

Developing a framework for enhancing survivability of sustainable supply chains during and post COVID-19 pandemic

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Abstract: The pandemic has created a restrictive working system including remote working, and flexible hours for the firms and employees all around the globe thus, transforming into a platform economy may reduce unemployment and enhance job opportunities. Therefore, firms are now trying to identify the ways for enhancing survivability of Sustainable Supply Chains (SSCs). This study has made an effort to develop a framework for enhancing survivability of SSCs to survive in and post COVID-19 pandemic. This study has utilized Stepwise Weight Assessment Ratio Analysis (SWARA) method for identifying the significant factors for enhancing survivability of SSCs to be focused in pandemic situation. The study revealed that ‘Supply Chain Network Viability (SCV)’ is the main criterion for managing buyer-supplier relationship and enhancing survivability of SSCs during and post COVID-19 situation. This study is helpful for firms, suppliers, and other stakeholders to focus on the identified factors for healthier future.

Keywords: Sustainable Supply chains (SSCs); Survivability; Buyer-supplier relationship; Viability; Digital data driven SCs; COVID-19 pandemic.

1. Introduction

Global Supply Chains (GSCs) are facing demand-supply disruptions all across the world. The global and local economies are severely affected by Corona-virus outbreaks and thus, supply availability has been reduced and misbalanced with the rising demand of essential goods. Despite that many sources of risks are uncontrollable, resilient supply chains systems can be immediately developed (Araz et al., 2020). Since early February 2020, COVID-19 cases are continuously increasing in USA, Europe and Asia bringing border restrictions, lockdowns and quarantine, and consequently there is a huge dip in the international trade, declining between 13 % and 32% (WTO, 2020). Most of the GSCs have become prone to this uncontrollable pandemic (Ivanov, 2020). The global cost of pandemic depends on the number of affected countries and then on the required duration of lockdowns policies. The spatial extent of the pandemic is the most important driver of global cost (Guan et al., 2020). The COVID-19 has not only relentlessly affected economies and communities rather pose a threat

and a question to the resiliency of SCs of all the industries. Overall, SCs of the apparel, jewelry, shoes, electronics durables, and IT industry are significantly affected by COVID-19 directly (Mckinsey, 2020). 94% of the fortune 1000 companies are being influenced by the disruptions occurred due to COVID-19 (Fortune, 2020). The data obtained by Resilinc system exhibits that the world's largest 1000 SCs own more than 12000 facilities in quarantine areas (Ivanov and Dolgui, 2020; Linton and Vakil, 2020). A report by Dun and Bradstreet (2020), a data analytics firm reveals that 51000 companies have direct suppliers and approximately 5 million firms have tier-two suppliers in the region Wuhan, origin of COVID-19. The threat from corona virus has transformed the traditional jobs culture and therefore, platform companies are fostering remote working, flexible working hours, and delocalized work to make earning a living easier for individuals (Hoang et al., 2020). The social responsibilities can be well performed with flexible or limited hours of working.

The global sustainability includes economic, social & environmental issues and enforces the firms to re-think and redesign their practices to manage their relationships with suppliers by collaboration or assessment (Ni and Sun, 2018). Supplier's collaboration and governance are equally significant to manage their relationship with buyers for providing sustainable outcomes (Reuter et al., 2010; Badraoui et al., 2019; Alghababsheh, and Gallear, 2020). Due to coronavirus spread, life-threatening environment is persistent all around the world that is coercing undeniable regulations, stringent safety rules, long queue of public, stock out situations, and restricted working hours all together, has brought the whopping responsibility on firm's stakeholders, policymakers and government to manage their SCs in context to social, economic and environmental issues created in the economies (Cohen, 2020; Sarkis et al., 2020). The pandemic has created a long-lasting struggle for companies to survive during this situation and moreover, challenges are posed to provide sustainability outcomes in the pandemic situation. The demand-supply function of SCs has been disrupted extensively due to upsurge in the demand of products such as mask, sanitizer, gloves and disinfectant where the supply of these goods was unmanageable and thus, the SCs are struggling considerably for their survivability and sustainability in all the coronavirus affected areas.

India's GDP has fallen to the lowest in over six years on 3Q 2019-2020, which further posed with COVID-19 challenges. In India, in case if the COVID-19 would not be controlled and lockdown may extend further, it will reach a critical point where 30% of the retail organizations will discontinue and 18 lakhs people may lose their jobs. In the extension of the restrictions and lockdowns, this would be a double whammy for the Indian economy, as it will have to bear the brunt of domestic as well as global demand destruction (RAI, 2020). To

save life of the people, the government of India has taken strict steps i.e. a complete consecutive lockdown of states, nationwide restrictions to control the COVID-19 spread, which has brought the economic activities and SCs to a standstill (KPMG, 2020).

GSCs are complex in structure; consist of many organizations dispersed across numerous locations. The distance amid buyers and suppliers enforces confronts to manage sustainability (Blackhurst et al., 2011). The traditional approach of SCs is not significant in present scenario and therefore, new forms of SCs to remain competitive, sustainable, and connected with the customers in the long run (Albors-Garrigos, 2020). SCs need to assess the environment, anticipate the demands of consumers during the lockdowns, and endeavor to provide satisfactory services by collaborating with the local suppliers. The buyer-supplier relationship of SCs is based on many factors such as supplier networks, supplier assessment, supplier collaboration, performance, value creation, communication, and data integrity (Kumar and Rahman, 2016; Kumar, 2019; Ampe-N'DA et al., 2020). Thus, organizations need to develop Sustainable Supply Chains (SSCs) according to the social context, customer demand, and the availability of the local partners so that the order fulfillment will be made possible without the loss of business and also the buyer-supplier relationship can be managed. But what are the main factors on which SCs need to focus for achieving survivability and sustainability during pandemics are still unanswered. Through qualitative research, the following research questions need to be answered.

R1. What factors are prominent in enhancing survivability of SSCs in COVID-19 situations? How buyer-supplier relationship is managed during in COVID-19 outbreaks?

R2. What should be the focus areas of SCs to sustain in long-run post COVID-19 situation?

This work aims to explore and evaluate the factors significant for enhancing survivability of SSCs during COVID-19. Keeping this in view, a comprehensive review is conducted and the following research objectives are established.

RO1: To identify the prominent factors that may enhance survivability of SSCs in COVID-19 situations.

RO2: To analyze the factors important for managing buyer-supplier relationship during COVID-19.

This study has employed Multi-Criteria Decision-Making (MCDM) - Stepwise Weight Assessment Ratio Analysis (SWARA) method. SWARA method helps in measuring the factors of sustainable SCs. The study has used this method for computing the relative weights coefficients that contribute to rational judgment and obtain reliable results (Wang et al., 2019). The foremost contributions of this study are as follows:

- This study contributes to the assessment of factors developing sustainable SCs during the pandemic COVID-19. This research assists in understanding the key factors that need to be considered for maintaining an effective buyer-supplier relationship for enhancing survivability of SSCs.
- This research will help the organizations to manage their SCs to survive in this pandemic situation.

The paper is organized in 6 sections. Section 2 elaborates the literature on factors significant for enhancing survivability of SSCs and buyer-supplier relationship. Section 3 describes the research method -SWARA descriptions employed in conducting the research, followed by the steps of proposed framework in section 4. The findings, discussions and implications are presented in section 5. Section 6 summarizes the conclusions and future directions of research.

2. Literature Review

This section provides literature on the factors which are playing a significant role for enhancing survivability of SSCs during and post COVID-19 pandemic by managing buyer-supplier relationship.

2.1 Factors for Enhancing Survivability of Sustainable Supply Chains

Sustainable Supply Chain (SSC) is the intersection of supply chain and sustainable development. It includes economic, social and environment issue to manage their relationships with suppliers (Dubey et al., 2017). In the pandemic situation, the organizations are shifting towards demand-driven model for managing their SCs (Chi et al. 2020; Choi, et al., 2020). The COVID-19 has created intense pressure on the organizations to provide both core and non-core services and hence they are switching to new forms of SCs. The companies outsource third parties and utilize their SC networks collaborations with multi-tier suppliers to fulfill the demand and supply (Wilhelm et al., 2016). The GSCs are utilizing digital and non-digital forms to develop their reach through both the forms for sustaining in the market (Araz et al., 2020). The SCs managed inventory provides access to real-time inventory information, demand forecast and order details to the supplier that provides benefits to the upstream supplier (Prince et al., 2019). The focus of the SCs is focusing on additional networks, collaborations, value-addition, co-creation, optimization of delivery and pickup options, omni-channel supply chains, managing volatile demand, order fulfillment, adopting digital apps, and crowd and resource management (Mckinsey, 2020). In relation to

information sharing, studies designate that an organization structure of the firm is dependent on collaboration. The uncertain situation has enforced the SCs to collaborate with different partners in order for reducing risk and uncertainty (Hughes et al., 2019; Li and Jiang, 2019; Madsen and Petermans, 2020). This collaboration has enhanced the performance of the SCs by reducing a firm's cost and improving cash flows. The collaboration of retailers and suppliers helps in dropping the bullwhip effect in SCs (Dolgui et al., 2020). The supply chains take different forms, the alliance of different sectors, in distinct sizes aim at relieving suffering of the affected population. The resources shared commonly include tangibles and intangibles and these resources and information sharing are the key factors for effective coordination among buyers and suppliers (Pankowska, 2019). The viability of the supply chain is the highest analysis level for SC reactions to the disturbances based upon stability, robustness and resilience (Ivanov, 2020). In past research studies, SC response to the disturbances has been studied at the semantic network analysis level, structural properties, and complexity factors (Ivanov et al., 2010; Li and Zobel, 2020; Pavlov et al., 2019). The extent of the viability is survival orientation, and ecosystem focus. The viability of supply chains integrates the angle of sustainability and resilience, and extends them by survivability (Ivanov and Dolgui, 2020).

The significant factors for enhancing survivability of SSCs and buyer- supplier relationships are identified from the available literature. The process is completed in 5 steps: i) establishing research objectives ii) selection of database ii) keyword identification; iv) selection of appropriate articles; v) data extraction.

The questions are framed related to SSCs and the buyer-supplier relationship during COVID-19, followed by the selection of databases including "Scopus" and "Web of Science" (WoS). The keywords are searched with the term "Sustainable Supply Chain*" AND "Supply chain*", AND "Resilient*" "OR "Supplier relationship*" OR "Supplier network", these term should be present in the titles, keywords and abstract. The type of the document considered in the research was "articles" and time limits are from "2010-2020". The first search resulted in 454 articles in WoS and 934 articles in Scopus. After the omission of duplicates from the databases, 1045 articles selected which are related to the research questions. Only the articles appeared in journals are undertaken, therefore, conference papers, proceedings and working papers are excluded. After excluding the unrelated articles, 189 articles are chosen. After reading the abstracts of the papers 42 papers are finally selected. From the selected papers, factors for enhancing survivability of SCs and buyer-supplier relationships are identified. The selected factors are grouped on the triple bottom line dimensions of sustainability i.e.

economic, social and environment. Each expert is asked to thoroughly read the data sheet attached to the questionnaire and asked to evaluate each factor (Appendix 1). Expert details have been provided in subsection 3.2. The experts validated these factors under six main criteria- Criteria 1 (C1): Performance of SCs under uncertainty (PS); Criteria 2 (C2): Supply chain configuration (SCC), Criteria 3 (C3): Supply chain governance works (SCG); Criteria 4 (C4): Supply Chain Viability (SCV); Criteria 5 (C5): Supply Chain Collaboration (SCCo); Criteria (6) Digital-data driven SC (C6). Each criterion has sub-criteria. The final representation of main and sub-criteria is exhibited in Table 1.

[Table 1 about here]

2.2 Research Gaps

Researchers have discussed supply chains issues, barriers, networks, information sharing, integration, supplier participation (Liu and Lee, 2018; Marques, 2019; Roy et al., 2020; Nazam et al., 2020); Coordination (Wankmüller and Reiner, 2020); Buyer –supplier relationship and sustainability (Kumar and Rahman, 2016); Order fulfillment and Delivery SCs (Ishfaq and Raja, 2018); Role of power in supplier relationship and sustainability (Touboulic et al., 2014); Model development of supply chain management (Brandenburg, 2019) and sustainable SCM (Tidy et al., 2016; Sauer, 2017; Patel and Desai, 2019;) etc. The digital advancement affects on SCs, and its appropriateness to the changing environment (Iftikhar and Khan, 2020; Ivanov et al., 2018). Risk management (Wang et al., 2020); Mapping social responsibility and sustainable supply chains (Carbone et al., 2012) independently. The exploration of the SC network resilience in the ripple effect has also been conducted (Li and Zobel, 2020).

The existing literature has addressed the issues of supply chains but the comprehensive study of necessary significant factors for enhancing survivability of SSCs during pandemics like COVID-19 is still untouched. Thus, this study bridges this gap and analyzes the factors to provide new insights to the companies to redesign their sustainable supply chains to survive in pre and post COVID-19 situation.

Table 1: Factors for enhancing survivability of sustainable supply chains during and post COVID-19 pandemic

Criteria	Factors	Implied meanings	Sustainability outcomes on triple bottom line dimensions	References
C ₁ Performance of SCs under Uncertainty (PS)	Economic performance (C ₁₋₁)	Market, operations and accounting based matrix formulation	Adoption of practices to benefit suppliers for cost reduction.	Blome et al. (2014); Gereffi and Lee (2016); Leszczynska (2018)
	Social performance (C ₁₋₂)	Considers human rights, labor practices, worker safety, community welfare, and safety standards	Adoption of socially responsible practices such as compliance of labor laws and social standards	Ashby et al. (2012); Harms et al. (2013); Yawar and Seuring (2017)
	Environmental performance (C ₁₋₃)	Efficient utilization of resource, recycling and waste management	Adoption of environmental management systems, environmental certifications and practices	Merminod and Pache (2011); Lintukangas et al. (2015); Tidy et al. (2016); Ni and Sun, (2018)
C ₂ Supply-Chain Configuration (SCC)	Traditional SC (C ₂₋₁)	The first-tier suppliers are only linked with buyer	Focal firms may focus to bring sustainability to their direct suppliers	Tachizawa and Wong (2014); Nakano and Matsuyama (2020)
	Flexible SC (C ₂₋₂)	The buyer has links with multi-tier supply chains	Focal firms may extend sustainability to their multi-tier suppliers	Kudla and Klaas-Wissing (2012); Wilhelm et al. (2016); Dania et al. (2019)
	Closed SC (C ₂₋₃)	Inclusion of	Buying firm may collaborate with	Wilhelm et al (2016); Roy et al.

		non-economic actors with in the SC	non-economic actors such as NGOs (third party). Formal and informal communication to improve upstream sustainability outcomes	(2018)
C ₃ Supply chain Governance (SCG)	Improving supplier capabilities (C ₃₋₁)	Focal firm provides training and support to its suppliers	Focus to improve supplier capabilities or performance in context to the environmental, social or economic goals	Busse et al. (2016); Marques (2019)
	Multi-stakeholder initiative (C ₃₋₂)	Collaborations with other corporations such as government, unions etc.	To manage sustainability outcomes by collaborating with government association	Aßländer (2016); Liu et al. (2018)
	Third party (C ₃₋₃)	Collaboration with third parties (industry specific)	To manage sustainability outcomes by collaborating cross industries	Reinecke et al. (2012)
C ₄ Supply Chain Network Viability (SCV)	Resiliency (C ₄₋₁)	Ability to withstand a disruption and recover the performance	Balances the supply chain systems to fulfill economic or social goals during pandemics	Carvalho et al. (2012); Adobor (2019); Hosseini et al. (2019)
	Robustness (C ₄₋₂)	Ability to withstand a disruption to maintain the planned performance	To fulfill the demand in changing environment or pandemics and bring economic benefits	Simchi et al. (2018)

	Stability (C _{4.3})	Ability to come back in pre-disturbance state	To fulfill the demand in changing environment	Demirel et al. (2019)
C ₅ Supply Chain Collaboration (SCCo)	Collaborative planning, forecasting and replenishment (C _{5.1})	The collaboration with the suppliers to anticipate unpredicted demand through systematic planning	The demand and supply balance during pandemics may bring social benefits	Hollmann et al. (2015); Panahifar and Shokouhyar (2019); Holgado de Frutos et al. (2020)
	Internal collaboration dynamics (C _{5.2})	It helps to improve information sharing, integration and flexibility.	Information sharing strengthens buyer-supplier relationships and selection of supply chains appropriate for emergency	Bodi-Schubert (2014); Touboulic and Walker, (2015); Pakdeecho and Sukhotu (2018); Kumar (2019)
	Co-creation (C _{5.3})	Collaborative development of new value; Collaborative innovation	Enhances value creation for SCs	Chen et al., (2017); Eggers et al., (2017); Chakraborty et al. (2018)
	Competitive advantage (C _{5.4})	Capabilities develop competitive advantages. SC support to mitigate risk and create	To benefit society through competitive pricing, products and novel ways to benefit society.	Wu et al. (2017); Feizabadi et al. (2019)

		competitive advantages during pandemics		
C ₆ Digital-data driven SC	Order fulfillment/Just in time delivery (C ₆₋₁)	SCs are exhausting local partners to jointly work for pickup and delivery items	Digital driven data analytics to deliver order on time saves cost and resources.	Rao et al. (2011); Ishfaq and Raja, (2018); Ishfaq and Bajwa (2019)
	Information technology, Industry 4.0, Big data, IoT (C ₆₋₂)	Advanced technology to cope up with customer needs	The technological advancement to manufacture environmentally friendly products	Hofmann and Rutschmann (2018); Ralston, and Blackhurst, (2020); Iftikhar and Khan (2020)

3. Research Methodology

The SWARA method is applied to obtain the weights of factors for enhancing survivability of SSCs based on their sustainability outcomes. The SWARA method helps in reducing uncertainty and subjectivity of decision-makers. It is the most suitable method for high-level of decision-making (Zavadkas et al., 2018). In the method, expert plays a vital role in evaluations and computation of weights. An expert uses his or her own knowledge, information and experience for evaluation of criteria. The ability of estimating experts' opinion about importance ratio of the criteria for weight determination is the main component of this method. The main advantage of this method includes the chance of removing insignificant criteria and variables. Experts compare the criteria together and in case if the distance between the criteria is high, they can argue that the criteria is insignificant in the developed research model (Zolfani and Sapauskas, 2013). SWARA method is different from the other MCDM methods like AHP, ANP and TOPSIS etc. as it provides an opportunity to the decision-makers to choose their priority on the basis of current situations prevailing in the environment and economy. This method will be helpful in analyzing the factors in the context of COVID-19. Thus, this method has a smaller number of comparisons as compare to AHP and thus simple and convenient for the decision-makers. As this study has been undertaken to assess the factors for enhancing survivability of SSCs in the pandemic situation, SWARA is the most appropriate method to be applied. The detailed method is discussed in the following sub-section.

3.1 *Stepwise Weight Assessment Ratio Analysis (SWARA) Method*

The experts are asked to provide the dominance of each weight and rank according to their preference order as per their knowledge, expertise and experience. The criterion with the highest priority is ranked as 1 while the least important criterion is ranked as last using a 9-point scale. This method has been applied for selection in several areas such as sustainability, green supplier, location, quality of service, vehicle, solar plant and many others (Vafaeipour et al., 2014; Prajapati et al., 2019). The following steps describe the calculation of weights.

Step 1: Arranging of criteria as per experts' opinion. The sorting of the criteria is done in descending order as per experts' judgment.

Step 2: Specifying relative weightage for criteria. From second criterion ahead experts show the corresponding importance of j^{th} criterion in congruence with the previous ($j - 1$) criterion through comparative importance of average value (s_j) ratio.

Step 3: Co-efficient computation k_j :

...Eq. (1)

Step 4: Determination of recalculated weight w_j

...Eq. (2)

Step 5: Final weights calculation

...Eq. (3)

Where q_j is the relative weight of the w^{th} the criterion and n represents criteria number.

Step 6: Synthesis

The global weights of factors are calculated by multiplying the weight obtained (W_j) with individual sub-criteria weights.

3.2 Data Collection

The data has been collected from the experts of SCs with an experience of more than 10 years. The experts include supply chain practitioners (procurement managers, production managers, sales managers, C&FA agents, distributors, and retailers) from different organizations of FMCG industry. The data was collected through a structured questionnaire communicated via e-mail during April 12, 2020 and May 9, 2020. Finally, 18 experts are chosen belonging to the different areas, experience, and geographical locations for this study. The demographic profile of the experts is exhibited in Table 2.

Table 2: Demographic details of experts

Variables	Number
Gender	
Male	13
Female	5
Age	
30-35 years	11
36-40years	7
Education	
Graduation	3
Post-graduation	15
Experience	
Less than 10 years	0
10-12 years	11
12-15 years	7
Expertise	
Production (Manager)	3
C&FA	2
Sales (Manager)	3
Procurement (Manager)	3
Distributors	3
Suppliers	2
Retailers	2

3.3 Proposed Research Framework and Application

The framework includes three-step process to achieve the research objectives. In the first step, the factors required for enhancing survivability of SSCs and managing buyer-supplier relationships during the COVID-19 pandemic are identified through systematic literature review. The second step incorporates validation of factors and analysis through SWARA method for computing weights. On the determination of the weights, the main factors for managing SSCs and supplier relationship are identified and discussed in third step. The proposed research framework is demonstrated in Figure 1.

Figure 1: Proposed research framework

The application of the proposed research framework has been discussed in the section 4.

4. An Application of Proposed Framework

The study emphasizes on exploring factors for developing sustainable chains and managing buyer-supplier relationships during pandemic COVID-19. The 18 experts are undertaken where each expert is equal in terms of experience, knowledge and services.

The SCs need to monitor the dynamic environment and their performance to take proactive actions. The experts include 3 managers working in production and procurement departments. The 2 managers from the sales department are also undertaken for considering the dynamism of market and sales. For comprehending downstream value chain, the equal number of suppliers, distributors and retailers are taken as experts. For inputs from logistics, 2 C&FA are also included in the expert panel. The suppliers, distributors, and retailers

undertaken in the expert panel are associated with the SCs for more than 10 years. The selected SC practitioners are responsible for managing procurement, production, demand and supply, logistics, order-fulfillment, delivery, sales and customer relations. The range of the experience of the experts is 10 to 15 years. The detailed information of all the factors along with the questionnaire is mailed to the experts for their responses (Appendix A, Table A1).

4.1.1 Identification of the factors and weights calculations using SWARA

The literature review elaborates 19 significant factors further validated by experts. To answer research questions, the research study conceptualizes a framework shown in Figure 2 for assessing significant factors responsible for enhancing survivability of SSCs and benefitting buyer-supplier relationship.

Figure 2: Conceptual framework of factors for enhancing survivability of sustainable supply chains during and post COVID-19 pandemic benefitting buyer-supplier relationship

FACTORS	
C₁: Performance of SCs uncertainty (PS)	<ul style="list-style-type: none"> • Economic performance (C₁₋₁) • Social performance (C₁₋₂) • Environmental performance (C₁₋₃)
C₂: Supply-chain configuration (SCC)	<ul style="list-style-type: none"> • Traditional SC (C₂₋₁) • Flexible SC (C₂₋₂) • Closed SC (C₂₋₃)
C₃: Supply chain Governance (SCG)	

The steps discussed in the previous section are followed for priorities computation. Each expert is asked to provide weightage on the response sheet (Appendix A, Table A2). The geometric mean of the priorities provided by the experts for main categories are computed and shown in Table 3.

Table 3: Priorities (main criteria)

Criteria (Main)	Weightage	Rank
C ₁ (PS)	0.07992123	4
C ₂ (SCC)	0.02750119	6
C ₃ (SCG)	0.04689168	5
C ₄ (SCV)	0.45455483	1
C ₅ (SCCo)	0.24428464	2
C ₆ (DD)	0.14256124	3

Similarly, the priorities for sub categories are computed and shown in Table 4.

Table 4: Priorities (sub- criteria)

Main criteria	Sub –criteria	Weight priorities
C ₁ (PS)	C ₁₋₁	0.30102
	C ₁₋₂	0.53621
	C ₁₋₃	0.16196
C ₂ (SCC)	C ₂₋₁	0.17770
	C ₂₋₂	0.52359
	C ₂₋₃	0.29820
C ₃ (SCG)	C ₃₋₁	0.16048
	C ₃₋₂	0.54476
	C ₃₋₃	0.29429
C ₄ (SCNV)	C ₄₋₁	0.54096
	C ₄₋₂	0.16372
	C ₄₋₃	0.29493
C ₅ (SCCo)	C ₅₋₁	0.49734
	C ₅₋₂	0.14853
	C ₅₋₃	0.27117
	C ₅₋₄	0.08240
C ₆ (DD)	C ₆₋₁	0.64456
	C ₆₋₂	0.35519

The example of inputs from Expert 1 for main and sub-criteria are shown for global weight calculation is shown in Appendix A (Table A3, Table A4). On the basis of the relative weights the criteria and sub criteria are arranged in Table 5.

Table 5: Ranking of criteria and sub-criteria

Major criteria	Relative weight	Sub-criteria	Geometric mean	Global weights	Ranking
C ₁ (PS)	0.079921	C ₁₋₁	0.3010200	0.0241	11
		C ₁₋₂	0.5362100	0.0429	8
		C ₁₋₃	0.1619600	0.0129	15
C ₂ (SCC)	0.027501	C ₂₋₁	0.1777000	0.0049	18
		C ₂₋₂	0.5235900	0.0144	13
		C ₂₋₃	0.2982000	0.0082	16
C ₃ (SCG)	0.046891	C ₃₋₁	0.1604800	0.0075	17
		C ₃₋₂	0.5447600	0.0255	10
		C ₃₋₃	0.2942900	0.0138	14
C ₄ (SCV)	0.45455	C ₄₋₁	0.5409617	0.2459	1
		C ₄₋₂	0.1637282	0.0744	5
		C ₄₋₃	0.2949382	0.1341	2
C ₅ (SCCo)	0.24428	C ₅₋₁	0.4973463	0.1215	3
		C ₅₋₂	0.1485379	0.0363	9
		C ₅₋₃	0.2711707	0.0662	6
		C ₅₋₄	0.0824097	0.0201	12
C ₆ (DD)	0.14256	C ₆₋₁	0.6445619	0.0919	4
		C ₆₋₂	0.3551904	0.0506	7

4. Discussion of Findings

In this current study, the significant factors for enhancing survivability of SSCs based upon supplier-buyer relationship are ranked on the prominence value calculated through SWARA method. This study helps the companies, decision-makers, and stakeholders in managing the buyer-supplier relations successfully during COVID-19 for managing their SCs. The results shown in Table 3 exhibits that ‘Supply-Chain Network Viability (C₄)’ is the most important criteria to develop SSCs in COVID-19 situation. The order of the criteria is C₄>C₅>C₆>C>C₃>C₂ as per experts’ choice.

From Table 5, main criteria are ranked according to their global weights, exhibiting that Supply-Chain Network Viability (C₄) has attained the highest weight (0.4545). The Viable System Model proposed by Beer (1981) describes viability as the ability of the system to

meet the demands of surviving in a dynamic environment. The viability is the ability of the SCs to manage and survive in disruptive environment through redesigning and replanning of structures to develop long-term effects. This pandemic has affected all the industries, economy and posing a development of new decision-making environment of SC practitioners (Ivanov, 2020). The current study shows that during the uncertain event COVID-19 pandemics, resistance of SCs to disruptions has to be viable for surviving, sustaining and escaping from market collapses. In complex systems the viability of SCs is commonly considered that connects individual systems (Aubin, 1991). The viability of the SCs will help to secure their business mobility in long-term in the societies. The SCs survival in pandemics goes beyond their performance, profits or revenues and their issue of being sustainable has brought collective behavioral changes in risk management decisions (Keogh, 2020). This main criterion has three sub-criteria- Resiliency ($C_{4.1}$), Robustness ($C_{4.2}$) and Stability ($C_{4.3}$). The study reveals that resiliency and stability are the two main factors that attained the global weights (0.2459) and (0.1341) respectively. Both these factors are to be focused in enhancing survivability of SSCs. Supply-Chain Viability (C_4) is a behavior-driven property of a complex system with structural dynamics whereas, resiliency is considered as disruption-driven property. Stability is ‘the most desirable property of a supply network without an explicit consideration of performance’. The stability of SCs is required to attain resiliency (Ivanov and Dolgui, 2019). The example of COVID-19 has paved a path for SCs to analyze new perspectives of resiliency and viability mechanisms where multiple behaviors are exhibited due to changing buyer-supplier relationships for long-term existence.

The viability of SCs is also dependent on the collaboration or buyer-supplier relationships. The supply chain collaboration (SCCo) has obtained a weight of (.2442) second highest among main criteria. The SC collaboration acts as a tool to reduce bullwhip effect. Therefore, SCs need to develop a holistic and robust system to fulfill the demands of the customers supported by collaborations among each member of the supply chains. The main criteria Supply chain collaboration (SCCo) (C_5) includes 4 sub-criteria- Collaborative planning, forecasting and replenishment ($C_{5.1}$), Internal collaboration dynamics ($C_{5.2}$), Co-creation ($C_{5.3}$), and Competitive advantage ($C_{5.4}$).

From Table 6, it is revealed that Collaborative Planning, Forecasting and Replenishment (CPFR) ($C_{5.1}$) and Co-creation ($C_{5.3}$), have attained weights (.01215) and (0.0662) respectively indicating that both these factors are significant in managing buyer and supplier relationships and also enhancing survivability of SSCs. CPFR ($C_{5.1}$) is a business activity that unites the intelligence of several SCs and jointly practicing forecasting and planning for

improving demand visibility and efficiency (Singhry and Rahman, 2018). The demand and supply of essentials is outside the boundaries for which the SCs are designed for and thus, CPFR will provide the accuracy in forecasting or anticipating demand. The SCs need to develop new demand forecast that ensures the accuracy in projection as well as additional inventory for the demanded essentials. GSCs and local SCs need to prepare contingency plans, backup plans as the COVID-19 will spread to other areas. The firms contemplate sustainability as a strategic opportunity for collaborating with suppliers (Ni and Sun, 2018). The Co-creation is to improve process and product and add value in SCs.

Data-driven SCs are fulfilling demands by providing essentials to the stores and at the doorstep of the customers. SCs are adopting the order-fulfillment and just-in-time delivery options for supporting the self-isolation, quarantine, stay at home orders and restricted time of stores operations. The SCs are also reducing their variety of products, to mainly focus on the fulfillment of the orders on time with safety and hygiene. Same-day delivery or next day delivery have been adopted by a majority of firms and temporary tie-up has also been arranged with additional staff. Firms must assess their store's readiness to fulfill a surge in online orders, and reallocate the staff to support areas experiencing spiked demand. Due to the surging demand of the essentials, firms are closely working with suppliers where daily meetings are held to secure a sufficient supply of the essential high-demand products. The scary situation across the world, the consumers have increased the purchase of health and wellness products, products essential to virus containment, and safety measures such as masks and gloves. To manage the supply and demand, inventory control at a local level is required to be considered for preventing stock-out situations and managing order fulfillment. The social performance of the firms under uncertainty is also one of the significant areas where the firms need to focus during pandemic. The coronavirus has created a new approach of working culture all around the world focusing on achieving organizational efficiency with flexible working hours and remote working. This can be an opportunity for the platform companies like Amazon, Google, e-bay etc. to help the economy by facilitating platforms for employment generation and continuing their social responsibility towards employees' safety.

5.1 Implications of the Research

The long-term social, economic, and health effects of COVID-19 are still unknown. Whether this situation may last week or months, it is visible that the global response to the virus has changed the thinking and planning of the SCs. The spread of this pandemic is affecting huge number of companies worldwide currently with significant economic implications. Policies

intended to prevent the spread of this infections includes travel restrictions and quarantines that have disrupted international supply chains and diminishing profits too.

The study for assessing factors managing SSCs and buyer-supplier relationships is two-fold. Firstly, this study explored the social, economic, and environmental outcomes on organizations for enhancing survivability of SSCs in long run. The study reveals that SCs have to become viable for surviving and sustaining in long run as COVID-19 has longstanding effects on the global economies. A SC focusing on resiliency, robustness, advance data analytics, collaboration with supplier for value-addition are more effective in this difficult time as these strategies not only helpful in increasing operational efficiency only for the short-term but also in developing their SC sustainable to deal with post COVID-19 situation. To sustain and survive in long run SCs of FMCG industry need to adopt changes according to the volatile social and economical environments. The social environment is forcing the consumers to stay at home, maintain social distancing and hygiene, which leads to the immediate spike in managing SCs for fulfilling the demands of essentials like sanitizers, soaps, gloves, mask, disinfect equipment, immune boosting medicines etc. and where online fulfillments are not as per demand, in-store sales need to be managed. The social obligations are also stressing FMCG organizations to manage their SCs with multiple challenges such as short of labor, unpredictable customer demand, and extended working hours of employees, maintain social distancing among long queue, and handling customers' incoming without mask and gloves In-case, if all these challenges don't get resolved will definitely lead to business failure in future. Thus, viable SCs enable to deal with such disruptions during and post COVID -19 situations. The SCs of FMCG industry need to observe demand and inventory for short as well as long run with the help of advance technology like IoT, big data analytics to process orders on real time data for compensating the loss incurred in production, factory shutdowns and economic downfall. The FMCG companies to shift their focus on digitalization of SC practices to survive and sustain in post pandemic situation as the 'new normal' scenario will be more towards changed preferences of the customers.

Secondly, the spread of pandemic across the globe is radically changing living conditions, consumer preference and behavioral patterns. The shift to online order, click & collect, contact-less delivery options, and hikes in certain product category consumption is creating a new SC environment. SCs are facing inventory diminution as consumers stock up essential supplies for quarantine or stay at home. Thus, order fulfillments at the doorstep of consumers are becoming more appealing to the customers, who want to avoid public gathering, long queues and fear of safety. In most of the countries like India, where the living stage is

restricted, SSCs of FMCG companies need to adapt strategies appropriately as per the changing social environment, and environmental conditions. As soon as the restricted living ends, and move into a normal living phase, demand forecasting and inventory management for order fulfillment at local levels need to be considered for tackling stock-out situation. SCs have to closely monitor government regulations on different types of restrictions and relaxations. There is an urgent need for SCs to deal with restricted living phase while preparing for the 'new normal'. In a 'new normal' scenario, SCs of FMCG companies should focus on resiliency and viability to sustain for long run and transforming into a platform economy to provide economic and social benefits to the society.

The study has given insights to the FMCG companies to formulate new strategies on the basis of changing consumer preferences and behavioral patterns as it will be effective in post-COVID-19 situations such as shifting of customer preference towards online platforms, order fulfillment, regular sanitization, following social distancing, knowledge of employees about hygiene and personal safety measure etc. Today, organizations are extending employee awareness campaigns on hygiene and sanitation via several communication platforms to deal with this crisis. The COVID-19 is acting as a catalyst to develop sustainable adaptive supply chains to deal with any crisis. The need for the situation is the SCs approach for resiliency, collaboration, data analytics, and order fulfillment to sustain in COVID-19 pandemics.

5.2 Unique Contribution of the Research

This has made an effort to discourse the affected SCs due to coronavirus outbreaks. The study helps in identifying factors for enhancing survivability of SSCs and managing buyer-supplier relationships. The study reveals the directions for the practitioners, organizations, suppliers, and government organizations to manage their SCs in a way that fulfill the social and economic needs of the society appropriately without losing the business during the pandemics. The study has employed advanced MCDM method SWARA for assessing the significant factors to survive in COVID-19 situation. As a unique contribution, this study concentrates on identifying factors to design and manage SSCs for FMCG companies in the unstoppable environment of pandemic COVID-19. It provides insights on viability and resiliency of SCs and may change their present strategies to enhance their survivability in pre and post pandemic situation.

5. Conclusion

Pandemics are radical forms of business disruption. The traditional methods of managing SCs may have changed forever as COVID-19 has brought intensified level of insubstantiality. The COVID-19 is a buzzer for the organizations to plan and prepare for the unpredicted in order to be resilient and flexible as a course of doing business. For SCs, it is an urgent to redesign their business strategies for adapting global disruption, and changing social environment to transform their business models including multiple platforms to achieve sustainable economic and social benefits. Resilience, viability, real time information, order fulfillment/just-in-time, stability, data analytics, collaboration, integration, and demand forecasting are the key factors for the FMCG companies to survive and sustain in pre and post COVID-19 situation. The successful resilient SCs engage suppliers and other stakeholders with open and transparent system for integrating the efforts towards sustainable performance of the FMCG companies. To survive, the resilient SCs for FMCG companies may be built through appropriate demand planning, forecasting, supplier networks, supplier meetings, supplier collaboration, and anticipating the effects of economic and social environments. The Coronavirus has a long run impact on the SCs and thus it is essential to manage a variety of order fulfillment options. The adoption of order fulfillment/just-in-time delivery strategy will lower down the cost and will shift the focus to practice safety inventory stock supply strategy that will support the survivability of the FMCG supply chains.

This study has attempted to explore and analyze the significant factors using SWARA method for enhancing survivability of SSCs and managing buyer-supplier relationships during COVID-19. There is no single factor to be focused independently by the SCs in this pandemic but currently the focus should be on resiliency, stability, data-driven demand supply, supplier collaboration and order fulfillment strategies. Social distancing and fear of spread at public places are encouraging the consumers to use online order and delivery or contactless delivery options thus creating a new direction to develop into SSCs for facing post- COVID-19. This study has explored an opportunity for SCs, human and machine ratio, employing hybrid model and operating models. This study helps to practice collaborative, integrated and viable SSCs in pre and post COVID-19 situation and if organization fail to meet customers' expectations will place themselves at high risk of losing business and survival in the long run.

This study has some limitations. Firstly, the factors for SSCs are assessed on the decision team of experts that may be biased. The research may further be validated through empirical studies. The expert groups selected in the study has excluded the customers, therefore it is desirable to collect and include customer database from the retailers who purchased essentials

during COVID-19 pandemic that can enhance the credibility of the expert group. Secondly, the impact of COVID-19 is global and hence the research has to be extended in other nations. The future studies can specify how organizations and customers are responding to the pandemics globally. Third, this study is focused on single industry i.e. FMCG, hence results might not be applied to other industries and thus future studies may employ data sets of other industries.

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Appendix-A

Table A1: Factors for enhancing survivability of SSCs and buyer-supplier relationship

Code	Main criteria	Brief Description
C ₁	Performance of SCs under uncertainty (PS)	Improving sustainability performance of SCs in uncertain environment
C ₂	Supply-Chain configuration (SCC)	Structural arrangement of supply chains for achieving sustainability outcomes
C ₃	Supply-Chain Governance (SCG)	Improving supplier capabilities for enhancing social, economic and environmental outcomes
C ₄	Supply-Chain Network Viability (SCV)	System ability to meet the demands of survival in the dynamic environment
C ₅	Supply-Chain Collaboration (SCCo)	Collaboration with suppliers for joint planning to achieve sustainability outcomes
C ₆	Digital-data driven SC (DD)	Inclusion of advance technologies for providing real time data for order fulfillments/delivery
	Factors (Sub-criteria)	
C ₁₋₁	Economic performance	Market, operations and accounting based matrix formulation to achieve economic sustainability outcomes
C ₁₋₂	Social performance	Considers human rights, labor practices, worker

		safety, community welfare, and safety standards for enhancing social sustainability outcomes
C ₁₋₃	Environmental performance	To utilize resources efficiently, recycling and waste management to achieve environmental sustainability outcomes
C ₂₋₁	Traditional SC	Only first-tier suppliers are linked with focal firms.
C ₂₋₂	Flexible SC	The buyer has links with multi-tier supply chains.
C ₂₋₃	Closed SC	Buyers can collaborate with NGOs (third party) to extend sustainability to strengthen their upstream suppliers for achieving sustainability outcomes
C ₃₋₁	Improving supplier capabilities	Focal firms provide training and support to its suppliers for improving capabilities or performance to achieve sustainability goals
C ₃₋₂	Multi-stakeholder initiative	Collaborations with other corporations such as government, unions etc. to achieve sustainability outcomes by collaborating with government association
C ₃₋₃	Third party	Collaboration with third parties can be industry specific for achieving sustainability outcomes by collaborating with government association
C ₄₋₁	Resiliency	Ability to withstand a disruption and recover the performance
C ₄₋₂	Robustness	Ability to withstand a disruption to maintain the planned performance
C ₄₋₃	Stability	Ability to come back in pre-disturbance state
C ₅₋₁	Collaborative Planning, Forecasting and Replenishment	To collaborate with suppliers for anticipating unpredicted demand through systematic planning to sustain and survive in long run
C ₅₋₂	Internal collaboration dynamics	It helps to improve information sharing, integration and flexibility to sustain and survive
C ₅₋₃	Co-creation	Collaborative development of new value; Collaborative innovation for developing sustainable products or services
C ₅₋₄	Competitive advantage	Capabilities develop competitive advantages. SC support to mitigate risk and create competitive advantages during pandemics
C ₆₋₁	Order fulfillment/Just in time delivery	SCs are exhausting local partners to jointly work for pickup and delivery items to survive and sustain in pandemic situation
C ₆₋₂	Information Technology, Industry 4.0, Big data, IoT	Advanced technology to cope up with customer needs by providing real-time data

Table A3: SWARA calculation for main criteria as response received by Expert 1

Main criteria	S_j	K_j	Q_j	W_j
C_4	0.00	1.00	1.0000	0.46443
C_5	0.90	1.90	0.52631	0.24443
C_6	0.80	1.80	0.29239	0.13579
C_1	0.80	1.80	0.16244	0.07544
C_3	0.50	1.50	0.10829	0.05029
C_2	0.70	1.70	0.06370	0.02958

Table A4: SWARA calculations for Sub criteria (C_{1-1} - C_{6-2}) responses received by Expert 1

Sub- criteria	S_j	K_j	Q_j	W_j
C_{1-1}	0.00	1.00	1.0000	0.56093
C_{1-2}	0.95	1.95	0.5128	0.28766
C_{1-3}	0.90	1.90	0.2699	0.15140
C_{2-2}	0.00	1.00	1.0000	0.51127
C_{2-3}	0.70	1.70	0.5882	0.30075
C_{2-1}	0.60	1.60	0.3676	0.18796
C_{3-2}	0.00	1.00	1.0000	0.54983
C_{3-3}	0.90	1.90	0.5263	0.28938
C_{3-1}	0.80	1.80	0.2923	0.16077
C_{4-1}	0.00	1.00	1.0000	0.54323
C_{4-3}	0.85	1.85	0.5405	0.29363
C_{4-2}	0.80	1.80	0.3003	0.16313
C_{5-1}	0.00	1.00	1.0000	0.51742
C_{5-3}	0.95	1.95	0.5128	0.26534
C_{5-2}	0.90	1.90	0.2699	0.13965
C_{5-4}	0.80	1.80	0.1499	0.07756
C_{6-1}	0.00	1.00	1.0000	0.66102
C_{6-2}	0.95	1.95	0.5128	0.33898