

Towards a Resilient Supply Chain Model: Critical Role of Knowledge Management and Dynamic Capabilities

Abstract

Purpose – Recent research has highlighted the beneficial role of supply chain resilience for ensuring efficient production and business processes. The purpose of this study is to explore enablers of supply chain resilience. In particular, we examine whether and how dynamic capabilities and knowledge management can help firms develop a resilient supply chain in times of high disruption and uncertainty.

Design/methodology/approach – A single longitudinal case study was adopted. Data was collected over 8 years from a Pakistani textile producer and supplier through semi-structured interviews and was analyzed through NVivo to generate codes and themes that contributed to the development of the supply chain resilience model.

Findings – The analysis of case study shows that our focal firm strategically acquired, transferred, and integrated market knowledge by investing in digital technologies and idiosyncratic resources and consequently developed a supply chain model that was resilient in addressing logistics and delivery challenges in these critical times.

Originality/value – The outcomes provide some early hints on how companies in emerging economies can adopt and integrate novel digital technologies, and overhaul their organizational routines to facilitate knowledge management and dynamic capabilities, and consequently enhance the resilience of their supply chain operations.

Research /implications – The study brings together three main research streams of organizational theory, namely supply chain, knowledge management, and dynamic capabilities, and proposes a nuanced resilient supply chain model.

Practical implications – By applying the research findings, managers can adjust, develop and adopt supply chain resilience to address market volatilities, thereby creating value and longevity in their supply chain operations. However, the findings are contextual and should be applied cautiously.

Keywords: Supply Chain Resilience, Knowledge Management, Dynamic Capabilities, Digital Technologies

Introduction

In recent decades, globalization and digitization have changed the landscape of the global business environment, such that firms tend to enter into collaboration arrangements to achieve production efficiencies and / or seek new business opportunities (Buckley, 2011). The mutual interdependence between firms located in different geographical regions requires an uninterrupted supply chain for smooth business operations (Sheffi and Rice, 2005) especially at times of high disruption and uncertainty. The ability of firms to cope with uncertainties and disruptions for uninterrupted operations is termed supply chain resilience. Supply chain resilience has been defined as “*the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at desired levels of connectedness and control over structure and function*” (Ponomarov and Holcomb, 2009). This concept has received considerable scholarly attention in recent times (Modgil et al., 2021, Gölgeci and Kuivalainen, 2020, Bag et al., 2019, Ali and Gölgeci, 2019, Cheng and Lu, 2017). A group of scholars in this domain has identified several enablers/ antecedents that can enhance firms’ capabilities (Teece, 2018) in developing supply chain resilience such as visibility, collaboration (Jüttner and Maklan, 2011), absorptive capacity (Gölgeci and Kuivalainen, 2020) and supply chain reengineering (González-Zapatero et al., 2020) to name but a few. Despite some early hints on how firms can build a resilient supply chain model, this research stream is under-explored and needs further investigation (Gölgeci and Kuivalainen, 2020, Vanpoucke et al., 2017). This study plans to address this dearth which is vital to both scholars and practitioners.

To advance research on the antecedents of supply chain resilience, we focus on the interplay between knowledge management and dynamic capabilities. Effective knowledge management practices can help firms develop the new capabilities essential for business model innovations (Ramdani et al., 2019) and to enhance supply chain resilience (Fjeldstad and Snow, 2018). While firms need to continuously overhaul their organizational routines to overcome external shocks and disruptions (Khurshid et al., 2019), effective knowledge management practices can help firms overhaul organizational routines, create flexibility in operations, and ultimately build a resilient supply chain model (Umar et al., 2021). In sum, knowledge management facilitates capabilities development regarding supply chain resilience. Interestingly, recent advances in information technology (e.g. artificial intelligence, big data, cloud computing, shared platforms, and the internet of things) have significantly increased the speed of data collection, analysis, and knowledge creation (Ruel et al., 2017, Vanpoucke et al., 2017, Ju et al., 2021). To handle and keep pace with the rapid inflow of knowledge, firms need to develop dynamic capabilities so that the same resources can be deployed on several fronts when required (Cheng and Lu, 2017). Thus, dynamic capabilities facilitate effective knowledge management. Given that both knowledge management and dynamic capabilities broadly complement each other in improving supply chain resilience, there is a dearth of research on understanding the underlying processes.

This study proposes that continuous investments in digital technologies to access, acquire, and process information not only help effective knowledge management practices but also facilitate the development of the dynamic capabilities essential for a resilient supply chain model. Unlike resourceful MNCs (Reeves et al., 2015), current study focuses on suppliers' from developing economies where in addition to supply chain disruptions other factors such as weak institutions, underdeveloped markets factors (Bilgili et al., 2016), and economic inequalities (Bapuji et al., 2018) further complicate the situation for already resource deficient firms. Therefore, the main question of this research is: *RQ: How does a supplier from an emerging*

economy manage market knowledge so as to develop a resilient supply chain model for longevity in its operations?

To address the research question, a holistic single case study approach was adopted. Using the purposive sampling technique (Quinn, 2014), we selected a Pakistani apparel company, engaged since 2000, in supply ties with international brands/companies, American hyper/superstores and retailers such as JC Penny, Macy's, Kohls and Wal-Mart. The company has faced numerous challenges in its supply chain that posed a serious threat to its survival in international markets. To manage those threats, the company employed different alternatives and strategies to develop a resilient supply chain model. Relying on grounded theory, we tracked the company over 8 years and conducted semi-structured interviews with knowledgeable respondents to collect the data that was later analyzed using NVivo 12. We found that the case company made strategic investments in digital technologies, machines, and logistics networks in order to acquire new knowledge, integrated this new knowledge with its own online data interface and digital data platform in real-time, and successfully managed to fine-tune its supply operations according to the market needs. This supply chain resilience model facilitated the survival of the focal company in times of high disruption and uncertainty.

This study makes several contributions to the literature. First, we found evidence of firms' strategic pursuit of innovation in their supply chain model(s) for enhancing resilience and longevity in business (Golan et al., 2021). Specifically, we highlight why the information and data from the international markets need proper management (acquisition, sharing, and analysis to make sense) (Sumbal et al., 2017) through an appropriate proper digital strategy (Ruel et al., 2017, Cui et al., 2020, Ju et al., 2021). Second, we propose that firms should continuously overhaul their organizational routines so as to acquire market knowledge, integrate it with internal knowledge to enhance their operations, and overcome internal and external disruptions (Rojo-Gallego-Burin et al., 2020, Ju et al., 2021).

The following sections present the literature review, methodology, the results, discussion and conclusions of the study.

Literature Review

2.1 Knowledge Management and Supply Chain

Knowledge is a vital resource in organizations and a key aspect (Del Giudice and Maggioni, 2014) in the contemporary business environment. It is seen as a vital resource to gain competitive advantages in the supply chain and improve supply chain outcomes. Knowledge in organizations can be categorized as tacit and explicit knowledge. Tacit knowledge is context-specific knowledge residing in the minds of individuals and cannot be replicated easily, whereas explicit knowledge is the documented knowledge in organizations in the form of SOPs, notes, manuals, etc. Which can be stored and used by others. In order to capitalize on using this knowledge, organizations need to improve their KM capabilities which are divided into two main categories, namely KM processes and KM infrastructure capability. The first category of KM processes involves the three major processes in knowledge management namely knowledge acquisition (gaining new and existing knowledge within and across organizations), knowledge sharing (among organizational members), and knowledge utilization (of the acquired and shared knowledge) to gain a better position in the market. The acquisition of knowledge helps firms to capitalize on their market position and enables them to understand the market dynamics and adapt in a timely manner to foster innovation. This acquired knowledge must be shared across the organization and with related actors (Choo, 2013) i.e., knowledge sharing. Knowledge sharing is important in bringing new insights and knowledge to the relevant actors (Jarrahi, 2018). It serves as a vital social mechanism that enhances interaction and learning, thus, contributing towards effective decision making (Bolisani and Bratianu, 2018) and the generation of new ideas. This shared knowledge then needs to be applied within the organizations for enhanced performance, gaining competitive advantage and learning from past experiences in avoiding repeating the mistakes and reinventing the wheel. Moreover, knowledge application is vital in creating flexibilities and competencies so as to change existing models or develop new ones (Valentim et al., 2015).

The infrastructure capabilities are technical, structural and cultural. Technical capabilities involve use of IT for enhanced knowledge acquisition and sharing. Structural capabilities such as network structures enable supply chain members to collaborate and transfer knowledge more effectively. Similarly, the culture of knowledge acquisition and sharing among supply chain members promotes effective supply chain operations. Modern firms proactively learn and acquire knowledge continuously. Dynamic firms invest in routines, technologies and infrastructure and combine resources in a way that fosters acquisition, sharing and application of knowledge in real-time. These new technologies and infrastructure include internet of things (IoT), online platforms, intranet, search engines, and more recently big data, blockchain and artificial intelligence (Sumbal et al., 2019). These technologies support firms in their KM by providing access to a large pool of data, analyzing and understanding this data for further knowledge creation, sharing and utilization (Del Giudice et al., 2020). A knowledge-intensive organization such as in fast fashion apparel business, constantly acquires and utilizes the market knowledge to respond to the market dynamics efficiently by developing and utilizing resilient supply chain models. As our study takes into account the knowledge as a resource to improve the supply chain resilience, the research work is based on knowledge-based theory of the firm (Grant, 1996) which takes knowledge as an inimitable resource for organizations to gain competitive advantage. We now review the existing body of knowledge related to supply chain in connection with knowledge management.

To resolve the challenge of scattered knowledge within an organization, the enterprise resource information system is used which helps to integrate the knowledge available within the

organization in the supply chain environment. It helps to achieve the objectives efficiently and effectively. This is the reason that most organizations, including small, medium, and large enterprises, are investing in the implementation of the EIS such as Enterprise Resource Planning (ERP) (Wang et al., 2016). Until now, ERP was used to manage physical assets, but now companies are using it to manage knowledge. The organizations need to have the ERP and KM systems integrated, although it's a complicated process it helps them to increase their efficiency (Xu et al., 2006, Khan et al., 2019). Research also indicates the usage of different platforms for the extraction of knowledge from the wikis and their utilization in specific contexts (Monticolo et al., 2020). There has been a significant awareness in information technology systems with an increase of mobile knowledge workers as well, which emphasizes the fact of having a mobile knowledge management system as well. Organizations in the context of the supply chain need to have such an integrated system that can cope with having a mobile environment. For this purpose, usage of individual mobile devices is a common method for sharing the knowledge between staff social software is used. The central knowledge base acts as a server for managing the whole knowledge cycle in the mobile environment (Zhang and Jasimuddin, 2015). Moreover, the supply chain system of any organization needs to have integration between the logistics and procurement services (ILPS) provided by third-party logistics (3PL) firms in supply chain management. The lack of integration can cause disconnected knowledge patterns, leading to high risks of uncertainty and cost. This demands efficient knowledge creation, sharing, and application through the integration of various components of supply chain systems (Yang and Yu, 2019). If there is variance within the supply chain, there is the wastage of the resources including time, money, quality & technology. Variance is basically the number of suppliers who are involved in the process of sourcing. If there are huge numbers of suppliers, the process becomes complicated rather than being optimized. Recent research also developed methods for the companies to manage their processes (Nabhani et al., 2018). Uncertainty happening in the supply chain can cause high costs to the companies so it's important to have simulation models which can calculate the upcoming risk (Vieira et al., 2020). As digital transformation is taking place in almost every organization, it is important to reshape the supply chain system. International mobility and trans-nationalization help in sharing intellectual resources across the globe which ultimately helps in improving the supply chain (Li, 2020). In connection to disruptions and changing environments, an emerging field in the supply chain resilience area is discussed in the next section.

2.2 Knowledge Management and Supply Chain Resilience Models

The increasing frequency of disruptions like COVID-19 (Ivanov, 2020), extreme weather conditions (Wang et al., 2016), terrorism (Pettit et al., 2010), energy crises (Urciuoli et al., 2014), economic recessions, currency fluctuations (Akkermans and Van Wassenhove, 2018), logistics, lower production capacity (Ghadge et al., 2019) industrial accidents, and other disruptive events (Pettit et al., 2019) has compelled businesses to pay more attention and responded to them in a dynamic way so as to develop a resilient supply chain model as a vital source of strategic advantage (Dubey et al., 2021). Interestingly, disruption in general and the COVID-19 pandemic, in particular, has attracted more interest in supply chain resilience research and practice for gaining competitive advantage. Advancing the research on resilience in the supply chain has become more important because of the high magnitude disruptions and the breaking of global supply chains. It has affected the global supply chains and caused an imbalance in the demand and the availability of supply (Ivanov and Dolgui, 2020), while it also resulted in a huge surge of demand in some supply chains (e.g., protective suits, face masks,

disinfectants, and hand sanitizers). Because of the changing scenarios, it has been tough to meet the supply and demand. Recent research has been focusing on the development of models and simulations for developing resilient supply chain models for support in decision making as well as matching the varying demands. In this regard, the role of strategic response, dynamic capabilities, and innovative culture of a firm cannot be neglected in coping with the uncertainties and creating agility and resilience in the supply chain (Sabahi and Parast, 2020)

As supply chain resilience is an emerging discipline, two main approaches have been found to describe resilience in the literature. The first approach is to create response capabilities within the supply chain network (Christopher and Peck, 2004, Sheffi and Rice, 2005). These capabilities may comprise a skilled workforce, geospatial distancing, agile production systems, and multiple supply networks. Negri et al. (2021), after performing a systematic literature review, argued that the area of supply chain resilience is less mature and calls for more attention. There is a need to further work on the integration of sustainability and supply chain resilience which can be achieved through proper knowledge management.

The second approach to supply chain resilience is connected to redundancy which means having additional capabilities to respond “Just-in-case” when disruptions occur. Researchers have also highlighted other factors, such as agility, alignment and adaptability as the main components of supply chain resilience (Christopher and Peck, 2004, Reich, 2006). Agility is related to the ability of the supply chain to sense and rapidly respond to changes in the environment. Alignment is the property of a supply chain that aligns the interest of all the involved actors in the supply chain network through a free exchange of information, integration and cooperation, role clarity and sharing of risk. Adaptability is related to the ability of a supply chain to sense and then respond to changes in the environment (Dubey et al., 2018) in a dynamic manner.

In relation to how knowledge management contributes towards resilience supply, a few studies have been reported. A recent study by Umar et al. (2021) stated that KM processes can help build supply chain resilience through KM infrastructure capabilities such as networking facilities, collaborative cultures, and IT advancements. These capabilities help in efficient knowledge creation, sharing and application thus contributing towards supply chain resilience. Their findings are based on the data collected from food supply chains in South Asia. Similarly, Kassaneh et al. (2021) stated that it has become vital to coordinate and manage resources and innovative efforts at the supply chain level. The researchers mentioned various KM practices such as community of practices, lessons learned, knowledge cafes, and mentoring to build resilient supply chain models and practices. These two recent studies have focused on the role of knowledge management in the development of resilience supply chain models indicating the need to further explore the role of KM on supply chain resilience. Moreover, these studies did not focus on the developing economies context than the supplier perspective. Specifically, when there is cross-border knowledge creation, sharing and application, various contextual factors come into play which can force companies to adopt more resilient supply chain models. Thus, our research attempts to cover this gap.

Methodology

The current study adopted an in-depth longitudinal, exploratory single case study approach (Yin, 2018, Van de Ven, 1992). As the objective was to analyze the capabilities and knowledge management practices to enhance and develop resilience in supply chain, this approach was

considered suitable, thus, permitting a rich and context-specific description of the phenomenon under investigation (Yin, 2018, Eisenhardt and Graebner, 2007). Furthermore, implementing an exploratory research design creates flexibility and openness in investigating new phenomena from different dimensions, when no prior fixed routine and hypotheses are available to guide the study. In practice, it allows researchers to reveal surprising and novel facts, anomalies (Timmermans and Tavory, 2012) and new research problem(s) (Dubois and Gadde, 2002) in the search for resilience in the supply chain.

In general, a case study is more useful in business and other process research areas (Ghauri, 2004, Miles and Huberman, 1994), in addressing the “how” and “why” questions and to investigate the phenomena within the real setting (Welch et al., 2011, Yin, 2018). Based on the recommendation by Yin (2018), a single case study is helpful when there is a unique situation; where we explore a distant phenomenon longitudinally. Similarly, the single case study is deemed useful in studying a phenomenon that has been largely inaccessible (Yin, 2018), and in gaining a better understanding of the dynamics and evolution of a process (dynamic capabilities, knowledge management to enhance resilience) over time (Langley et al., 2013). Moreover, longitudinal studies are highly important and suitable in international business research (Pereira et al., 2016) to track and explore the underlying dynamics over time. In addition, it allows depth (Piekkari et al., 2009) and richness of the results. We employed purposive sampling (Patton, 2002) and selected the most suitable case and industry that serve the purpose of our study in a longitudinal manner.

3.1 Case and Context Selection

We screened and interviewed three firms from different industries, and the current case firm (hereafter Z) was selected based on the following factors. First, Z has well-established outsourcing ties with international brands over a longer period, with about 85% of its production destined to the USA and Europe. It has composite production facilities in Pakistan, and offshore production, R&D and marketing facilities in the USA, Jordan, Bangladesh and China. Given the very specific type of company, the nature of its operations and remoteness to the main market, Z faced challenges in meeting the production capacity, long lead time, delays in production and delivery schedule and lack of capabilities to address volatile market demand. Due to these challenges, Z faced problems in retaining its business and its survival remained threatened. To address the situation, Z designed and implemented various responses to enhance resilience in its supplies. Second, we selected the textile sector due to its importance in the internationalization and innovative capabilities of local firms and contribution to exports and GDP of Pakistan. Pakistan is among the top five cotton and yarn producer in the world. Textiles constitute about 46% of total manufacturing and 54% of Pakistan’s total exports, contributing to 38% of the manufacturing employment and 8% of the GDP of Pakistan (Pakistan Economic Survey, 2016-2017). Third, the context itself provided fertile ground to study the phenomena. Given the low market and institutional development, Pakistan is considered a traditional emerging economy (Bilgili et al., 2016). Few in-depth and longitudinal case studies have been conducted in such an economy due to limited access to data (Sinkovics et al., 2018). Furthermore, the majority of such firms are more risk-averse and short-term focused, thus avoid risky and market-specific investments. Equally, volatile market conditions, and the underdeveloped institutional environment further hinders development of their capabilities (Hitt et al., 2005). Despite such challenges, Z managed to invest, acquire and integrate technologies in a dynamic manner to enhance KM and develop an innovative model for uninterrupted supplies.

3.2 Data Collection

We contacted the company through personal contacts and conducted interviews in four rounds. The first-round was conducted in February 2013, and we visited the company and undertook eight in-depth semi-structured interviews with senior-level managers (R1-R8). We asked about the history of the firm, critical incidents, firms supply strategy, main markets/clients, opportunities and challenges faced and firm's response to those challenges. In addition, we asked about the main customers, nature of the offerings, the duration and nature of the relationships, order filling procedures, materializing a transaction, modes of contacting buyers, frequency of orders, specific investments, management of knowledge/ information, reasons for continuation/ termination of orders and ties.

Based on the experience of the respondents and their involvement in various relevant aspects, we requested details on the ideation and implementation of various strategies. Also, we visited each department to observe the process from purchase order (PO) to the final delivery in detail. Additional questions were asked, whenever required, and included in the analysis accordingly. In March-April 2015, the second round of interviews was conducted with the same respondents. We asked questions related to the company's operations in the US and other international markets. We got insights and could better track the acquisition, integration, and management of information and knowledge across different operations, changes in company operations, addressing the supply and delivery challenges and exploring the application of the new supply strategies and their effectiveness. The third round of interviews was conducted in November 2018 with the same respondents. The Director of Marketing (R2) had left the organization in 2018, so we interviewed the new Director Marketing. We focused more on the role of various departments in the implementation of the new supply model. This explicitly helped us to clarify aspects of delivery time, planning, forecasting and predictive knowledge and integrating the KM and digitization in developing a new model. We noted all the changes in the international supply operations.

The COVID-19 pandemic persuaded us to conduct a fourth round of interviews, as it severely affected the global supply chains and supplies operations of companies from this region. Accordingly, we conducted interviews with R1, R2, R4, R6 & R7, in October-November 2020, to explore the effect of the pandemic and the aftermath on the supply chain model of Z. We explicitly looked into the challenges and opportunities that the pandemic created for Z in its international supplies' operations and the role of the new supply chain model in addressing them.

The first round of interviews was face to face while other rounds were conducted through Skype and WhatsApp. All the interviews were conducted in English and transcribed verbatim according to the sequences and relation to certain aspects. The interviews lasted between 40-120 minutes, see table 1 for details. We used both primary and secondary data to enhance the diversity in viewpoints (Ghauri, 2004) and triangulation and reduce misinterpretation.

.....Insert table 1 here.....

An interview guide was prepared, consisting of four parts. The first part sought background information about the respondents and case firms, their main responsibilities, overall understanding of the global supply chain, Z's supply ties with international brands and evolution of supplies ties over time. The second part sought interviewees' perceptions about how the exogenous and temporal factors affected their supply ties and supply chain in

international markets, the main challenges and adversities the suppliers faced in sustaining their sourcing ties. The third part investigated how Z acquired and utilized resources in a certain way to address uncertainties. The fourth part asked about the reconfiguration of resources, and knowledge to create a new supply model to enhance resilience in their international supplies.

The interview questions included: (A) how and when did the focal started and engaged in international outsourcing ties? (B) can you please mention the main partners and regions with which your firm is involved? (C) can you describe how you managed your business (supplies)? (D) please tell us about the main products, processes, and services your firm gets involvement in its supplies to international brands? (E) can you identify changes in the nature of offerings, supplies, and relationships with your main clients over time? (F) please tell us about the challenges that your firm faced/is facing in its international supplies (G) please tell us about how the uncertainties affect your firm? And in what way? (H) How has your firm addressed the uncertainties? (I) can you please identify the resources and capabilities that have enabled your firm to tackle the situation? (J) please tell us how you manage your international operations afterward? what changes have your firm adopted in strategies, actions, and operations (K) how does it affect your international supplies operations and ties with clients? (L) please tell us about your present market ties and operations? (M) what strategies will you suggest or your firm is planning to implement in the future?

Secondary data was collected from diverse sources such as annual reports, websites, publicly available documents, magazines, journals, published industry reports and statistics from various departments, and press releases related to COVID-19 impact on the apparel supply chain. Multiple sourced information served in the triangulation of the results to enhance confirmability and trustworthiness of the analysis and reduce bias (Creswell et al., 2003). Given a large amount of material, these documents were not coded, yet, they give access to critical insights and enrich understanding of the context (Denzin and Lincoln, 2011).

3.3 Data Analysis

Data was entered into an electronic database and analyzed by authors 1 and 2 individually and then matched to resolve and avoid conflicting interpretations. We analyzed the data following the theory-building approach based on case studies (Eisenhardt and Graebner, 2007), allowing us to iterate between the data and the emerging theoretical arguments. We adopted an exploratory approach and thematic analysis to identify patterns of meaning and answer the research question. These patterns were identified by following a systematic process of data transcribing, data coding/sub coding, and theme development. We followed Miles and Huberman (1994) and used a three-step analysis from raw data to the outcome.

In the first step, we conducted phase analyses (i.e., 8 interviews in 3 phases and 5 interviews in phase 4). We created a dataset based on the interviews and secondary data of each phase and for our research question (Ghauri, 2004). Doing so resulted in a narrative summarizing the challenges and uncertainties in the supply chain and the firm's response and solutions for each phase, providing deeper insights into the phases. In the second step, we conducted cross-phase analyses and searched for common, unique, and different patterns. The third step examined within-phase and between-phases to fully conceptualize the patterns in our data related to the connection between KM and developing resilience in the supply chain model. In the last step, we synthesized the themes into the main theoretical dimensions by iteratively looking for connections and relationships between the themes and dividing them into more specific and

aggregate dimensions (categories). The KM, dynamic capabilities and the supply chain resilience literature guided us to interpret the data, and develop our emerging theoretical framework.

We analyzed the transcripts of the phase 1 interviews and identified various dimensions of dynamic capabilities, knowledge management capabilities/practices and various challenges faced and different modes and aspects adopted by Z to enhance resilience in its supply chain. We used a constant comparison method (Williams and Moser, 2019) to identify commonalities, and differences within the same phase of interviews. As a result, initial codes were assigned systematically based on the indigenous terms used by each respondent. It is followed by second-order code, or axial categories generated from codes, and relevant data grouped together under each of these categories. Then selective themes were generated from the axial clusters of codes and categories. Selective coding is critical as it influences both emergence of theoretical constructs and how meaning is created through presentation, impacting the reception of the findings (Williams and Moser, 2019). In the last stage, these themes went through detailed refinement and clarification. The data and research objectives and existing concepts and theories together guided the coding and the process of thematic analysis (Dey, 2003).

We started with the analysis of interview 1 in phase 1, and an initial 21 codes were generated, out of which 15 were relevant, 15 axial codes were generated, forming seven themes. Analysis of transcript of interview 2, produce three additional codes, analysis of phase 3 and 4 produce one additional code each, while 5 and 6 produce two additional codes, but after this, no additional codes or categories were obtained. By this point, we had got data saturation (Braun and Clarke, 2021, Fusch and Ness, 2015). At this point, 20 codes were acquired, after recategorization, they were summed and grouped under ten categories and seven themes. A similar approach was adopted for the analysis of the interviews for each phase.

Cross phase analysis was then undertaken to identify similarities and differences among the interviews and phases in adopting dynamic capabilities, knowledge management capabilities to address challenges and enhance the resilience of the supply chain.

We adopted several measures to enhance the trustworthiness of this study. We adhered to four aspects of trustworthiness: credibility, conformability, dependability and transferability. Several steps were taken to ensure the consistency of the research process. First, the data was collected from multiple respondents in various units in four phases at different times, and the conclusions were drawn by examining various aspects of the phenomenon (Lincoln and Guba, 1985). Second, the research design and methodological decisions, interpretations and findings were continuously reviewed (Miles and Huberman, 1994). The investigation was carried out by the already established methodologies. Third, multiple respondents from different units were interviewed, and their information was cross-checked with secondary sources to reduce the informant bias (Miles and Huberman, 1994, Lincoln and Guba, 1985). Fourth, explicit selection criteria were adopted for the selection of the case, and a purposive sampling strategy was adopted to study the information-rich case to allow generalizability (Miles and Huberman, 1994). Lastly, congruence with existing theory and the literature was sought to assist with the generalization (Miles and Huberman, 1994, Eisenhardt, 1989).

Results

4.1 The Case Company Information

Z is a vertically integrated knitting manufacturing company, established in 1993 in the textile rich city of Faisalabad, Pakistan. It is one of the leading companies specialized in designing and manufacturing a diversified range of knitted apparel and related services from this region. It specializes in OEM, OBM and ODM and pattern development services to international brands and hyper retailers such as Adidas, Nike, H&M, Zara, JC-Penney, Walmart, Sears, and Kohls. Z has continuously changed its supplies operations, due to increasing volatility in the market such from increases in competition, increasing market pressure on the retail side, proximity from the main market, demand uncertainties and shorter lead time, among others. Z passed through a series of developments in terms of its focus, resources, and commitment to international markets, thus making constant changes in its supply model to address uncertainties and enhance resilience in its production and international supplies. Z strives to focus on continuous innovation, high-value offerings and longevity in its operations. It invested in vertical integrated production and supplies facilities in Pakistan, and offshore production, R&D and marketing facilities in Jordan, Bangladesh, China and the USA. It has a workforce of 12500, a presence in 27 countries and exports about 85% of its production to the American and European markets. The foreign sales account for about 92% with a total turnover of 225 million USD in 2019.

.....Insert table 2 here.....

4.2 Identification of Challenges Related to Supply Chain Resilience

This section analyzes the data and discusses the results that emerged from the data. These results have been categorized based on different themes that originated during the coding process. It is noteworthy that resilience in the supply chain is an emerging term in production, logistics and supply chains. The data showed that Z adopted various strategies and dynamic capabilities to address challenges in the external business environment due to exogenous factors (Buckley, 2021) and to enhance resilience in its international supplies (Tukamuhabwa et al., 2017). These are discussed in the following:

4.2.1 *Shift in Focus and Business Model*

The change in focus and business model to address the dynamics in the market is well documented. The data identified a sudden shift in the strategy and business model, where Z adopted a hybrid business model, started selling its retail brand in the local and US market besides focusing on OEM and ODM ties in local and international markets. This was a major jump in high value-added retail operations (Sinkovics et al., 2018). The change was a result of learning and resource acquisition (Barão et al., 2017, Love and Ganotakis, 2013) through its collaborative ties with international clients. However, Z did not sustain its retail branding business due to lack of resources and fierce competition from global brands in the US market, and eventually discontinued it. The respondents mentioned:

*“We proactively moved downstream in the retail business via selling our brand in the local and US market. But stopped it later due to lack of resources, market knowledge, and expertise in distribution”
(R5)*

“Selling under our own brand was a strategic move..., but we were in hurry and overall, it came out as immature decision at that time. Eventually, we stopped it.... due to our inherited resource and knowledge constraints and fierce competition from global brands” (R2)

The failure of the retail business was a result of poor planning, lack of sales infrastructure and in-depth knowledge of the retail market as typical challenges facing by emerging economies firms (Cui and Xu, 2019). Therefore, Z did not take into account the temporal and exogenous factors (Buckley, 2021), and the failure was a critical turning point that compelled Z to change its strategy and focus on a supplies model once again. The company proactively learned from its failures and experience (Jackson et al., 2021), and firmly focused on its core business (contract manufacturing, OEM, ODM, OBM and exports). Accordingly, Z diverted its focus, commitment and resources on customer-centric strategies in its supplies ties, and thus invested in sophisticated machines, processes and systems in order to excel in the supplies business. Thus, ties were strengthened with international clients, as narrated:

“We learned from our failure. We evaluate ourselves after the setback.... and identify the future course of action [business model]. We adopted market-centric strategies and made strategic investments to serve international clients” (R2)

The respondents identified knowledge and market information as vital factors of competitive advantage and strategic adaptation to the market dynamics (Zhou and Li, 2012). In order to strengthen/established ties in the international market, Z made strategic investments in digital technologies and systems to establish routines that acquired new knowledge, market trends in a timely manner. Thus, Z was able to explore, exploit and utilize market knowledge from existing ties to enhance its operations (Ali, 2021). This helped the company to be directly involved with international clients, understand their preferences and market trends to further expand its business.

“Knowledge about the market and clients is critical for us. Therefore, we focus to establish direct contact with our clients... We capitalized on our previous ties to know about our customers, their preferences and market trends” (R3)

“We strategically focus on market knowledge, know-how, and made strategic investments in latest machines, technologies, and processes to support international supplies ties” (R4).

The data relate digital technologies and KM practices with the success of supplies model (Hock-Doepgen et al., 2020). Digital technologies enhanced the company to manage, acquire and share information in a fast phase to produce and deliver the demanded products and services (Li et al., 2020). Accordingly, Z enhanced agility and speed in its operations to a certain extent and expanded its international supplies ties by adding new business accounts.

“The focus on supplies and the use of digital technologies to acquire on time confirmation enhanced our ties with our existing clients... JC Penny, Fruit of the loom and Tommy Hilfiger, and successfully meet their required OEM, ODM demand in different product categories.” (R4).

“We established close contact and share timely information with our clients. We acquire and integrate the information through digital system in our production planning and supply chain to produce and deliver... We are the lead supplier to some of them” (R2)

Based on the above mentioned findings, we propose that

Proposition 1: The shift in focus and change in business strategy supported by customer-centric and acquisition of information leads to sustainable business operations across borders.

4.2.2 Challenges in Production Capabilities

The production capacity and capabilities are important aspects in meeting the demand and varieties in OEM, ODM supplies ties (Vickery et al., 1993, Zhang, 2011). The data identified the success of the contract manufacturing supplies model, close ties with the international clients and the increasing international demand for knitted garments attracted more business for Z. Due to the surge in international demand, Z faced serious challenges in meeting the production capacity (Ojha et al., 2019) and in time delivery, due to lack of production capabilities (Ghadge et al., 2019).

“It was a paradox for us, that at one side, we were getting business while on the other side, we were constantly losing orders. We run our machine 24/7, but were unable to complete and deliver the order in time....were badly hit our limited production capacities” (R8)

Given the situation, it was not possible to make investments to increase the production capabilities overnight. The problem was further intensified by the lack of adequate knowledge and expertise (Ghadge et al., 2019) to materialized the client’s ideas into design and products. Thus, Z has left with inefficiencies in production, which caused delays. In addition, Z entertained certain orders from buying houses where Z did not have direct contact with the main clients, and access to information (Wang and Hu, 2020) caused delays in acquiring, sharing and implementing the information and specification. Given such challenges, it was not possible for Z to produces and deliver the orders in time.

“Sometimes we received orders which are more technical and demanding, as they require more time and expertise to design and developed product and supply it in a stipulated time. It always takes time and resources....” (R5)

“Certain orders were received from a buying house, where we have no or limited connection with the principal client and so information. It takes more time and energy to discuss and acquire/share the information with the buying house instead of the main client.” (R1)

Agile production approaches and conversion of ideas into physical products through dynamic means permit companies to respond quickly to demand volatilities (Gunasekaran et al., 2018). A respondent identified various strategies and capabilities (Iqbal et al., 2020) adopted by Z to mitigate the production and delivery problems, thus, enhancing resilience in their supply operations (Zineb et al., 2017) to a certain extent. For instance, Z capitalized on the knowledge and production expertise of local producers by outsourcing parts of its international orders, thus was able to overcome the challenges in production capacity, address the diversity in demand and in-time delivery.

“As a contingency plan we outsource parts of our production to local vendors to meet demand and deliver the supplies in an agile manner.... This approach somehow works out...” (R6).

Over time, Z continued exploring different options (Das and Lashkari, 2015), and used their knowledge of relationships and market knowledge to acquire the required resources and capabilities, thus, meeting the demand and controlling the supply of products.

“We knocked on different doors.... we established a production partnership with a Jordanian company. We openly share the information and trust each other. This offshore production enhanced our capabilities and capacities to address production uncertainties and control of supply to a certain extent in a contingent manner” (R2)

“Connectedness and knowledge of the market remained influential to know about the dynamics in the international markets. Accordingly, we established sales and marketing offices in the US to get connected in the market” (R3).

The importance of external market knowledge is well documented (Lin and Wu, 2014, Bag et al., 2021), so as to know and adopt the market trends for better performance. It is not only knowledge but the firms’ capabilities to absorb and implement the relevant knowledge that leads to competitive advantage (Hock-Doepgen et al., 2020). In addition to the acquisition of external knowledge and resources, Z equally focused on the development of internal resources and capabilities to enhance resilience in its operations. This involved enhancing the knowledge management capability through investing in infrastructure, R&D, experts and usage of the latest technologies.

“In addition to investments in infrastructure, we established industrial engineering and R&D facilities and acquired US-based designers and developers. This allows us to translate the ideas into physical products and enhance our capabilities to explore innovative ideas and develop new products” (R5)

“Our priority to invest in systems and routines, that only acquire data and knowledge, but to interpret, share and implement them [product, processes, services] in a timely manner” (R7)

Based on the above-mentioned facts, we propose that

Proposition 2: Contingent and agile production strategies and priority-based investment in production capabilities mitigate the challenges related to production capabilities and capacities.

4.2.3 Challenges Related to Variation in Specifications, Lead Time, and Poor Internal Coordination

A number of studies have described and explained the negative impact of ripple and bullwhip on supply chain sustainability (Dolgui et al., 2020, Ojha et al., 2019, Yao et al., 2021). These effects cause additional challenges and uncertainties for firms (Alvarado-Vargas and Kelley, 2019) especially those from emerging economies. This is due to their inherited resources constraints, expertise and strategic structural fit to address constant variations and varieties in demand, thus, leading to serve disruptions in the global supply chain (Khurshid et al., 2020). The data identified various challenges and complexities due to demand volatility, preferences and changes in standards that hit the production and operational capabilities of Z. Due to such fluctuations, Z faced challenges in maintaining quality, lead time and addressing the variations in orders, small batches, and shorter product life cycle.

“We are prone to changes from the “cotton to carton” that challenge us. Fashion garments production is volatile due to high-fashion contents and variations in demand. There are many aspects that changed and are constantly changing such as innovations in raw materials, manufacturing, washing/processing, CSR, logistics and supply etc. that affect our operations...” (R4)

“The nature of orders is highly complex...Customers are picky and need more diversity and variety on the table. Even some order requires unique finishes, washing and special treatments...It reduces speed, needs more time and continuous changeover on the production floor” (R5)

Furthermore, the data mentioned numerous strategies and dynamic responses (Blome et al., 2013, Bocken and Geradts, 2020, Felin and Powell, 2016, Lin and Wu, 2014) including offshore production, focus on close contact with customers, and utilization of digital

technologies for the acquisition of real-time information. Thus, the case firm adopted different points in time to handle uncertainties and enhance longevity in its supply operations (Zollo and Winter, 2002). The dynamic response was both short-term and long-term. For instance, the firm adopted a contingent response (offshore production) to have a quick fix and used offshore production facilities to enhance flexibility in its operation without making huge investments. In addition, Z enhanced its competitive position through the offshore production facilities in Jordan and Bangladesh due to lower export taxes to the US and EU. To cope with the challenges of a bullwhip, Z focused on knowledge management capabilities (Ojha et al., 2019) to enhance resilience in its operations.

“Our response is quick and contingent to mitigate challenges in demand volatilities. ...we divert some orders to our offshore production facility in Jordan and Bangladesh, which worked best” (R1)

“ The offshore production arrangement not only enhance agility and resilience in our operations....but also provide taxes, duties and levy benefits to export from Jordan and Bangladesh due to lower taxes by the US and EU”

Several studies have identified the role of digital technologies in information sharing, visibility, and collaboration in enhancing resilience in the supply chain (Gunasekaran et al., 2015, Kamalahmadi and Parast, 2016), others viewed collaboration and reconfiguration of resources as main aspects to enhance flexibilities and agility (Ambulkar et al., 2015, Gunasekaran et al., 2015). The respondents mentioned a combination of strategies and capabilities more focused on investment in digital technologies and close connection with lead customers. This enhanced the acquisition and sharing of information in real time, thus helping Z to forecast, plan and produce the required size, color, design and variety.

“Our focus is on-time information sharing mechanisms with our clients and suppliers. Accordingly, we invested in technologies, systems and mechanisms to facilitate knowledge acquisition and sharing to create resilience in our supplies.” (R7)

“We developed routines to address orders with the special arrangement. We categorized our customers based on their importance to our company. We reserve special production space, machine cells and production teams to handle specific orders, share the information on an emergency basis, and deliver it within the schedule.” (R6)

Based on the above-mentioned arguments, we propose that

Proposition 3: Offshore production partnership and close ties with customers through digital technologies enhances Z capabilities to cope with the demand variation.

4.2.4 Challenges due to Delays in Supplies (Inward)

The interviews identified a number of challenges related to the upstream supply chain that have direct and indirect effects on the downstream supplies (Sinkovics et al., 2018), and thus, impact the supply chain [disruptions and resilience] (Tukamuhabwa et al., 2017, Xu et al., 2020). A respondent mentioned several problems, originating at different points in time such as extreme weather, terrorism, pandemics, economic crisis, hikes in energy and inputs cost, currency fluctuations etc., that negatively affect the supply chain (Akkermans and Van Wassenhove, 2018). The case company adapts dynamic responses to cope with the uncertainties. For instance, harsh weather played a vital role in delaying the supply of chemicals which had a direct effect (delays) in the downstream supplies. As mentioned by respondents

“We are sourcing from world top suppliers. We faced various challenges that interrupt our operations. For instance, back in 2010 a shipment from our main dye and color supplier in Germany was delayed due to bad weather and heavy snow that caused delays in our delivery schedule” (R1)

Fluctuations in currency and exchange rates impact on the sourcing from/ to a global network of suppliers [buyers and suppliers]. In addition, unexpected events such as economic and energy crises (Urciuoli et al., 2014) impact on the supply chain.

“...currency fluctuations or increase in wages and services rates affect us. The increase/decrease in unit cost has a huge impact on our operations. The sudden variations in prices in international markets leads to disagreements, price renegotiation, discounts and even losses” (R2)

“Some uncertainties are beyond control that intensifies the impact of risk, such as an increase in wage, energy/oil prices, pandemic etc., influence our supply chain. The problems of a supply chain trigger risk for the entire network” (R3)

The prevalence of concurrent strategies is well documented in addressing uncertain situations and are quick in addressing uncertainties during or after, and reactive strategies are focused on post-disruption (Tukamuhabwa et al., 2017). The respondents identified several dynamic responses and strategies such as long/short-term relations, portfolio of suppliers, barrow stock for competitors, reserve stock etc. that are used to address the uncertainties. (Gunasekaran et al., 2015)

“We have a mix of long term and short-term ties with suppliers to ensure the availability of right quality supplies. We consciously searching for alternatives sources of supplies, as we have a portfolio of a supplier that helps us to divide the risk and enhance flexibility in uncertainties” (R6).

“We have close ties with competitors, in case of emergency we barrow stock and get their opinion on various matters” (R8)

Based on the above-mentioned arguments, we propose that

Proposition 4: The disruption in the supply chain due to delays in supplies can be mitigated by establishing ties with market actors such as suppliers and competitors.

4.2.5 Terrorism and Energy Crisis

Terrorism, infiltration, and energy shortages have a devastating role in delays in production and the blockage of the supply chains (Pettit et al., 2010, Urciuoli et al., 2014), in emerging economies in particular. It is observed that since 2007, Pakistan has been badly affected by intensified extremism and terrorism. As a result, international brands and customers were reluctant to do business and were skeptical about their existing contracts. In addition, the hikes in energy prices and long electricity breakdowns added to the problem which affected the production and delivery schedules and causes delays. The respondents mentioned the negative impact of such factors on Z in addition to production [under production] and delays in international supplies.

“We sacrifice a lot during the war on terrorism, despite a safe distance of our production facilities from the hot zone, still impacted our operations. International brands were reluctant to visit us and remained in chronic stress with their business with us. Some clients shifted to India, Bangladesh and China while others partially stop working with us. It was great to set back...” (R4)

“The misery remained; as terrorism and electricity load shedding left the country in crisis, and paralyzed our operations. We were unable to run our production at full capacities, and meet demand and the delivery schedule. In addition, the increase in energy prices made the production cost high, leaving us uncompetitive as compared to Indian and Bangladeshi producers” (R2)

Due to the challenges related to energy and security, many apparel companies either shut down their operations or moved to other countries.

“We were in panic as our machines were not working on full production. Some of the manufacturers either shut their operations or shifted to Bangladesh and Sri Lanka. Because they were unable to run their operations, all because of the poor security and unfriendly business situation in the country.” (R8)

However, the data identified concurrent risk management strategies and indigenous responses that enhanced the continuity of operations (Katsaliaki et al., 2021, Zineb et al., 2017, Sabahi and Parast, 2020). It is evident from the data that Z adopted a mix of strategies and KM capabilities to cope with the situation. As it was not possible for Z to shut or shift its entire vertical setup to other countries, they built in-house energy power generation and Biomass units to cater for the power shortages. Furthermore, Z fully utilized its offshore production facilities and warehouses as an alternative strategy in a dynamic way, as it diverted the majority of orders to offshore locations to cope with the situation and meet the demand.

“We remained vigilant, we capitalized on contingency strategies as we fully utilized our offshore production facilities in Bangladesh and Jordan. Furthermore, we set two warehouses in the East and West Coasts of the USA and Dubai for nonstop supplies. This helped us to handle the situation in a cost-effective manner” (R2)

“We invested in power generation units and utilized digital technologies to acquire information and address the uncertain situations with timely and informed decisions” (R7).

Based on the above-mentioned arguments, we propose that

Proposition 5: Utilization of alternative production (offshore production), warehousing and investment in energy facilities can mitigate the risk and delays in supply chain associated with terrorism and energy crises.

4.2.6 Geographic Proximity (Long Distance) and Logistic Problems

Supplier proximity has vital advantages in general and to the fast fashion market in particular (Runfola et al., 2021). The literature identified cultural, distance, technological, knowledge and other proximities as the main factors that influence the supply chain. Spatial proximity and long-distances in the supplies relationship create challenges in communication, delay and lead time (Tukamuhabwa et al., 2017, Schmitt and Van Biesebroeck, 2013). The interviews identified critical problems associated with long-distances from the main markets in the fulfilment of customized orders, delivery failure, delays in logistics and integration of supply chain, among others (Tukamuhabwa et al., 2017). So, given the large distances from the main market, Z faced serious challenges in meeting delivery schedules and retaining its international operations.

“Long-distance from main clients and /or supplier is problematic and triggered threats in the supply chain. If you are 6000 km away from your main market, you are in the problem [communication gap, delays and failure in supplies, cost of transportation, and damages during supply, poor-quality raw materials, shortages and financial difficulties of suppliers]”

“...We faced serious challenges in meeting the delivery schedules and affects our relations and business. We offer huge discounts, use a fast and expansive mode of logistics to cover for the delays. Things were getting worst as most of the clients withdraw their orders due to not meeting the delivery schedules, which was a threat to our existence” (R2).

To overcome such problems, Z developed a dynamic supply chain model “Direct to Store” (DTS) in collaboration with its US-based clients and experts. Under this unique model, Z integrated more than 1200 outlets of different clients across the US with its production, warehouses and shipment in transit through digital interchange technologies. Thus, DTS acquire, share and apply the actual store data with the production, warehouses and logistics to produce and supply in real-time. This enhances KM that reduces cycle times, reduces lead times and visibility in the supply chain and reduces disruption in an agile manner. In addition, Z provides the DTS services to other suppliers in Pakistan and South Asia, hence, creating new business opportunity i.e. servitization (Palo et al., 2019)

“We developed a supply model [“Direct-to-Store”] through the support of our main clients and IT/supply chain specialists to serve the American market via agile supply strategy. The model based on 5 dimensions [digital data interchange, US-based warehouse, production facilities in Pakistan and offshore production units in Jordan, and Bangladesh, and shipment in transit]” (R8)

Based on the above-mentioned arguments, we propose that

Proposition 6: A delay in the supply chain due to the spatial distance can be handled with real time information acquisition, sharing and implementation and DTS arrangement.

-----Insert table 3 here-----

4.2.7 COVID-19 and the Aftermath Effect

The exogenous shock of COVID-19 has created an extraordinary situation that has enormously challenged and changed the global value chains (Verbeke, 2020). The pandemic has, in particular, cracked the global supply chain (Strange, 2020), and equally affected the suppliers from emerging economies. The interviews identified COVID-19 and post COVID-19 as a decisive factor that significantly affects Z sourcing ties with the global value chain (Gereffi, 2020, Zhao and Kim, 2021). The interview acknowledged the pandemic risk in short- and long-term effect on the supply chain.

“The pandemic shattered the global supply chain. It has a multitude of effect on us. ...we were out of supplies which halted our production. Also, customers hold their orders due to a decrease in demand and closure of borders. Likewise, certain restrictions were imposed by the authorities to reduce the number of hours and workers. It forced us to close our operations” (R4)

“COVID-19 posed a severe threat to the global supply chain because of the economic slowdown and social distancing... It interrupted the international supply chain by slowing down international business including the textile and fashion apparel supply chain. We witnessed a huge drop in sales” (R2)

Recent studies have identified a mix of strategies such as the adoption of technologies (artificial intelligence & big data analytics and robotics etc.), shorter, more focused and diversified chains to address the post-COVID-19 era and bringing resilience into production networks (Strange, 2020, Shih, 2020, Miroudot, 2020, Buckley, 2021). The respondents identified diverse strategies such as the changed focus on the specific product line, online sales and real-time

demand through digital technologies to respond to the exogenous shocks and reduce the volatility, uncertainties, complexity and ambiguity (Murugan et al., 2020) to a certain extent.

“...our operations continued, though we stopped our production for two months. Overall, we got low orders but we witness an increase in our lounge, house and sleepwear and safety finishes. So, we shifted our focus in that segment” (R3)

“We invested in digital cultures and to strengthen supply chain model, as we connect our supply operation with clients demand in real-time. We focused on digitalized supply chain and crisis mitigation strategies that integrate our systems, applications, processes and information on a single digital platform. It enhances our capabilities to address the crisis, planning & control, forecasting, postponement and vendor management and reduce cost” (R6)

Based on the above-mentioned arguments, we propose that

Proposition 7: The focus on alternative product segments, online sales, and the adoption of digital culture in organizations enhance resilience in the supply chain during pandemics and other crises.

5. Discussion

This study highlights the connection between knowledge management and dynamic capabilities and identified the critical role of digital technologies in sharpening knowledge management practices and developing new capabilities essential to create supply chain resilience. Over years, the importance of information, communication and digital technologies (artificial intelligence, internet of thing (IoT), big data, and share platforms) have been magnified in knowledge management, which has surprisingly increased the speed of data sharing, acquisition and implementation/ creation of new knowledge (Del Giudice et al., 2020, Bolisani and Bratianu, 2018). Thus, the firm needs to handle the constant inflow of information and knowledge in a dynamic way to utilize it in real-time to make in time decisions/changes in wake of uncertainties. Our findings imply that KM and dynamic capabilities such as offshore production, connection with GVCs and investments in digital technologies, machines, and logistic infrastructure enhance the acquisition and implementation of market knowledge in real-time to fine-tune supply operations according to the specific need. The literature suggests that organizations focus on the knowledge and the dynamic ways to manage knowledge to develop specific capabilities that enable a firm to cope with disruptions (von Delft et al., 2019, Bharadwaj et al., 2015). Our findings identified that the KM infrastructure capabilities such as technical, structural and cultural capabilities are necessary to enhance supply chain resilience. Therefore, the investment and adoption of digital technologies to enhance digital culture remain vital. Based on our findings and literature, we proposed seven propositions to build a supply chain resilience model.

Our findings identified innovation in the supply chain model (direct to store) through the integration of digital technologies with the KM. The focal firm connects the clients, their retail chains with its planning & control, production and supply chain through the online system. This enables the focal firm to directly receive real-time data and information through a digital data platform in real-time, integrate it and fine-tune its operations (production, logistics, warehousing and delivery) according to the dynamics of the market. Under the direct to store (DTS) model, the focal was able to reduce the delivery time from 45 days to 12 days that was considered impossible for a firm operating in this region (Pakistan). It allows the direct connection, quick search, access and retrieval of client and market-specific information to enhance agility and alignment in the supply chain (Lindner and Wald, 2011). So, modified,

created and extended resource base to change, create and implement new supply models (Karimi and Walter, 2016, Teece and Linden, 2017, Teece, 2018) to address uncertainties. Also, the creation of digital culture, adoption to change and development of supply chain model have strategic importance (Agarwal and Helfat, 2009, Warner and Wäger, 2019), to create resilience. Furthermore, the provision of commercial DTS services to other textile producers/suppliers create new business for the focal firm and contributing to the logic of servitization (Palo et al., 2019, Kohtamäki et al., 2019).

It is evident that the focal firm adopts a portfolio of supply models or changed, developed and implemented several models over time. This constant change was fueled either by their strategic intent, failure or to cope with external challenges. So, it is interesting to note that certain models (a sub-business model) are necessary to change within an already established model over time through a change in technologies and the need for the latest knowledge. This nullified the view that changes in the business model are hard to implement (Christensen et al., 2016), thus contributing to how an established business model (von Delft et al., 2019) can be changed. Our findings contribute to a group of scholars (von Delft et al., 2019, Ramdani et al., 2019, Warner and Wäger, 2019, Hock-Doepgen et al., 2020, Sabahi and Parast, 2020) who stresses further investigation on supply chain resilience through innovative logistics. Specifically, we identify the mechanism and integration of the firm's strategy and strategic change (dynamic capabilities) and KM in the development of resilient supply chain models. Also, the findings described diverse dynamic responses to specific uncertainty(s) and showed that dynamic capability is an integration of diverse responses which we termed as "dynamic response capabilities" that holistically address uncertainties. Fig.1. illustrates the constructs derived from the findings related to the connection between KM, dynamic capabilities and supply chain resilience.

-----Insert figure 1 here-----

6 Conclusions

The study identified that it is vital for companies, and fashion apparel suppliers in particular, to develop or modify existing supply models to sustain their cross-border supplies. The role of dynamic capabilities is increasingly relevant in the contemporary knowledge economy, and influences international supplies operations. In this regard, the adoption of technology to enhance KM capability is becoming a cornerstone for companies, specifically the ones from emerging economies. The KM capability helps them to acquire, store, share, and develop new knowledge/models to enhance resilience and sustainable competitive advantage. KM and the new supply model connection can be enhanced through dynamic response capabilities: i) investments and integrating advanced digital/ manufacturing technologies for fast acquisition, sharing, application, and creation of knowledge/products, ii) establishing connection points (sales and marketing, warehouses, experts, design studios and offshore production facility) in the target markets to respond to uncertainties, iii) keeping track of the market changes and trends to create knowledge and make decisions in an agile manner. The focal firm rapidly changed its supplies models over time, based on digital data interchange, investment in technology/infrastructure, dynamic responses to manage knowledge and addressed uncertainties, created longevity and connectivity in the market.

6.1 Theoretical Contribution

This study extends existing research on supply chain in general and supply chain resilience in particular. The extant research accentuates the role of supply chain resilience for smooth business operations, nevertheless, this research stream is still unexplored. This is mainly due to the complex interactions and integrations of various aspects based on the nature of risks and uncertainties. Unlike previous studies, the current study considers complex relationships among the supply chain, knowledge management, and dynamic capabilities to acquire knowledge, understand the uncertain market conditions and reshape the supply chain. As such, this research has attempted to integrate KM with the supply chain and highlight the key role of dynamic capability in shaping resilience and flexibility in operations. By focusing specifically on the resilience in supply chain, we provide a more nuanced integrated theoretical understanding and empirical evidence of the dynamic nature of suppliers' engagement in developing an innovative supply chain. Knowledge and information are characterized as the key elements to identify the contemporary changes in the market and in turn help firms to adjust their operations accordingly. The findings of this study explicitly identified dynamic capability as a necessary condition to speed up the in-time acquisition of the relevant market knowledge/information, but not enough to create operational flexibilities and supply chain efficiencies. Thus, the acquired information should be shared and integrated with existing systems, resources, and operations in a dynamic way to enhance flexibility and change. Specifically, we identified and highlighted the importance of numerous strategies and strategic responses in acquisition, sharing, and application of knowledge and resources and integration with existing operations in the pursuit of flexibility and resilience. This study suggests that integration of knowledge, resources, and digital technologies in a dynamic way remained a vital aspect in overhauling organization routines and governing the relationships between information exchange and diverse operations to overcome internal and external disruptions. In this connection, information, knowledge, and capabilities provided by market actors must be used in an integral fashion to create flexibility. Figure.1. depicts the constructs derived from the findings related to the connection between KM, supply chain resilience, and dynamic capabilities.

In addition, previous studies focused on the (supplier) upstream perspective of the supply chain, while this study includes the downstream (buyer) perspective and integrates the supply chain, KM, and dynamic capabilities to enhance resilience for upstream and downstream partners in their relationship. Therefore, the findings of this research address the suppliers' perspective, demonstrating that supply chain resilience is also influenced by the supplier's deliberate actions and situation-specific responses, and proactive KM practices.

Furthermore, the findings identified diverse responses to specific uncertainty(s) and showed that dynamic capability is a combination and integration of diverse responses which we termed as "*dynamic response capabilities*" that holistically address uncertainties. Thus, dynamic capabilities are an integration of diverse responses taken by firms to address uncertainties, contributing to DC literature.

6.2 Practical Contribution

The study can support managers in identifying the key factors that enhance the overall KM capability and connect technology, resources, and processes to better coordinate product and information flow in a crisis. It guides them to dynamically employ strategies to manage and generate knowledge from external and acquire sources through the intersection of technology, processes, and systems to develop new or change existing supply models. Furthermore, it enhances their knowledge to adjust resources and strategies in a contingent manner to enhance resilience in international operations. It provides flexibility in the adoption of the business model, as the choice of the business model should not be static, and managers and strategists should adopt a portfolio of supply models according to the needs of specific uncertainty and time. One can change an existing or develop a new model at any point in time, depending on the market volatility and proper integration of KM, technology, and strategy in a dynamic manner.

6.3 Limitation

This study acknowledges limitations. It adopts a single case study design which reduces generalizability, though our study is logical, covers the events over 8 years, and uses multiple respondents and secondary data to enhance trustworthiness, conformability, creditability, and dependability (validity and reliability). We investigated the lead supplier firm in a single industry in one country as an extreme case. Care is required in adopting similar models and dynamic response capabilities in addressing uncertainties across space and time. However, the results suggested new avenues for fashion apparel manufacturers and suppliers in creating resilience in their international operations. While we interviewed knowledgeable respondents and cross-checked their information to capture facets of KM, dynamic capabilities, and resilience in the supply model, still there is a chance of personal coloring and self-impression.

6.4 Future Studies

Future studies could adopt a quantitative methodology to understand the phenomenon in multiple industries and countries in order to deduce generalizable results. The concepts of blockchain, big data analytics, digitization, and Industry 4.0 are becoming more common in the supply chain, logistics, and resilience. It would be interesting to see their impact on the connection between supply chain resilience and KM. Also, future studies could investigate the role of location, control, and time in KM and supply chain resilience. The effect of COVID-19 on the supply chain resilience or innovation in logistics could be an interesting area to study. In addition, an assessment of the policy and managerial interventions to improve the resilience of these supply chains would be helpful. For instance, research into the construction of a supply chain KM and resilience index would be helpful for various industries. Nevertheless, the current study provides valuable insight into the links between KM, dynamic capabilities, and how these influence supply chain resilience. We hope that the suggested propositions be future research.

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Table 1: Details of the Participants

Abbreviation	Respondent	Interview Time Duration			
		First Round	Second Rounds	Third Round	Fourth Round
		February 2013	March-April 2015	November 2018	October-November 2020
R1	Deputy Director Supply Chain and Logistics	1 hour 25 minutes	1 hour	1 hour 35 minutes	1 hour 10 minutes
R2	Director Marketing	2 hours	1 hour 10 minutes	1 hour 15 minutes	1 hour 25 minutes
R3	Senior Manager, Merchandizing	45 minutes	50 minutes	1 hour 10 minutes	Nil
R4	Senior Manager, Marketing-USA	1 hour 15 minutes	1 hour	1 hour 10 minutes	1 hour 15 minutes
R5	Manager, Product Development & R&D	55 minutes	1 hour 15 minutes	1 hour 35 minutes	Nil
R6	Deputy Director Production Planning & Control	1 hour 15 minutes	1 hours 30 minutes	1 hour 25 minutes	55 minutes
R7	Director IT	1 hour and 25 minutes	1 hour	1 hour 30 minutes	1 hour
R8	Director Production	1 hour 55 minutes	1 hour 35 minutes	1 hour 20 minutes	Nil

Table 2: Case Company Information

Establishment	1993
Type of Company	Private Limited Company listed in Pakistani Stock Exchange
Industry / main business	Production and supplies of technical yarn, knitted fabrics, knitted apparels
Sales	22.5 billion USD (2019)
International sales	85%
Number of employees	12500
Main International Clients	H&M, Zara, Abercrombie & Fitch, Polo Ralph Lauren, Calvin Klein, Nautica, Tommy Hilfiger, Next, Macy's, Khol's, Sear's, Levi's, Chaps Ralph Lauren, Russell, JC-Penney, Wal-Mart, Polo Jeans, VF, Champion, Hanes, American Eagle, New Yorkers, Under Armour, Reebok
Services	Sourcing and supplies of OEM, OBM, ODM, DTS services
Main Markets	USA, Europe, Middle East, East Asia and Oceania
Major activities	Vertically Integrated production facility from cotton fibre to retail-ready garments and knitted fabrics (i.e. ginning, knitting, processing of yarn, dyeing, cutting, stitching, printing, finishing, laundry and apparel manufacturing).
Offshore Production	Partners in China, Bangladesh and Jordan
International Commitments	9 subsidiaries
International presence	27 countries

Table 3: Dynamic Capabilities and their Role in Connecting Knowledge Management and Business Model

	Disruption/ threat	Knowledge Management	Dynamic Capabilities	Supply Model
1	Challenges in sustaining existing business model (brand and supplies)	International market knowledge, Knowledge about the production (knitting and sewing)	Direct contact in the market via own local market office. Sales and marketing office. Capitalize existing contacts in the market Contract manufacturing with JC Penny. Focus on North American Markets Investment in the production facility	From hybrid business model to OEM & contract manufacturing
2	Delays due to production capacities and capabilities	Production Knowledge Market trends	Offshore production partnership in Jordanian. Outsource parts of production to local vendors. Acquire designers and product developers from the US. Investment in specialized knitting and sewing Biannual seasonal collections Established sales and marketing offices in the US	Sustain and expand OEM, OBM model Contingent supply chain
3	Issues in quality, lead time, and Poor internal coordination (Bullwhip effect)	Integrate the demand with the production. Knowledge of integrated production (concept to delivery) Better scheduling and forecasting Information sharing about quantity,	Alternative transportation Special workers, machines and machine cells for specific clients. Integrate machines and suppliers with orders. Reduce reliance on production outsourcing Vertical integration	Vertical integration and supply chain control

		quality, delivery and destination		
4	Delays in supplies (inward) and currency fluctuations	<p>Direct contact & acquisition of information from customers,</p> <p>Sharing resources and knowledge, specifications with suppliers</p>	<p>Lock the orders, price and quantity.</p> <p>Collaboration with local competitors.</p> <p>Create short and long term contracts with suppliers and customers.</p> <p>Trained local suppliers for the required quality of cotton</p> <p>Collaboration with customers and suppliers.</p>	Enhance the supply relationship management
	Delays due to poor quality, connectivity and defective products	<p>Sharing data knowledge at each stage from design to delivery.</p> <p>Customer specifications</p> <p>Information sharing</p> <p>Continuous monitoring</p> <p>Identify, locate and display the exact status of the supply chain</p> <p>Market intelligence</p>	<p>Investment in IT-based ordering and online checks.</p> <p>Backtrack system, ERP, RFID, Bar code,</p> <p>Communication technologies, smart systems</p> <p>Enhance visibility, coordination and communication</p> <p>Online fabric inspection “four-point quality system, in-house audit</p>	In time delivery, Enhance visibility and communication and resilience
5	Terrorism and Energy Crisis	<p>Multiplication offshore production and sourcing, Sharing information</p> <p>Filling the warehouse.</p> <p>Customer specifications/data via direct contact</p>	<p>Offshore production in Jordan and Bangladesh.</p> <p>2 Warehouse in the USA</p> <p>Own power generation plants</p>	Contingent Production enhanced flexibility and agility

6	Geographic Proximity (long-distance) and Logistic Problems	<p>Digitization of supply, Data and information flow.</p> <p>Knowledge Management</p> <p>Effective communication, trust cooperation via digital technologies.</p> <p>Integration and connection based on real time data.</p> <p>Accuracy and visibility</p>	<p>Connect 1200 stores data with digital interface with SC actors.</p> <p>Agile and flexible scheduling, forecasting and prediction.</p> <p>DTS an innovative supply and logistic model.</p>	Supply chain agility, flexibility and resilience
7	COVID-19 and post COVID-19 disruption	<p>Information collection, data analytics, mapping and coordination in SC viability.</p> <p>Physical SC based on actual transportation, inventory, demand, and capacity data and can therefore be used for planning and real-time control decisions.</p>	<p>Digital technologies</p> <p>Data driven analysis and decision making in disruptions.</p> <p>Integrating simulation, optimization, and data analytics.</p>	Survival and sustainable supply

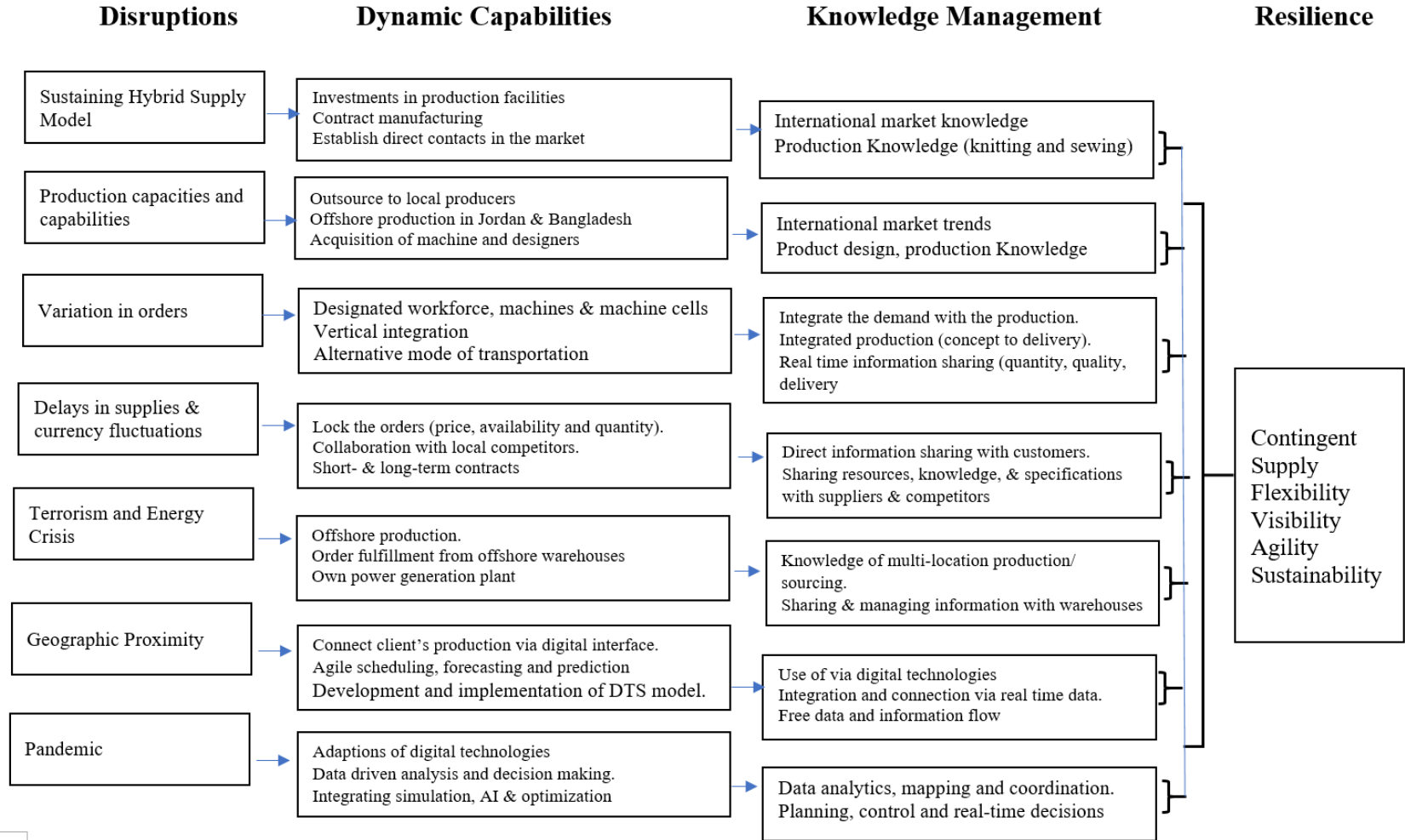


Figure 1. Theoretical Model- Connection between Knowledge Management, Dynamic Capabilities and Resilient Supply Chain