaran, A., Sushil, & Singh, T. (2015). Building theory of sustainable manufacturing using total interpretive structural modelling. *International Journal of Systems Science: Operations and Logistics*, 2(4), 231–247. https://doi.org/10.1080/23302674.2015.1025890

Edwards, W. (1977). How to use multiattribute utility measurement for social decisionmaking. *IEEE Transactions on Systems, Man, and Cybernetics*, 7(5), 326–340. https://doi.org/10.1109/TSMC.1977.4309720

Elias, A. A. (2021). Kerala’s innovations and flexibility for Covid-19 recovery: Storytelling using systems thinking. *Global Journal of Flexible Systems Management, 22*(S1), 33–43. https://doi.org/10.1007/s40171-021-00268-8

Faiz, S., Sabun, W., Nawaz, S., ur Rehman, A., & Wałtroński, J. (2021). Best-Worst method and Hamacher aggregation operations for intuitionistic 2-tuple linguistic sets. *Expert Systems with Applications, 181*, 115088. https://doi.org/10.1016/j.eswa.2021.115088

Fattaj, S.-R., Kabir, G., Eghujovbo, V., Ali, S. M., & Paul, S. K. (2020). Modeling transportation disruptions in the supply chain of automotive parts manufacturing company. *International Journal of Production Economics*, 222, 107511. https://doi.org/10.1016/j.ijpeco.2020.102726

Fenner, R., & Cernev, T. (2021). The implications of the Covid-19 pandemic for delivering the Sustainable Development Goals. *Futures*, 128, 102726. https://doi.org/10.1016/j.futures.2021.102726

Filho, W. L., Brandli, L. L., Salvia, A. L., Rayman-Bacchus, L., & Platje, J. (2020). COVID-19 and the UN sustainable development goals: Threat to solidarity or an opportunity? *Sustainability (Switzerland)*, 12(13), 1–14. https://doi.org/10.3390/su12133543

Fortune. (2020). Coronavirus impact: 94% of the Fortune 1000 are seeing supply chain disruptions|Fortune. Retrieved September 1, 2020, from https://fortune.com/2020/02/21/fortune-1000-corona-virus-china-supply-chain-impact/

Gerbeti, A. (2021). Market mechanisms for reducing emissions and the introduction of a flexible consumption tax. *Global Journal of Flexible Systems Management, 2021*, 1–18. https://doi.org/10.1007/S40171-021-00283-9

Govindan, K., Mina, H., & Alavi, B. (2020). A decision support system for demand management in healthcare supply chains under uncertainty. *Transportation Research Interdisciplinary Perspectives, 8*, 100240. https://doi.org/10.1016/j.trip.2020.100240

Guarte, J. M., & Barrios, E. B. (2006). Estimation under purposive sampling. *Communications in Statistics Simulation and Computation*, 35(2), 277–284. https://doi.org/10.1080/03610910600591610

Gupta, A. K., & Gupta, N. (2021). Environment practices mediating the environmental compliance and firm performance: An institutional theory perspective from emerging economies. *Global Journal of Flexible Systems Management, 22*, 157–178. https://doi.org/10.1007/S40171-021-00266-W

Gupta, H., Kusi-Sarpong, S., & Rezaei, J. (2020). Barriers and overcoming strategies to supply chain sustainability innovation. *Resources, Conservation and Recycling, 161*, 104819. https://doi.org/10.1016/j.resconrec.2020.104819

He, H., & Harris, L. (2020). The impact of Covid-19 pandemic on corporate social responsibility and marketing philosophy. *Journal of Business Research, 116*, 176–182. https://doi.org/10.1016/j.jbusres.2020.05.030

Heckmann, I., Comes, T., & Nickel, S. (2015). A critical review on supply chain risk—Definition, measure and modeling. *Omega, 52*, 119–132. https://doi.org/10.1016/j.omega.2014.10.004

Ho, W., Zheng, T., Yildiz, H., & Talluri, S. (2015). Supply chain risk management: A literature review. *International Journal of Production Research, 53*(16), 5031–5069. https://doi.org/10.1080/00207543.2015.1030467

Hwang, C.-L., & Yoon, K. (1981). Methods for multiple attribute decision making (pp. 58–191). Berlin: Springer. https://doi.org/10.1007/978-3-642-48318-9_3

Ikram, M. (2021). Models for predicting non-renewable energy competing with renewable source for sustainable energy development: case of Asia and Oceania Region. *Global Journal of Flexible Systems Management, 2021*, 1–28. https://doi.org/10.1007/S40171-021-00285-7

ILO. (2020). *COVID-19: Stimulating the economy and employment: ILO: As job losses escalate, nearly half of global workforce at risk of losing livelihoods*. Retrieved September 1, 2020, from https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_743036/lang–en/index.htm

Islam, M. H., Sarker, M. R., Hossain, M. I., Ali, K., & Noor, K. M. A. (2020). Towards sustainable supply chain management (SSCM): A case of leather industry. *Journal of Operations and Strategic Planning*, 3(1), 81–98. https://doi.org/10.1177/2516600X20924313

Kala, K., Bolia, N. B., & Sushil. (2020). Effects of socio-economic factors on quantity and type of municipal solid waste. *Management of Environmental Quality: An International Journal*, 31, 877–894. https://doi.org/10.1108/MEQ-11-2019-0244

Karmaker, C. L., Ahmed, T., Ahmed, S., Ali, S. M., Moktadir, M. A., & Kabir, G. (2021). Improving supply chain sustainability in the context of COVID-19 pandemic in an emerging economy: Exploring drivers using an integrated model. *Sustainable Production and Consumption, 26*, 411–427. https://doi.org/10.1016/j.spc.2020.09.019

Keeble, B. R. (1988). The Brundtland report: ‘Our common future.’ *Medicine and War*, 4(1), 17–25. https://doi.org/10.1080/07488008908408783

Klassen, R. D., & Vereecke, A. (2012). Social issues in supply chains: Capabilities link responsibility, risk (opportunity), and performance. *International Journal of Production Economics, 140*(1), 103–115. https://doi.org/10.1016/j.ijpe.2012.01.021

Kumar, A., Luthra, S., Mangla, S. K., & Kazançoglu, Y. (2020). COVID-19 impact on sustainable production and operations.
management. Sustainable Operations and Computers, 1, 1–7. https://doi.org/10.1016/j.suscoc.2020.06.001

Kumar, S., Haleem, A., & Sushil. (2019). Assessing innovativeness of manufacturing firms using an intuitionistic fuzzy based MCDM framework. Benchmarking: An International Journal, 26(6), 1823–1844. https://doi.org/10.1108/BII-12-2017-0343

Labuschagne, C., & Brent, A. C. (2005). Sustainable Project Life Cycle Management: The need to integrate life cycles in the manufacturing sector. International Journal of Project Management, 23(2), 159–168. https://doi.org/10.1016/j.ijproman.2004.06.003

Lightcastle. (2020). The effect of COVID-19 on Bangladesh’s Apparel Industry—LightCastle partners. Retrieved September 12, 2020, from https://www.lightcastlebd.com/insights/2020/03/29/the-effect-of-covid-19-on-bangladesh-apparel-industry

Lin, Q., Zhao, S., Gao, D., Lou, Y., Yang, S., Musa, S. S., Wang, M. H., Cai, Y., Wang, W., Yang, L., & He, D. (2020). A conceptual model for the coronavirus disease 2019 (COVID-19) outbreak in Wuhan, China with individual reaction and governmental action. International Journal of Infectious Diseases, 93, 211–216. https://doi.org/10.1016/j.ijid.2020.02.058

Lipschutz, R. D. (2004). Sweating it out: NGO campaigns and trade union empowerment. Development in Practice, 14(1–2), 197–209. https://doi.org/10.1080/0961452032000170767

Louviere, J. J., & Woodworth, G. (1982). On the design and analysis of simulated choice or allocation experiments in travel choice modelling. Transportation Research Record, 890, 11–17. https://doi.org/10.2307/3151440

Louviere, J. J., & Woodworth, G. (1983). Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data. Journal of Marketing Research, 20(4), 350. https://doi.org/10.2307/3151440

Majumdar, A., Shaw, M., & Sinha, S. K. (2020). COVID-19 debunks the myth of socially sustainable supply chain: A case of the clothing industry in South Asian countries. Sustainable Production and Consumption, 24, 150–155. https://doi.org/10.1016/j.spc.2020.07.001

Malek, J., & Desai, T. N. (2019). Prioritization of sustainable manufacturing barriers using Best Worst Method. Journal of Cleaner Production, 226, 589–600. https://doi.org/10.1016/j.jclepro.2019.04.056

Mani, V., Agarwal, R., Gunasekaran, A., Papadopoulos, T., Dubey, R., & Childe, S. J. (2016). Social sustainability in the supply chain: Construct development and measurement validation. Ecological Indicators, 71, 270–279. https://doi.org/10.1016/j.ecolind.2016.07.007

Mani, V., Gunasekaran, A., & Delgado, C. (2018). Enhancing supply chain performance through supplier social sustainability: An emerging economy perspective. International Journal of Production Economics, 195, 259–272. https://doi.org/10.1016/j.ijpe.2017.10.025

Mani, V., Jabbour, C. J. C., & Mani, K. T. N. (2020). Supply chain social sustainability in small and medium manufacturing enterprises and firms’ performance: Empirical evidence from an emerging Asian economy. International Journal of Production Economics, 227, 107656. https://doi.org/10.1016/j.ijpe.2020.107656

Masud, I., Ramadhan, A., Restuputri, D. P., & Amallynda, I. (2021). The effect of traceability system and managerial initiative on Indonesian food cold chain performance: A Covid-19 pandemic perspective. Global Journal of Flexible Systems Management. https://doi.org/10.1007/S40171-021-00281-X

McCarthy, I., Lawrence, T., Wixted, B., & Gordon, B. (2010). A multidimensional conceptualization of environmental velocity. Academy of Management Review, 35(4), 604–626. https://doi.org/10.5465/AMR.2010.53503029

McCloskey, B., Zumla, A., Ippolito, G., Blumberg, L., Arbon, P., Cicero, A., Enderick, T., Lim, P. L., & Borodina, M. (2020). Mass gathering events and reducing further global spread of COVID-19: A political and public health dilemma. The Lancet, 395(10230), 1096–1099. https://doi.org/10.1016/S0140-6736(20)30681-4

Meuleman, L. (2013). Cultural diversity and sustainability metagovernance. In L. Meuleman (Ed.), Transgovernance (pp. 37–81). Berlin: Springer. https://doi.org/10.1007/978-3-642-28009-2_2

Moktadir, A., Rahman, T., Jabbour, C. J. C., Mithun Ali, S., & Kabir, G. (2018b). Prioritization of drivers of corporate social responsibility in the footwear industry in an emerging economy: A fuzzy AHP approach. Journal of Cleaner Production, 201, 369–381. https://doi.org/10.1016/j.jclepro.2018.07.326

Moktadir, M. A., Ali, S. M., Jabbour, C. J. C., Paul, A., Ahmed, S., Sultana, R., & Rahman, T. (2019). Key factors for energy-efficient supply chains: Implications for energy policy in emerging economies. Energy, 189, 116129. https://doi.org/10.1016/j.energy.2019.116129

Moktadir, M. A., Dwivedi, A., Khan, N. S., Paul, S. K., Khan, S. A., Ahmed, S., & Sultana, R. (2021). Analysis of risk factors in sustainable supply chain management in an emerging economy of leather industry. Journal of Cleaner Production, 283, 124641. https://doi.org/10.1016/j.jclepro.2020.124641

Moktadir, M. A., Kumar, A., Ali, S. M., Paul, S. K., Sultana, R., & Rezaei, J. (2020). Critical success factors for a circular economy: Implications for business strategy and the environment. Business Strategy and the Environment, 29(8), 3611–3635. https://doi.org/10.1002/bse.2600

Moktadir, M. A., Rahman, T., Rahman, M. H., Ali, S. M., & Paul, S. K. (2018a). Drivers to sustainable manufacturing practices and circular economy: A perspective of leather industries in Bangladesh. Journal of Cleaner Production, 174, 1366–1380. https://doi.org/10.1016/j.jclepro.2017.11.063

Munini, Z. H., Sorn-Fries, H., & Dushenko, M. (2020). Identifying the appropriate governance model for green port management: Applying Analytic Network Process and Best–Worst methods to ports in the Indian Ocean Rim. Journal of Cleaner Production, 268, 122156. https://doi.org/10.1016/j.jclepro.2020.122156

Munny, A. A., Ali, S. M., Kabir, G., Moktadir, M. A., Rahman, T., & Mahtab, Z. (2019). Enables of social sustainability in the supply chains: An example of footwear industry from an emerging economy. Sustainable Production and Consumption, 20, 230–242. https://doi.org/10.1016/j.spc.2019.07.003

Németh, B., Molnár, A., Bozóki, S., Wijaya, K., Inotai, A., Campbell, J. D., & Kaló, Z. (2019). Comparison of weighting methods used in multicriteria decision analysis frameworks in healthcare with focus on low-and middle-income countries. Journal of Comparative Effectiveness Research, 8(4), 195–204. https://doi.org/10.2217/cer-2018-0102

New, S. J. (2015). Modern slavery and the supply chain: The limits of corporate social responsibility? Supply Chain Management: An International Journal, 20(6), 697–707. https://doi.org/10.1108/SCM-06-2015-0201

Ozili, P. K., & Arun, T. (2020). Spillover of COVID-19: Impact on the Global Economy. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3562570

Pamucar, D., Stević, Ž., & Sremac, S. (2018). A new model for determining weight coefficients of criteria in MCDM models: Full consistency method (FUCOM). Symmetry, 10(9), 393. https://doi.org/10.3390/sym10090393

Paul, S. K., & Chowdhury, P. (2020). Strategies for managing the impacts of disruptions during COVID-19: An example of toilet
paper. *Global Journal of Flexible Systems Management*, 21(3), 283–293. https://doi.org/10.1007/S40171-020-00248-4

Pérez Vergara, I. G., López Gómez, M. C., Lopes Martínez, I., & Vargas Hernández, J. (2021). Strategies for the preservation of service levels in the inventory management during COVID-19: A case study in a company of biosafety products. *Global Journal of Flexible Systems Management*, 22(1), 65–80. https://doi.org/10.1007/S40171-021-00271-Z

Petrucci, S. H. H., Ahmadi, H. B., Rehman, A., & Liou, J. J. H. (2021). Assessing suppliers considering social sustainability innovation factors during COVID-19 disaster. *Sustainable Production and Consumption*, 27, 1869–1881. https://doi.org/10.1016/j.spc.2021.04.026

Popkova, E., DeLo, P., & Sergi, B. S. (2021). Corporate social responsibility amid social distancing during the COVID-19 crisis: BRICS vs. OECD countries. *Research in International Business and Finance*, 55, 101315. https://doi.org/10.1016/j.ribaf.2020.101315

Queiroz, M. M., Ivanov, D., Dolgui, A., & Fosso Wamba, S. (2020). Impacts of epidemic outbreaks on supply chains: Mapping a research agenda amid the COVID-19 pandemic through a structured literature review. *Annals of Operations Research*. https://doi.org/10.1007/s10479-020-03685-7

Rezaei, J. (2015). Best–worst multi-criteria decision-making method. *Omega (United Kingdom)*, 53, 49–57. https://doi.org/10.1016/j.omega.2014.11.009

Rezaei, J., Kothadiya, O., Tavasszy, L., & Kroesen, M. (2018). Quality assessment of airline baggage handling systems using SERVQUAL and BWM. *Tourism Management*, 66, 85–93. https://doi.org/10.1016/j.tourman.2017.11.009

Saaty, R. W. (1987). The analytic hierarchy process—What it is and how it is used. *Mathematical Modelling*, 9(3–5), 161–176. https://doi.org/10.1016/0277-5387(87)90473-8

Saaty, T. L. (1996). *Decision making with dependence and feedback: The analytic network process*. University of Pittsburgh.

Sahebi, I. G., Masoomi, B., & Ghorbani, S. (2020). Expert oriented approach for analyzing the blockchain adoption barriers in humanitarian supply chain. *Technology in Society*, 63, 101427. https://doi.org/10.1016/j.techsoc.2020.101427

Sarker, M. R., Ali, S. M., Paul, S. K., & Munim, Z. H. (2021). Measuring sustainability performance using an integrated model. *Measurement*, 194, 109931. https://doi.org/10.1016/j.measurement.2021.109931

Sarkis, J., Cohen, M. J., Dewick, P., & Schröder, P. (2020). A brave new world: Lessons from the COVID-19 pandemic for transitioning to sustainable supply and production. *Resources, Conservation and Recycling*, 159, 104894. https://doi.org/10.1016/j.resconres.2020.104894

Sarkis, J., Helms, M. M., & Hervani, A. A. (2010). Reverse logistics and social sustainability. *Corporate Social Responsibility and Environmental Management*, 17(6), 337–354. https://doi.org/10.1002/csr.220

Schönborn, G., Berlin, C., Pinzone, M., Hanisch, C., Georgoulas, K., & Lanz, M. (2019). Why social sustainability counts: The impact of corporate social sustainability culture on financial success. *Sustainable Production and Consumption*, 17, 1–10. https://doi.org/10.1016/j.spc.2018.08.008

Settembre-Blundo, D., González-Sánchez, R., Medina-Salgado, S., & García-Muña, F. E. (2021). Flexibility and resilience in corporate decision making: A new sustainability-based risk management system in uncertain times. *Global Journal of Flexible Systems Management*. https://doi.org/10.1007/S40171-021-00277-7

Shahed, K. S., Azeem, A., Ali, S. M., & Moktadir, M. A. (2021). A supply chain disruption risk mitigation model to manage COVID-19 pandemic risk. *Environmental Science and Pollution Research*, 2021, 1–16. https://doi.org/10.1007/S11356-020-12289-4

Sharma, A., Adhikary, A., & Borah, S. B. (2020). Covid-19’s impact on supply chain decisions: Strategic insights from NASDAQ 100 firms using Twitter data. *Journal of Business Research*, 117, 443–449. https://doi.org/10.1016/J.JBUSRES.2020.05.035

Sharma, S., & Ruud, A. (2003). On the path to sustainability: Integrating social dimensions into the research and practice of environmental management. *Business Strategy and the Environment*, 12(4), 205–214. https://doi.org/10.1002/bse.566

Sharma, V., Kumar, A., & Kumar, M. (2021). A framework based on BWM for big data analytics (BDA) barriers in manufacturing supply chains. *Materials Today: Proceedings*. https://doi.org/10.1016/j.matpr.2021.03.374

Shukla, S. K., Sushil, & Sharma, M. K. (2019). Managerial paradox toward flexibility: Emergent views using thematic analysis of literature. *Global Journal of Flexible Systems Management*, 20(4), 349–370. https://doi.org/10.1007/s40171-019-00220-x

Somani, M., Srivastava, A. N., Gummadivalli, S. K., & Sharma, A. (2020). Indirect implications of COVID-19 towards sustainable environment: An investigation in Indian context. *Bioresource Technology Reports*, 11, 100491. https://doi.org/10.1016/j.biter.2020.100491

Suhi, S. A., Enayet, R., Haque, T., Ali, S. M., Moktadir, M. A., & Paul, S. K. (2019). Environmental sustainability assessment in supply chain: An emerging economy context. *Environmental Impact Assessment Review*, 79, 106306. https://doi.org/10.1016/j.eiar.2019.106306

Sumner, A., Hoy, C., & Ortiz-juarez, E. (2020). Estimates of the impact of COVID-19 on global poverty. https://doi.org/10.35188/UNU-WIDER/2020/800-9

Sushil. (2015). Valuation of flexibility. *Global Journal of Flexible Systems Management*, 16(3), 219–220. https://doi.org/10.1007/s40171-015-0100-6

Sushil. (2017). Multi-criteria valuation of flexibility initiatives using integrated TISM-IRP with a big data framework. *Production Planning & Control*, 28(11–12), 999–1010. https://doi.org/10.1080/09537287.2017.1336794

Sushil. (2018). Flexible systems methodology: A mixed-method/multi-method research approach. *Global Journal of Flexible Systems Management*, 19(2), 109–110. https://doi.org/10.1007/s40171-018-0190-z

Tomei, C. (2021). Lessons from the COVID-19 pandemic for accelerating sustainable development. *Environmental Research*, 19(October 2020), 110482. https://doi.org/10.1016/j.envres.2020.110482

Wood, D. J. (1991). Corporate social performance revisited. *Academy of Management Review*, 16(4), 691–718. https://doi.org/10.5465/amr.1991.4279616

World Economic Forum. (2020). *Here’s how global supply chains will change after COVID-19*. World Economic Forum. Retrieved September 12, 2020 from https://www.weforum.org/agenda/2020/05/this-is-what-global-supply-chains-will-look-like-after-covid-19/

World footwear. (2020a). *Bangladesh’s leather exports down by 22%*. Retrieved September 9, 2020 from https://www.worldfootwear.com/news/bangladeshls-leather-exports-down-by-22/5242.html

World Footwear. (2020b). *Footwear consumption to decline 22.5% in 2020 as supply chain gets re-organised*. Retrieved September 12, 2020, from https://www.worldfootwear.com/news/footwear-consumption-to-decline-225-in-2020-as-supply-chain-gets-re-orga nised/4867.html

Worldometer. (2021). *https://www.worldometers.info/coronavirus/?utm_campaign=homeAdvegas1*

WTO. (2021). *WTO*|2021 Press Releases—World trade primed for strong but uneven recovery after COVID 19 pandemic shock—
Zˇizˇovic´, M., & Pamuc ˇar, D. (2019). New model for determining
Springer Nature remains neutral with regard to
jurisdictional claims in published maps and institutional affiliations.

Zhou, C., Su, F., Pei, T., Zhang, A., Du, Y., Luo, B., Cao, Z., Wang,
Zadeh, L. (1963). Optimality and non-scalar-valued performance
criteria. IEEE Transactions on Automatic Control, 8(1), 59–60.
https://doi.org/10.1109/TAC.1963.1105511

Zambrano-Monserrate, M. A., Ruano, M. A., & Sanchez-Alcalde, L.
(2020). Indirect effects of COVID-19 on the environment.
Science of the Total Environment, 728, 138813. https://doi.org/
10.1016/j.scitotenv.2020.138813

Zhang, Y., & Ma, Z. F. (2020). Impact of the COVID-19 pandemic on
mental health and quality of life among local residents in
Liaoning Province, China: A cross-sectional study. International
Journal of Environmental Research and Public Health, 17(7),
2381. https://doi.org/10.3390/ijerph17072381

Zhou, C., Su, F., Pei, T., Zhang, A., Du, Y., Luo, B., Cao, Z., Wang,
J., Yuan, W., Zhu, Y., Song, C., Chen, J., Xu, J., Li, F., Ma, T.,
Jiang, L., Yan, F., Yi, J., Hu, Y., & Xiao, H. (2020). COVID-19:
Challenges to GIS with big data. Geography and Sustainability,
1(1), 77–87. https://doi.org/10.1016/j.geosus.2020.03.005

Žižović, M., & Pamućar, D. (2019). New model for determining
criteria weights: Level Based Weight Assessment (LBWA)
model. Decision Making: Applications in Management and
Engineering, 2(2), 126–137. https://doi.org/10.31181/dma
me190210z

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tainability. Current research of Dr. Santibanez-
Gonzalez is characterized by integrating mathematical models, big-data, and internet technology
to understand and model how climate change and
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and the performance of companies and organizations. He is serving as
Associate Editor of Journal of Cleaner Production (Elsevier), Journal
of Intelligent Manufacturing (Springer), Modern Supply Chain
Research and Applications (Emerald, new journal), International
Journal of Big Data Mining for Global Warming, and Heliyon
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Chinese Academy of Science and Elsevier. He has been the Managing
Guest Editor of several special issues in top-tier journals including
European Journal of Operational Research, Journal of Cleaner
Production, International Journal of Production Research, Sustain-
ability, and Guest Editor for special issues in journals such as Inter-
national Journal of Production Economics, Computers and Industrial
Engineering, and Science of Total Environment. He has also served as
regional editor for International Journal of Physical Distribution and
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published more than 40 articles in top-tier journals. He has had vis-
iting appointments in several universities of Brazil, China, and UK.
Currently, he is supervising and co-supervising graduate students in
Brazil, Chile and China. He leads the Circular Economy and Sus-
tainability 4.0 Initiative (CES4.0) and is involved in COVID-19
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jects and provided solution to real problems in different countries
such as Argentina, Bolivia, Brazil, Ecuador, Chile, Angola, China,
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