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INVESTIGATING THE ROLE OF RISK MITIGATION STRATEGIES ON SUPPLY CHAIN DISRUPTION IMPACT AMIDST COVID-19 OUTBREAK

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Komal Abdullah
Institute of Business of Administration, Karachi, Pakistan
Tashfah Tauqir
Institute of Business of Administration, Karachi, Pakistan
Mujtaba Hassan Agha
NUST Business School, National University of Sciences and Technology, Islamabad, Pakistan
Rameez Khalid
Institute of Business of Administration, Karachi, Pakistan

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ABSTRACT

Purpose - This contextual study evaluates the role of risk management practices in Pakistan amidst the COVID-19 outbreak in addressing supply chain disruption and ensuring supply chain resilience and robustness. The purpose of the study was to analyze the emerging challenges in supply chain disruption due to COVID19 and to add value to literature by leveraging the study to provide insights into the Pakistani context.

Methodology- For the quantification of data, structural equation modeling was used. A purposive sample of 174 respondents was selected to provide data in the study.

Findings- The results provide empirical evidence that disruption caused by COVID-19 in Pakistan did not affect the robustness and resilience of the supply chain due to a shift towards tier 1 suppliers, considered low adaptation of lean and recourse to buffer capacities for mitigating the disruption. Furthermore, the findings reveal that risk identification, assessment, and control within supply chain risk management practices play an important role in enhancing resilience and robustness in the supply chain system.

Practical Implications- Overall, the empirical contribution of the study supports the theorization that a combination of the resource-based view and organizational information processing theories influenced the SC management of risk practices. In Pakistan, organizations which had communicated new strategies and maintained closeness to their customers remained resilient, thus paving the way for practitioners to follow the same path.

Keywords: *Supply chain disruption, COVID-19, supply chain resilience, supply chain robustness, risk management, supply chain risk management practices*

Paper type: Research Paper

INTRODUCTION

In today's emerging world which is grappling with unexpected and exceptional conditions arising from the pandemic and recurring lockdowns, governments worldwide concerned about the impact on industry have started to think about how to restart economies (Al-Mansour et al., 2020).

Existing literature maps the impact of multiple unforeseen catastrophic events on organizations in recent times. Such incidents are generally termed as disruptions of unpredictable and fluctuating intensity (Pavlov et al., 2019). Due to these disruptions, stock return, sales, buyer and suppliers' performance and safety, organization image, and supply chain performance are impacted negatively (Butt, 2021). With these negative consequences giving rise to more spontaneous repercussions for the supply chains, supply, demand, circulation and transportation connections have become unapproachable (Fan et al., 2018; Ivanov et al., 2020). Literature suggests that organizations face difficulties in handling disruptions to their supply chain networks due to extraordinary outbreaks such as COVID-19. With such outbreaks causing more severe and long-term disruptions and negative effects on demand and supply, infrastructure, a ripple effect of challenges and constraints instantiates (Choi, 2020).

COVID-19 has affected developed and developing economies alike and its impact on the supply chain sector has been drastic. For instance, a study by Haren et al. (2020) addresses the negative impact of the COVID outbreak on the manufacturing sector. According to Fortune (2020), approximately 94% of organizations in 1000 have faced COVID-related disruptions. COVID-19 is not only causing disruptions but also spreading among the labor force in all industries, setting off a ripple effect in supply chain networks (Ivanov, 2020) Simultaneously, it is creating the most detrimental variations in the supply and demand streams. Conversely, COVID-19 is also producing a cascade effect in various domains of the supply chains. During COVID-19, supply chains experienced pressure due to enforcement of lockdown and flow of services and goods restricted (Biswas et al., 2020). Industries had to put on hold the raw material flow due to lockdowns, which caused major problems for manufacturers. Moreover, due to restricted supply, the prices of many products were raised. Due to the drastic effects of COVID-19, production has also been put on hold, and demand for those goods experienced a radical drop. In particular, the agricultural sector experienced sales drops of around 80-100% due to lockdowns (Butt, 2021).

This COVID-19 outbreak has directly and indirectly influenced the supply chains. From the perspective of the supply chain, manufacturing and production plants are directly impacted due to the lockdown. In terms of indirect effects, due to the unavailability of alternative suppliers, these indirect effects on the supply chain processes have increased greatly. Due to the decrease in consumption, a worrying indirect effect is the rise in unemployment. These indirect effects have been appeared more quickly due to travel and export bans (Singh et al., 2021). Moreover, at the same time, irrational buying behaviour which contributes to the bullwhip effect is discernible. Altogether, the pandemic has become flashpoint because it has caused uncertainties, fluctuated capacities, and created gaps in supply chains globally

(Ketchen Jr et al., 2020). Nonetheless, recent studies imply that COVID-19 has also mobilized organizations to reform and revisit the existing strategies of the supply chain and reflect on how short term actions can be deployed to mitigate the effects of the disruptions (Govindan et al., 2020; Ivanov et al., 2019)

Experiencing the destructive impact of COVID-19 on supply chains has compelled a global level re-examination of the industrial situations in developing economies and efforts to strategize the agenda to gain insights and develop a way forward for developing and developed economies alike (Al-Mansour et al., 2020). As Ivanov (2020) emphasizes, COVID-19 has proven disruptive to local and global supply and demand.

While recent studies outline some strategies to mitigate the disruptive supply chain, there are only a few empirical studies on supply chain resilience and robustness to demystify how organizations are coping and adopting the mitigation strategies to offset the impact of the epidemic (Butt, 2021; Ivanov et al., 2020).

Remko (2020) identifies the difficulties of supply chain practitioners in the operationalization of supply chain risk management and resilience and how they are facing the COVID-19 disruption impacts. Haren et al. (2020) and Hosseini et al. (2019) highlight that robustness tells about the ability of supply chains to sustain the planned performances in a disruptive environment while resilience tells about how to recover the performance post-disruption effects. For instance, Butt (2021) states that organizations can explicitly rely on their tier 1 suppliers to gain knowledge about inventory status and orders of production to respond during disruption. Similarly, organizations should use digital approaches to develop a different source of supplies within their capacity. El Baz et al. (2021) contributed to the literature through empirical evidence that SCRM practices are providing mediation on SC resilience and robustness in France. El Baz et al. (2021) also provide future directions to implement the same study in other contexts to check the similarities and dissimilarities between developed and developing economies.

Hence, the research objective was to evaluate how organizations in Pakistan were deploying supply chain risk management processes to encounter the impacts of COVID-19 disruption. To go beyond the present state-of-the-art in SCRM and improve the research domain concerning disruptive supply chain in the context of the pandemic requires analysis at a broader scale. The aim of the study was to analyse the emerging challenges in supply chain disruption due to COVID19 and to add value by examining whether findings in recent research on a similar theme (El Baz et al., 2021) are similar within a developing economy like Pakistan.

In line with this, research questions from the study by El Baz et al (2021) were adapted in the present study in order to investigate the mitigating strategies deployed in Pakistan to address disruptive supply chains through SCRM under COVID-19 threat.
:

(i) How do disruptions caused by COVID-19 affect the practices and performances of supply chain risk management (SCRM), supply chain robustness, and supply chain resilience in Pakistan?

(ii) Do SCRM processes in Pakistan affect supply chain robustness and resilience?

(iii) Could SCRM processes in Pakistan mitigate the effects on supply chain resilience and robustness due to COVID-19 disruption?

The study is organized into the following sections: In Section 1, a comprehensive literature review is presented, explaining the supply chain resilience and robustness, disruptive supply chain, and its impact caused by COVID-19 along with the framework and hypotheses underpinning the study. In Section 2, the research methodology under the influence of survey analysis is described. In Section 3, the results and analysis are demonstrated. In Section 4, the results are discussed and inferred. Finally, the conclusion compares the results from El Baz et al. (2021) with the results of the present study in the context of Pakistan, and discusses implications of the findings and directions for future research.

LITERATURE REVIEW

Theoretical Framework

To support empirical data, theoretical dimensions are explored. The theories of dynamic capabilities and organizational information processing which provided an explanatory lens for disruption impacts are discussed below.

Concept of Dynamic Capabilities

It is described as an organization's capacity to build, recaliberate, and integrate external and internal resources that handle changing environments. This enables the enterprise to spawn greater profits by producing differentiated products or services that reach new markets where demand is high. It involves 3 clusters: sensing, seizing, and transforming (Teece et al., 1997). Today, many researchers are deploying the concept of dynamic capabilities to examine how supply chain networks organize inter-organizational activities to structure or modify their capabilities against shifts in the market (El Baz et al., 2021). The concept of Dynamic Capabilities and Resource-Based View (RBV) builds up a relevant context of framework to determine how organizations synchronize their resources in response to risks in supply chain systems to quickly adapt to changes to prevent threats caused by disruption (Chowdhury et al., 2019).

Organizational Information Processing Theory

This theory elaborates on the processing of organizations during unpredictable supply chain disruptions. It is suggested that organizations should establish capabilities to handle the requirement during uncertain situations (DuHadway et al., 2019). According to El Baz et al. (2021), the organizations that develop processing information capabilities can face equivocality.

As El Baz et al. (2021) point out, in supply chain processes, major uncertainty is faced because it accumulates more information that is needed to be treated and interpreted correctly. It is noticed that processing information has become essential in the

developing phase of SC risk. Due to organizational information processing, the ability of the SC network can get better. Moreover, it also conceptualizes that if organizations use formalized ways to collect and interpret data then organizations could utilize them for preparedness and ability to mitigate the disruption impacts. With the help of this lens, SCRM practices can be put into a framework as organizations usually learn, position, share, and execute their capabilities. In these times, while the world is facing a pandemic, the ability of organizations to reconsider their abilities and capabilities under the influence of resources is the most crucial element. Those organizations that restructure their processes and resources in times of uncertainty are capable of mitigating disruptions.

Supply Chain Management

Supply Chain Management (SCM) has been interpreted as an engine of value creation which indicates that once the functioning of the whole system is clearly understood, strategies are formulated accordingly to maintain, control, and support the SC network. However, the command-and-control approach results in unpredicted hurdles that lead towards the management 'pathology'- where the structure mislays resilience and robustness. It is inappropriate to consider the supply chain as an insulated system as there are environmental factors that influence the system, implying that they are not independent of one another (Azadegan et al., 2021). Supply Chain streams should be a dynamic system because a change in one part influences other parts of the stream; therefore, considering the complexities of the world economy, the supply chain system must connect with the environment to interpret and reconfigure its existing capabilities (Wieland, 2021). Organizations that restructure and divert their strategies following uncertain environments can sustain supply chain performance under disruptions. Managing resources and proactively configuring networks refers to Supply Chain Risk Management (SCRM) which supports planned performance of supply chain (robustness) or performance recovery after demoting the disruption effects (resilience).

Risk Management in Supply Chain (SCRM)

Supply Chain Risk Management (SCRM) is referred to as discrepancies in possible outcomes or likelihood or subjective values of supply chain systems. This discrepancy may affect materials flow, products, or evidence (Butt, 2021). Risks in the supply chain are mainly associated with the breakdown of machines, delays in stock delivery, delivery of low-quality products, lack of information creates problems in data integrity which disrupts overall supply chain efficiency (Govindan et al., 2017). The management of risk is important for a holistic supply chain management system. Risks in supply chain systems have been focused upon in many recent papers thus indicating how risk jeopardizes supply chain management due to unforeseen circumstances. Pandemic outbreaks spur customers' panic behaviour, thus creating a huge impact on the demand side of the food supply chain (Behzadi et al., 2018). According to Govindan et al. (2020), decision support systems may help to mitigate risks caused by the COVID-19 outbreak whereas Sharma et al. (2020) argue that

employing policies to maintain more than usual inventory levels across supply chain systems might reduce the effects of uncertainty caused by COVID-19. Supply Chain Risk Management (SCRM) processes limit disruptive supply chains through a comprehensive framework that involves identification, assessment, control (treat), and monitoring uncertainties to alleviate supply chain risks (Chowdhury et al., 2019).

Risk Identification

The initial phase of SCRM is to identify the risk to avert potential supply chain risks through regular inspection and screening of supply chain practices (Buhman et al., 2005; Wieland, 2021). Organizations must try to develop ways to detect sources of early supply chain risks to reduce the severity of the disruption. These disruptions cause a ripple effect that disturbs the propagations within supply chain structures. Organizations must identify their critical processes, partners, flows, resources to mitigate the ripple effect (Ivanov et al., 2019). SCRM involves planned activity as it has operational, industrial, and financial influences. Two approaches evolve in supply chain risk identification. The first one refers to 'brainstorming' with supply chain members or partners to investigate prevailing risks which are mostly related to demand factors, positioning of the global value chain, the ability of the effective performance of delivery, pricing, and financial indicators the causes and effects of which are evaluated. The second approach refers to taxonomies which refer to delays, disruptions, intellectual property, inventory receivables, procurement, and capacity wherein risks are mostly identified as natural disaster, a dispute among the laborers, supplier bankruptcies, war, or terrorism which must be analysed (Cagliano et al., 2012).

Risk Mitigation

In this phase, risk in supply chains which needs to be mitigated through approaches before a disturbance occurs via appropriate contingency plans has been evaluated and measured (Shahed et al., 2021). Efficient risk mitigation relies on coordination with supply chain internal and external members and focuses on important supply chain practices to prevent interruptions in the process. Such mitigation measures support the following stage of 'risk control' (Wieland, 2021).

Risk Assessment

The phase of SCRM refers to assessing (measuring) the potential consequences of supply chain risks along with their extent of impact (Xie et al., 2011). Consequences refer to the magnitude of the threat that affects resources in terms of loss or damage of assets, delays in schedule, poor performance process, liabilities incurred, cost overruns, service level interruption. This process identifies profound details and information about antecedents of risks and triggering events (Mishra et al., 2021). The severity of a disruptive supply chain is concerned with the likelihood of each factor of risk and its speed of propagation (Li et al., 2021). Risk assessment is important because it prioritizes risks according to their severity inappropriate ways which assist SCRM practices to measure and control supply chain risks (Parast et al., 2021).

Risk Control

The last phase of SCRM refers to risk controlling and monitoring the progress made in response to risk, such corrective action plans may help in achieving desired performance (Xie et al., 2011). Risks are controlled through systematic processes, creating awareness among the employees, elaborating preventive plans, and articulating procedures that sustain suitable condition under the influence of supply chains (Heckmann et al., 2015).

In view of the fact that COVID19 has disturbed the availability of various products and damaged the SCs (Araz et al., 2020) and companies are managing their operations and processes, the following hypothesis is proposed:

H1: Disruption impacts due to outbreak affect significantly and negatively by risk management processes. Identification of Risk (H1a), Mitigation of Risk (H1b), Assessment of Risk (H1c), and Risk Control (H1d).

Supply Chain Risk Mitigation Strategies

In many of the previous studies, SC robustness and resilience have been primarily focused on examining competencies, capacities, enablers, practices needed to construct a sustainable SC network through strategies that are viable to address disruptions (Azadegan et al., 2021). Ivanov et al. (2020) support the structuring of strategies for enhancing supply chain flexibility and agility as well as improving visibility, redundancy, and collaboration among the partners within the SC structure. Various SC strategies have been extracted from the literature. These are summarized in Table 1 on the next page into two categories of reactive and proactive strategies.

Reactive Strategies

Reactive strategies refer to the information system of real-time and are inclined towards data-focused decision making, using supply chain simulation, and establishing online marketplaces. Strategies that are formulated to resolve current or aftershocks of any disruption like business continuous plans, reserves, and inventory capacity decision making are a part of reactive strategies. Often, strategies like supply chain collaboration and the development of virtual marketplaces can be a part of reactive as well as proactive strategies as per their purpose of use and their timing (Hernantes, 2017; Hofmann et al., 2019).

Proactive Strategies

Proactive strategy refers to strategies that are technology-driven such as automation in supply chain systems, developing technical infrastructures, digital connectivity to evade future disruptions. Strategies for preventive measures like regionalization sourcing, formation of integrated network systems for risk management are a part of proactive approaches (Hofmann et al., 2019).

Disruptions in Supply Chain

Supply chain disruptions are defined as the unanticipated incidence of events that disturb the streams of goods and material flow in a supply chain process which exposes organizations to financial and operational risks. Even only one stage faces any disruption, it spreads through the whole supply chain network affecting the functionality and other elements of SC (upstream or downstream. However, managing a highly complex and integrated supply chain system is challenging in a dynamic business environment (Wamba, 2020). Frequent fluctuations in supply and demand sides, shorter product life cycles and technology, rapid globalization, and increased use of external partners (distributors, logistics, and manufacturing) create an intricate network. As the intricacy intensifies, interdependency becomes more widespread causing the increase in the risk of the supply chain (Fan et al., 2018). Hence, identification and evaluation of risk and its interdependencies and effects of supply chain disruption on the overall performance of SC have become a growing interest to reduce uncertainty with an organization's supply chain from risk disruptions. Exposure of risk is broader than before which is why it is important to keep evaluating SC practices (El Baz et al., 2021).

Table 1: Risk mitigating strategies (Adapted from Belhadi et al., 2021)

Risk mitigation strategy in Supply chain		*Explanations*	*References*
Proactive Strategies	Technological connectivity	Technological connectivity for instance blockchain systems, (IoT) and digital twins are creating opportunities that enhance supply chain robustness and resilience through an easy flow of information that is transparent and accurate, obtainable through high connectivity.	(Hofmann et al., 2019; Ivanov et al., 2019)
	Localization	Preparing or souring should be localized in the same region to meet the demands because if there is a risk of disruption in one region, the risk may spill over to the next region.	(Kochan et al., 2018)
	Capabilities of human interference	It refers to the capabilities of humans involved in SC network concerned towards their analysis of enormous data, monitoring, and governing precarious dimensions within a network of the supply chain.	(Tukamuhabwa et al., 2017)
	Collaborative SC	Each tier within the network must work together to foresee, predict, and prevent supply chain risks and threats to meet the aligned objectives.	(Kamble et al., 2020; Kochan et al., 2018)

	Interconnected risk management	The focal organization must coordinate and collaborate with its SC partners. Thereby, risk management highly depends upon focal organization, but it is dominantly directed concerning supply chain networks.	(Q. Zhu et al., 2017)
	Automated supply chain systems	Utilize structures and means that minimize the dependence on humans between the organizations through developing automated systems that maintain on-ground informational data workflow across SC to advance steps.	(Hofmann et al., 2019; Tan et al., 2020)
Reactive strategies	Real-time information system	The use of big data analytics (BDA) assists in collecting, processing, and extracting information for real-time reasonable insights and data needed for timely and appropriate decision making.	(Belhadi et al., 2021; Kamble et al., 2020)
	Business continuity plans	Continuous planning of business is considered as important to develop processes and systems to prevent and recover distortions caused by uncertainty.	(Hernantes, 2017)
	Reserve and inventory capacity	Organizations must have sufficient stock and standby capacity to reduce the negative impact due to disruption.	(Hofmann et al., 2019)
	Decision-making proximity	The decision-maker must remain close to those nodes in the SC network where accuracy in information can collect to make appropriate decisions to combats any form of hiccups in the SC network.	(Zsidisin* et al., 2005)
	Supply chain collaboration	Every rank within the supply chain must work collectively to foresee, predict, and prevent supply chain risks and their impact.	(Q. Zhu et al., 2017)
	Supply chain stimulation	Stimulation in SC is a technique to support different criteria's decision however managing the complexities and uncertainties in the network.	(Hofmann et al., 2019; Ivanov, 2020)
	Lifeline maintenance	Supply chain systems during disruptions should be maintained, as any interruption or loss in the system will impact the whole SC.	(Ivanov et al., 2016)
	Digital Marketplace	It defines as the development of a virtual network for transmitting and supplying services and products.	(Kamble et al., 2020)

Supply chain Disruption by COVID -19

The pandemic caused by COVID-19 has created significant health risks and countries around the world had to respond to it through lockdown, quarantine measures, border closures to slow down the rapid increase in the infection. Such measures have adversely affected domestic and international supply chain structures (Belhadi et al., 2021). COVID-19 pandemic is the most severe catastrophe that has dismantled and disrupted the global supply chain system. Strict methods to reduce the spread of COVID- 19 led to trade and export closures and restrictions that in turn negatively affected the credit market (Handfield et al., 2020).

COVID- 19 caused a ripple effect diffused across industries, creating enormous pressure on the transportation of goods across the globe. Therefore, raw materials or goods were not able to reach the consumer market causing shortages. The reduction in supply quantities caused an increase in prices to fulfil large demand, yet many South Asian economies were not entirely negatively affected through COVID disruptions, as they were able to overcome their functioning through modifying inventory level policies, enhancing supplier-buyer relationships, and raising inbound material visibility (Butt, 2021).

Significantly, it has been highlighted that as pandemics instigate major forms of supply chain disruptions, they represent a unique threat to supply chain management, which are identified as comprising three components. First, pandemic disruptions are complex and long-term. Second, propagating disruption in the supply chain causes shortfalls leading to creating tension in the population. Lastly, pandemic hinders large-scale infrastructure due to unexpected shifts in supply and demand (Kumar et al., 2020).

Manufacturing and Service SC during COVID- 19 Outbreak

National Association of Manufacturers performed a survey on 558 organizations of United States to determine the effect of COVID- 19, the results show over 78 percent of the organization expected severe financial crisis because of uncertain conditions caused by COVID- 19 (NAM, 2020). Many studies have forecasted that financial constraints triggered by pandemic on manufacturing sector alone would be immersive, leaving the industrial powerhouses in the United States and European Union (EU) suffering from substantial supply disruption. These disruptions further escalated to manufacturing sectors of developing countries as a result of a disturbance in the network of the supply chain (Azadegan et al., 2021).

Nakamura et al. (2020) highlight the cost and the effect of the COVID-19 outbreak. China's large global share and its wide interconnection in international supply chains extended economic spill overs to other countries that were initially less affected by the infection.

COVID- 19 is affecting various sectors differently because of differences in the pattern of supply and demand. Service industries in a pandemic are highly affected due to

restrictions imposed on movement (such as travel). Retail sectors observed demand contraction but are relatively self-reliant while expanding their services to online platforms and offering home delivery services (Sharma et al., 2020). Thereby, preventive plans should be formulated to combat risks associated with the supply chain system. Forecasts suggest that supply and demand aftershocks could not be monotonous in industries (Belhadi et al., 2021). Hence it is important to explore industries in economies that are moderately affected by COVID-19 through examing their practices that are enriching to compete under uncertainties.

Robustness and Resilience in supply chain

The supply chain structure faces many challenges caused by different types of crises like economic, financial, operational, social, political, and ecological which has grasped the attention of many scholars to determine ways to achieve resilience and robustness (El Baz et al., 2021). Robustness in the supply chain refers to the ability to avoid any changes and maintain an initial level of performance even after unanticipated supply chain disruption. Important players in the system must predict, prepare, and prevent the impact of disruption through supportive strategies that reconfigure resources and respond quickly to embrace and strengthen core competencies that allow smooth recovery from SC disruption (Ivanov et al., 2019).

Robustness in the supply chain refers to proactive measures/strategies that directly influence the business performance to survive unexpected changes. Robustness is a very common keyword in supply chain management research because of recent increases in the volatility of the SC network. SC robustness enables organizations to manage fluctuations under different circumstances to sustain major disruptions (El Baz et al., 2021; Hosseini et al., 2019). The main difference between the two concepts is that robustness relies on the ability of an organization to maintain planned performance against any disruptions, whereas, SC reliance refers to overcoming the performance after witnessing the effects of disruption (Hosseini et al., 2019). To achieve supply chain robustness, organizations need to establish strong measures that support vulnerability in the SC system through scanning and then mitigating them before any risk occurrence. Reconfigure and leverage resources to maintain SC performance. Therefore, disruption caused by COVID- 19 pandemic must be able to deploy and reconfigure capabilities and resources through supply chain risk management (SCRM) to cope with interruptions or disruption needed to maintain SC resilience and robustness (El Baz et al., 2021).

Based on the foregoing discussion, we proposed the following:

H2: Resilience is negatively affected by supply chain disruption impacts

H3: Robustness is negatively affected by supply chain disruption impacts

H4: Resilience in the supply chain is positively affected by the management of risk processes i.e., identification of risk (H4a), mitigation of risk (H4b), assessment of risk (H4c), and control of risk (H4d)

H5: Robustness in the supply chain is positively affected by the management of risk processes i.e. identification of risk (H5a), mitigation of risk (H5b), assessment of risk (H5c), and control of risk (H5d)

The aforementioned hypotheses were first developed and tested by (El Baz et al., 2021) study in the context of a developed economy i.e. France. The same hypotheses have been adapted to investigate the supply chain disruption impacts amidst the COVID-19 outbreak in Pakistan to contextualize the study. The conceptual framework is shown in Figure 1.

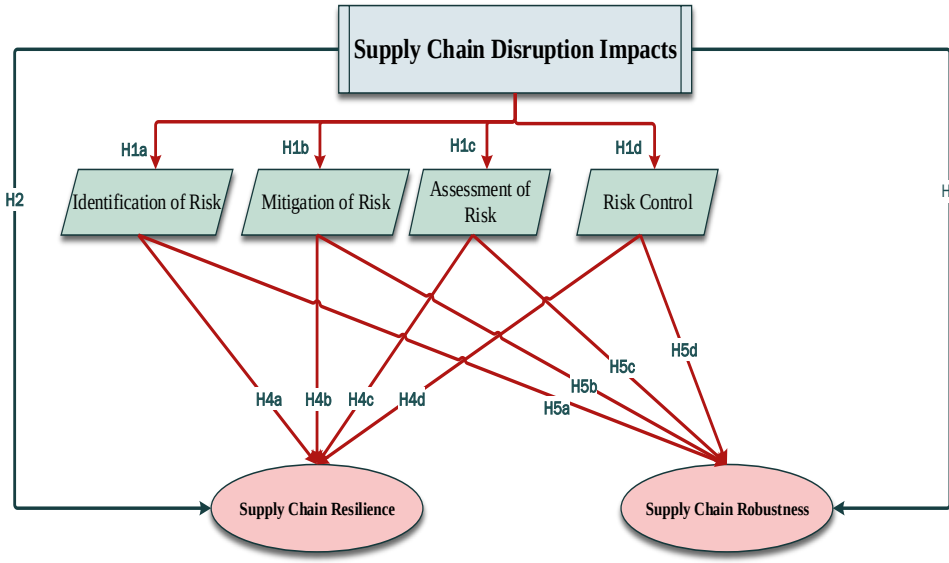

Figure 1: Conceptual Framework (Adapted from (El Baz et al., 2021)

METHODS

The research methodology adopted in the study comprises a deductive approach to evaluate the mitigating strategies of SCRM processes and practices towards supply chain disruption impacts during COVID-19 in Pakistan. As El Baz et al. (2021) recommended that their study should be contextualized in developing economies to see the similarities and dissimilarities of circumstances caused COVID-19 disruption on the overall mechanisms of organizations and their structure. Therefore, the same constructs were adapted to investigate the impacts. Based on constructs and existing literature review, quantitative research was required to analyse the effect of SC disruption on resilience, robustness, and SCRM processes in Pakistan. The methodology was based on the following steps; research design, data collection phase, and data analysis by using SmartPLS (3.0) software.

Instrument Development

The constructs and variables were taken from El Baz et al. (2021) and seven constructs were identified: Supply chain disruption impacts COVID-19, Supply Chain Disruption impacts due to COVID19, Identification, Assessment, Mitigation, and Control of Risk, Resilience, and Robustness. Online medium for survey questionnaire development and distribution was employed since its cost-effective, easily distributed, and readily accessible. The questionnaires were adapted from (El Baz et al., 2021), and a seven-point Likert scale was incorporated to perform the collection of data as (El Baz et al., 2021) stated that the 7-Likert scale (1= not at all, 7= a large extent) gives a different choice of options to reduce the respondents' frustration. The questionnaire was taken from (El Baz et al., 2021) and structured into eight parts such as demographic data, SC disruption, SC resilience, SC robustness, and SCRM practices.

Data Collection

To validate the instrument, a questionnaire was validated through pre-testing from two academicians and two professionals in SC. According to (El Baz et al., 2021), for sample size "a priori" analysis should be performed using the G*power tool and it was estimated that the minimum value of R2 should be 0.10 with a statistical power of 80%, the sample size should be at least 134. Therefore, more than 134 sample size was targeted to perform the analysis.

The sample population to be chosen for this study was extracted from major manufacturing (Textile), service (construction, banks), and other organizations operating in Pakistan as mentioned in Table 2. An email to obtain consent from the management of the said organizations was used to secure institutional consent. Next, an online questionnaire survey developed on google forms was emailed specifically to the target respondents of the selected organizations. The sample being targeted for this study were the supply chain professionals working at various manufacturing (Textile), service (construction, banks), and other organizations across Pakistan where the data were collected. Since our target respondents were available in various cities across Pakistan, the sampling method to be used in this study was non-probability sampling through the technique of purposive sampling. Purposive sampling was chosen since we need to make sure that the responses being analysed were indeed from an expert belonging to the industries of Pakistan.

Purposive sampling was used to get the required accuracy of data as noted by El Baz et al. (2021) who suggest securing the accuracy in data by means of a purposive approach. Manufacturing (Textile), Services (Banks and Construction), and other different industries were targeted as well as top management involved in strategic organizational decisions concerning supply chain disruption mitigation techniques were taken. The questionnaire was sent to 700 potential managers, supervisors, and directors in the different industries through an online survey form. The questionnaire was sent to 700 respondents. 179 responses were received, and after pre-processing of the dataset, 174 responses were retained. Thus, the response rate of the study was

recorded as 24.8% which was further used for analysis. The descriptive statistic of the sample set is displayed in Table 2.

Table 2: Respondents Profile (N = 174)

Respondents' Characteristics	Number	Percentages
Job Title		
Management Director	12	7%
Planning Engineer	3	2%
Process Engineer	2	1%
Procurement Executive	2	1%
Procurement officer	1	1%
Production Manager	3	2%
Project Manager	2	1%
Purchasing Manager	16	9%
Purchasing team member	11	6%
Quality Manager	2	1%
Supply Chain Executive	2	1%
Supply Chain Manager	65	37%
Supply Chain Officer	1	1%
Supply chain team	49	28%
Supply Executive	2	1%
Vice President (SCM, Operations, Purchasing)	1	1%
Job Experience		
In between 10-15 years	14	8%
In between 2 to 5 years	75	43%
In between 5 to10 years	42	24%
Less than 2 years	38	22%
More than 15 years	5	3%
Sectors		
Automotive	2	1%
Chemicals	4	2%
E-Commerce	3	2%
Energy	10	6%
FMCG	3	2%
Importers	1	1%
IT	3	2%
Manufacturing (Textile)	94	54%
Pharmaceuticals	16	9%
Retail	18	10%
Service and Humanitarian	15	9%
Transport	5	3%
Number of employees		
50	13	7%
1000 to 4999	49	28%
250 to 999	51	29%
50 to 249	24	14%
Greater than or equals 5000	36	21%

Data Analysis

Structural equation modelling (SEM) was performed to investigate hypotheses relations using SmartPLS. This method was used to analyse the complex models because it is predictive as implied by (El Baz et al., 2021). Moreover, it avoids indeterminacy issues in the data, and it is also used for theory development. Therefore, for this study PLS-SEM analysis was performed with other additional analyses. In this study, a two-step approach was performed to analyse the data: (i) Reliability and Validity Assessment (ii) Structure Modelling.

Furthermore, to test common method bias through collinearity statistics (VIF) in SmartPLS, the inner VIF values showed that all the latent variables: a prescribed value of VIF that is less than or equals to 3.3 (Kock, 2015). Therefore, the model was considered free of Common method bias.

Measures of Construct

The seven measures in the study were taken from a validated instrument from existing literature. The items in the survey to evaluate SC disruption impact asked about the overall efficiency of the organization's operations (impact1), delivery reliability (impact 2), and costs of procurement from supplies (impact3). For identification of risk, respondents were enquired to indicate the extent of informed risks in their SC (ident1), how to identify short-term risks (ident2), how efficient was their data gathering (ident3), and how closely they define indicators of early (ident4). For assessment of risk, the respondents were asked about how informed they were about the possible sources of SC risks (access1), the probability of SC risk to occur (access2), the impact of SC risks (access3), how well classified and prioritized is the effect SC risks (access4), and how serious are the SC risks (access5). For risk mitigation, the respondents were asked about reactive strategies (mitigate1), effectiveness of reactive approaches (mitigate2), and the significance of SC management (mitigate3). The risk control latent variable evaluated how much the existing employees are informed about the risks in supply (perfrisk1), professionally designed risk management process (perfrisk2), probability of minimizing SC risks occurrence (perfrisk3), minimizing the impacts of risks in SC (perfrisk4). The items that measure SC resilience operationalized to assess the ability to face the disruption in SC (Resil1), ability to adopt the changes caused by SC disruption (Resil2), ability to respond quickly to SC disruption (Resil3), ability to preserve awareness about high situational circumstances all time (Resil4). SC Robustness was evaluated through the ability to preserve SC even after the changes occur (Robust1), capability of suitably respond to SC disruptions (Robust2), and capability to execute SC functions after the damage done to it (Robust 3), and capability to execute SC functions after the damage done to it (Robust 4).

RESULTS

Assessment of Measurement Model

In the previous literature by Buhman et al. (2005) and Wieland (2021), the impact of disruptions, practices of supply chain management, SC resilience, and SC robustness was referred to be reflective. Therefore, using a similar perspective of reflections will have variations in latent constructs that can cause changes in the hypothesized indicators (Chin, 2010). The competence of all the constructs in the measurement model has been examined through I) factor loadings, II) discriminant validity III) convergent validity, and IV) composite reliability, which are shown in Table 3.

After analysing the data, the model reliability was proven as the item loadings met the prescribed cut-off of 0.70 as shown in Figure 3. The Cronbach's α was established for all the variables as it was above the lower threshold of 0.60. The composite reliability of all the variables indicated a good fit as they were greater than the threshold of 0.60. Convergent validity is proven as all the constructs had a value above the prescribed limit of 0.50. To determine discriminant validity, we used (Fornell et al., 1981) criteria, which suggests that the square root of average variance extracted of each construct be greater than the correlation of other constructs, therefore this criterion was achieved for each and every construct in the model.

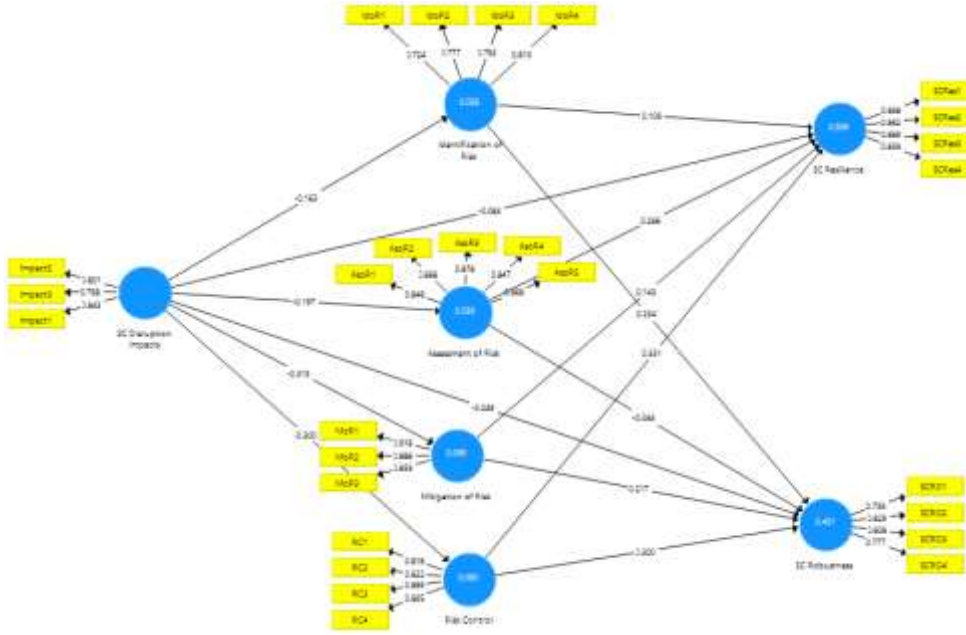

Figure 3: Measurement Model

Table 3: Reliability and Validity

Constructs	Items	Loadings	Composite Reliability	Cronbach's Alpha (α)	Average Variance Extracted
Identification of Risk	Ident1	0.724	0.858	0.780	0.603
	Iden2	0.777			
	Iden3	0.792			
	Iden4	0.810			
Assessment of Risk	Assess1	0.848	0.937	0.917	0.750
	Assess2	0.888			
	Assess3	0.878			
	Assess4	0.847			
	Assess5	0.868			
Mitigation of Risk	Mitigate1	0.918	0.919	0.867	0.790
	Mitigate2	0.888			
	Mitigate3	0.859			
Risk Control	perfrisk1	0.818	0.917	0.879	0.734
	perfrisk2	0.822			
	perfrisk3	0.889			
	perfrisk4	0.895			
SC Resilience	Resil1	0.868	0.925	0.893	0.756
	Resil2	0.862			
	Resil3	0.889			
	Resil4	0.859			
SC Robustness	Robust1	0.759	0.872	0.805	0.630
	Robust 2	0.829			
	Robust 3	0.808			
	Robust 4	0.777			
SC Disruption Impacts	Impact1	0.843	0.846	0.728	0.647
	Impact2	0.801			
	Impact3	0.768			

Table 4: Discriminant Validity through (HTMT).

		1	2	3	4	5	6	7
1.	Assessment of Risk							
2.	Identification of Risk	0.833						
3.	Mitigation of Risk	0.892	0.706					
4.	Risk Control	0.725	0.660	0.847				
5.	SC Disruption Impacts	0.240	0.218	0.393	0.372			
6.	SC Resilience	0.756	0.684	0.776	0.778	0.369		
7.	SC Robustness	0.567	0.621	0.655	0.667	0.307	0.756	

Another approach used to determine the discriminant validity was the Heterotrait-monotrait ratio (HTMT) the value of which ranged from 0.21 to 0.89 which is below the threshold of 0.90 (Henseler et al., 2015). Therefore, Fornell-Larcker Criteria and HTMT.90 support the construct measure's discriminant validity as shown in Table 4. Using bootstrapping to test whether HTMT is significantly different from 1, our model indicates the confidence interval of each construct that is not a part of the confidence range (HTMT <1) (Henseler et al., 2015). Therefore, all the approaches support the construct measure's discriminant validity.

To examine Structural model quality, impacts of SC disruption do not have a significant effect through any supply chain risk management activities in Pakistan as R2 values were below the threshold of 0.5 (Hair et al., 2012). The 4 SCRM practices indicate 0.59 of SC resilience and 0.40 of SC robustness. Model's predictive relevance was backed by entire elements whose values were greater than zero. Following are the values for 4 SCRM values of Stone-Geisser Q2 = 0.026 for assessment of risk, Q2 = 0.013 for identification of risk, and Q2 = 0.074 for mitigation of risk, Q2 = 0.064 for risk control, Q2 = 0.43 for supply chain resilience and Q2 = 0.23 for supply chain robustness.

PLS structural modelling uses two correlation and path coefficients to explain the relationship between variables. Using the bootstrapping neutralizes the β coefficient to measure the significance and error. Our analysis depicts a negative and significant direct relationship of assessment of risk, control of risk, and mitigation of risk with the disruption impact. Thereby, the findings suggest that the impact of disruption caused by COVID-19 significantly and adversely affect the supply chain risk management practices except for the process of risk identification. Hence, H1a was rejected whereas H1b, H1c, H1d were supported. On the contrary, supply chain resilience and supply chain robustness had no significant direct effect on the impacts caused by disruption which means that Pakistan was not negatively influenced by the SC disruption. Therefore, H2 and H3 were rejected.

Furthermore, the results of our findings show that SC resilience is positively impacted by only two SCM of risk practices, i.e., assessment of risk and control of risk. Thus, H4c and H4d were supported, whereas H4a and H4b were rejected which means that firms within Pakistan focused more on the assessment of risk and risk control strategies to overcome the performance post disruption effects.

Moreover, it was found that supply chain robustness is influenced positively by only two types of supply chain risk management practices i.e. risk identification and risk control strategies. Therefore, H5a and H5d were supported while H5b and H5c were rejected as shown in Table 5. This means that firms in emerging economies were successfully able to implement identification and control of risk management strategies to sustain planned performance during COVID-19 disruption.

Our findings show that risk control activities comprise a crucial component for supply chain robustness and resilience. The results of our findings are depicted in Table 5.

Table 5: Results of Structure model

S No.	Hypothesis Testing	T value	Direct Effect	T value	Indirect Effect	T value
H1a	SC Disruption Impacts -> Identification of Risk	1.936	0.050	1.495	0.136	1.936
H1b	SC Disruption Impacts -> Mitigation of Risk	4.530	0.000	1.577	0.116	4.530
H1c	SC Disruption Impacts -> Assessment of Risk	2.329	0.020	0.327	0.744	2.329
H1d	SC Disruption Impacts -> Risk Control	4.214	0.000	1.968	0.050	4.214
H2	SC Disruption Impacts -> SC Resilience	1.660	0.098	3.587	0.000	4.018
H3	SC Disruption Impacts -> SC Robustness	0.742	0.459	3.449	0.001	3.001
H4a	Risk Identification -> SC Resilience	1.199	0.231	0.906	0.365	1.199
H4b	Risk Mitigation -> SC Resilience	1.184	0.237	1.106	0.269	1.184
H4c	Risk Assessment -> SC Resilience	2.192	0.029	1.586	0.113	2.192
H4d	Risk Control -> SC Resilience	3.482	0.001	2.608	0.009	3.482
H5a	Risk Identification -> SC Robustness	2.610	0.009	1.495	0.136	2.610
H5b	Risk Mitigation -> SC Robustness	1.649	0.100	1.577	0.116	1.649
H5c	Risk Assessment -> SC Robustness	0.385	0.700	0.327	0.744	0.385
H5d	Risk Control -> SC Robustness	2.402	0.017	1.968	0.050	2.402

To further examine the results of our model, Importance map analysis (IPMA) was conducted to investigate the major construct that predicts resilience and robustness in SC as depicted in Table 6.

The results indicate that risk mitigation within SC management of risk practices has the highest performance in robustness and resilience of SC. Yet, practices of identification of and control of have the most important to support supply chain robustness having figures of 0.23 and 0.30 in Pakistan. It means each unit increase in identification of risk from 69.92 to 70.92 would progress supply chain robustness by

0.23 and each unit increase in control of risk practices would progress SC robustness via 0.30 points.

Table 6: Results of IPMA

Constructs	SC Robustness		SC Resilience	
	Importance	Performance	Importance	Performance
Assessment of Risk	-0.044	69.929	0.266	69.929
Identification of Risk	0.234	63.051	0.109	63.051
Mitigation of Risk	0.217	71.533	0.143	71.533
Risk Control	0.300	62.701	0.331	62.701
SC Disruption	-0.049	63.901	-0.083	63.901

Therefore, organizations that want to improve SC robustness must focus on their identification of risk and control of risk practices. With regards to supplying chain resilience, our results show the most important to risk assessment and risk control practices with values 0.26 and 0.33. Hence, an organization that wants to attain SC resilience must focus on risk assessment and risk control activities in the management process.

DISCUSSION

The purpose of the paper was to determine the supply chain risk management practices in Pakistan against the impacts of disruption by the COVID-19 outbreak to build overall resilience and robustness in SC. The findings revealed that COVID-19 disruption does not seem to have affected supply chain robustness and resilience within Pakistan because firms in developing economies believe that they can recover performance post any disruption efficiently to maintain SC resilience. Further, SC robustness was not directly affected by the disruption.

After all, many firms in developing economies relied on the use of existing resource slack such as excess material inventory, buffer capacity, and backup facilities and channels. The organizations surveyed in developing economies declared that their firms did not effectively implement Just in Time (JIT) systems which allowed them to maintain extra inventory level, production, and warehousing capacity that supported their supply chain robustness and resilience. To further investigate, some of the managers also mentioned the idea of localization where they were able to reach local suppliers to accommodate market demands, a concept also stipulated by (Farrell et al., 2020; Sarkis, 2020). Whereas, when the same hypothesis was evaluated in a developed economy in the paper by El Baz et al. (2021), it indicated that COVID-19 disruption harmed SC robustness because many developed economies were not anticipating such uncertainty, or they were not willing to change their existing strategies or system to meet the unforeseen challenges (Remko, 2020).

The findings indicate that disruption impacts due to COVID-19 are significant and negatively affect the SCRM practices of assessment, mitigation, and control in Pakistan whereas risk identification was not negatively affected. Hence, it means that firms within Pakistan were able to proficiently inspect and screen supply chain practices to avoid any risks. Being able to identify risks helps in formulating proactive strategies which can enhance SC robustness and resilience as firms can prepare well-defined production schedules, and they can work with a logistic provider who works through multiple alternative routes like air cargo, seaports, roads, rail, etc, firms can develop modularized production units to mitigate the impact of COVID-19 (Butt, 2021). According to El Baz et al. (2021), within developed economies practices of risk mitigation and risk control were not negatively influenced by disruption as firms were able to successfully deploy contingency and corrective action plans to achieve desired supply chain performance as reactive strategies.

Furthermore, the findings suggest that resilience in the supply chain is positively affected by risk assessment and risk control SCRM practices. Hence, firms that can measure the potential consequences of supply chain risks along with the extent of the impact can control risks through prioritizing inventories and orders and production facilities, introducing new mechanisms to meet crucial demands, maintaining closer buyer-supplier relationships to regain the performance post disruption (Zhu et al., 2020)

Lastly, the findings direct that robustness in the SC is positively affected by SC management of risk practices (i.e. risk identification and risk control) which refer to service level considerations, cost management and flexibility to change to reduce the effects of uncertainty (Ivanov et al., 2016). Our study suggests that risk assessment and risk controls practices support SC resilience and risk identification and risk control practices support SC robustness whereas the study by (El Baz et al., 2021) indicates that SC resilience is supported by all the four SCRM practices which creates a major contradiction in both the studies. Thus, a new synergy or mediator should be considered that fully supports the context of supply chain resilience within all the economies.

The findings of our study also substantiate the theory of Organization information processing theory (OIP) that suggests processing information (improve flow and quality) in a way that commutes uncertainty (Goel et al., 2021). As the result, our study shows that control of risk practices has a significant impact on both supply chain robustness and resilience in emerging economies, the firms need to develop such capabilities to collect, treat and interpret information proactively to combat uncertainties (DuHadway et al., 2019). Our study also supports dynamic capabilities theory by providing strong conjecture to implement SC management of risk practices to improve robustness and resilience in SC network as a firm's dynamic capabilities.

CONCLUSION

In this study, the linkage between SC management of risk practices, disruption impacts, resilience, and robustness in SC was evaluated empirically in the context of

Pakistan to compare the results with those reported by El Baz et al. (2021) since the latter was done in a developed country (France). The findings were insightful in theoretical as well as practical domains.

Theoretical Implications

This study supports the SCRM practices which emphasize prior literature through a conceptualization of risk management in supply chains (El Baz et al., 2021; Fan et al., 2018). The implications of SCRM practices help to investigate the challenges in risk management. The findings support the statement of (El Baz et al., 2021) that SCRM practices help to analyse and predict the supply chain disruptions in times of outbreaks. Thus, the findings suggest that a combination of Resource-based view and organizational information processing theories will impact the SC management of risk practices at different stages of risk management in the supply chain during disruption impacts. Furthermore, our findings indicate that processing and delivering information plays an important part during a disruptive environment that enforces the implementation of organizational information processing theory and having individualistic resources to compensate for uncertainty proves the dynamic capability role. As Butt (2021) revealed, in developing economies organizations monitored their schedules and status of shipments, and developed connections with first-tier suppliers from non-impacted locations to make their information processing effective in the times of COVID-19.

Based on these findings, it is important to enhance the dynamic capabilities and better organizational information processing with the help of collaboration of different supply chain partners in each stage to exchange knowledge in identifying the challenges that can enhance the SCRM practices. Moreover, our study highlights the governance of supply chain members to collaborate and provide impactful relations with resilience and robustness. Dynamic capabilities and OIP also assess the impact of resilience and robustness in the supply chain. Findings reveal that dynamic capabilities and OIP enhance the links between SCRM practices and SC disruption. As Azadegan et al. (2020), pointed out that having dynamic capabilities and OIP increase the chances of survival in a disruptive environment which include knowing about the lead time, resources availability, and better informational capabilities could help to remain stable in disruption. Therefore, those organizations which have a theoretical perspective of SC in a disruptive and uncertain environment could improve their resilience and robustness capabilities.

Practical Implications

The findings show that in Pakistan, organizations were well prepared to mitigate and control the supply chain disruption impacts. It is also revealed that the COVID-19 outbreak has affected negatively SCRM practices. Therefore, it is suggested that organizations need to execute novel SCRM practices to make their strategies better in times of uncertainty. The findings revealed that organizations should have focused on postponement and modularized production units to maintain their supplies (Butt,

2021), and suggested that organizations should incorporate a digital approach to managing the SCRM practices.

Furthermore, the findings showed that SC robustness was not affected negatively by disruption impacts, it is indicating that organizations have robust practices such as understanding their status of inventories (Butt, 2021). Therefore, it is suggested that to remain resilient during outbreaks, organizations should contact their suppliers to gain information on their inventories. Moreover, the study found that in Pakistan, organizations have managed to resist the impacts of disruption due to having strong SC resilience. As stated by (Butt, 2021), those organizations who had communicated new strategies and kept close to their customers remained resilient. As manufacturing firms remained in touch with their suppliers to build their capabilities to mitigate the COVID-19 disruptions

The reason why developed countries had to face disruption is that the lean system makes organizations less flexible during a mitigating disruption in an uncertain environment (Chopra et al., 2014) and incapable of synergizing with SC resilience and robustness, However, in developing economies low adaptation of lean has observed (Shah et al., 2016). Therefore, developed countries faced more disruption because lean enforced less inventory hold. Thus, it is suggested that organizations need to strategize before making their systems lean because it does not remain stable in disruptions such as COVID-19.

In developing contexts, organizations worked on recovery systems because revised their strategies to become resilient (Butt, 2021). Thus, organizations should revisit or renew their risk management practices because through it they can make their internal system strong and build better contingency plans to make their systems more resilient. Conclusively, our findings suggest that COVID-19 has brought various insightful and deep concussions to the supply chain.

Limitations and Future Directions

Various studies have been conducted in developed countries within the context of evaluation supply chain risk management practices. However, the present research has considered the aspects of one country 'Pakistan' as a developing economy. Therefore, it is suggested that in future research, studies should focus on other SAARC countries to assess their mitigation strategies amidst COVID-19. Second, as suggested by El Baz et al. (2021), there is an inaccessibility of longitudinal data. The present study was also a snapshot. Therefore longitudinal study should be done as research suggests that while impacts of disruption result may be consistent for a shorter period, they could be affected in a longer span (Guan et al., 2020). Third, we focused only on contextualizing El Baz et al's (2021) research in the context of developing economies such as Pakistan. Therefore it is suggested that in future research, more mediating variables could be used to analyse the disruption impact such as inventory slack time, SC performance, and SC maturity as SC resilience and robustness are enhanced by these factors (Goel et al., 2021; Lockamy Iii et al., 2008; McCormack et al., 2008; Parast et al., 2021)

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