



MASTER'S THESIS

SUPPLY CHAIN DISRUPTION, RESILIENCE AND TECHNOLOGY

CASE: POLYCOM Inc.

Lappeenranta University of Technology LUT

Master's Programme in Supply Management, Master's thesis

2022

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ABSTRACT

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Degree Programme in Business Administration

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SUPPLY CHAIN DISRUPTION, RESILIENCE AND TECHNOLOGY

Master's thesis

2022

83 pages, 15 figures, 7 tables and 2 appendices.

Examiner(s): Professor Veli Matti Virolainen and Professor Katrina Lintukangas

Keywords: Supply chain risk management (SCRM), Supply chain disruptions (SCDs) and, Supply chain resilience (SCRES)

COVID-19 pandemic has evoked major supply chain disruptions which are linked to basic supply chain risks previously investigated in existing literature as can be seen in the literature review below. This research aims at bridging the gap between existing SCRES strategies and post COVID-19 efforts in industries to develop a more resilient/robust supply chain through the exploration of challenges faced by industries during the COVID-19 crisis and suggest proactive strategies that can be implemented by SC managers to eliminate/mitigate future risks/disruptions. The outbreak of COVID-19 has exposed some loopholes in the existing supply chain risk management (SCRM) strategies in that the COVID-19 pandemic affects basically every region worldwide as well as every industry and with globalization and high interdependence of firms plus product complexity, companies have since the start of the pandemic struggle to sail through the severe supply chain disruption caused by the pandemic. With the case study Polycom Inc. this research found out that amidst all the operational risks existing Polycom Inc. faces threat from demand related risks, finance risks, and logistics risks. Furthermore, the covid-19 pandemic impact on Polycom also shows that Polycom faces disruption risks. As such this paper is to provide insights and recommendations towards the development of a resilience supply chains through enhancement of visibility and responsiveness. The theory of this thesis was based on the existing academic literature on supply chain disruptions (SCDs), supply chain risks management (SCRM) and supply chain resilience (SCRES) with a focus on global pandemic (COVID-19). The empirical part of this research would be carried out using mixed (hybrid) research

method which include questionnaires to be answered by the case company as well as interviews to be carried out with two supply chain management staffs at Polycom Inc.

ACKNOWLEDGEMENTS

Writing this thesis has been a long journey and it gladdens my heart that it has come to an end which marks the end of my time at LUT. Many people have been part of this project in one way or the other. First appreciation goes to my Supervisors Professor Veli Matti Virolainen and Professor Katrina Lintukangas for supporting and guiding me through this process. Secondly, I greatly appreciate my case company supervisor Mr. Ejong Charles Mejame and all the interviewees who made the empirical part of this research a success. Finally, I want to thank my family for all their support during this academic journey and special thanks to my fellow students who have made my years at LUT a memorable one despite the COVID-19 social distance restrictions. As I mark the end of my study and move to the next phase of life, I feel grateful for the knowledge, networking and experience gained during my stay at LUT.

Abbreviations

| | |
|----------|------------------------------|
| COVID-19 | Coronavirus disease 2019 |
| SC | Supply Chains |
| SCRM | Supply Chain Risk Management |
| SCDs | Supply Chain Disruptions |
| SCRES | Supply Chain Resilience |
| GSCs | Global Supply Chains |
| RQ | Research Question |
| Inc. | Incorporated |

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1 INTRODUCTION

Supply chain disruption though has proven to have a low probability of occurrence, its impacts on companies are significant which thus, makes the phenomenon significant. Some remarkable cases are the Phillips semiconductor plant fire incident in the year 2000 that caused \$400 million loss for Ericsson, the 2011 earthquake and tsunami together with the subsequent nuclear crisis in Japan that led to a drop in Toyota's production by 40000 cars causing profit/loss per day of \$72 million and the October 2011 Catastrophic Thailand flood that disrupted the SC of computer manufacturers and Japanese automotive manufacturers with manufacturing plants in Thailand. (Sahi, 2019.)

Despite the experience of SC disruptions in the past decades that has caused companies to develop strategies to be resilient, there have never been a global pandemic like the COVID-19 pandemic that has affected all regions and companies at the same time which now calls for SC managers to re-strategize their risk management strategies to cover scenarios of pandemics.

This introductory chapter constitute the background study of the case company, introduction to previous studies for identifying research gaps (literature review), defining research questions and objectives of this study as well as theoretical framework and limitations, research methodology and data collection plan. In addition, it presents definitions of the key concepts used in this thesis and, the structure of the thesis.

1.1 Literature Review

There has been existing literature on SCDs and resilience since the early 2000s (Tang 2006, Craighead et al. 2007; Simchi-Levi, Schmidt, and Wei, 2014; Chopra and Sodhi, 2014) with the first acceptable definition of SCDs in 2007 by Craighead et al (Craighead et al. 2007, p. 132). But not much has been covered on pandemic related disruptions until 2020 during which SC experts, researchers and managers

have been so interested in pandemic related disruption topics. This is because COVID-19 pandemic has highlighted SCRM and SCRES for global companies, exposing the loopholes that existed in previous research on global supply chains (GSCs) disruptions. It has exposed the shortcomings in SCs including the effects of disruptions on GSCs-global network scale, as individual SC connections and nodes fails. GSCs has been disrupted since March 2020 with the COVID-19 pandemic outbreak to the extent that companies are turning to insurance to mitigate the risks since pandemics, trade tensions and natural catastrophes risks are all insurable risks.

Although researchers have since March 2020 had all hands-on deck investigating the impact of the ongoing pandemic (COVID-19 pandemic) on the one hand and pandemic related disruption on SCs on the other as well as, redefining SCRM strategies to be resilience in pandemic related situations, identifying the difference between a pandemic related supply chain disruption and other supply chain disruptions (Moritz,2020; Habib, Sprecher and Young, 2021). There is still a long way to go to exhaust the topic (pandemic related disruptions and resilience) as stated by Remko (2020). Agreeing with Golan, Jernegen and Linkov's (2020), point of view, there is a gap in existing supply chain literature as there is the need for network analysis and advanced resilience analytics with the need for a network resilience that would include supply chain modeling that takes into consideration systemic threats such as disease pandemic like COVID-19. This, gap arose because researchers paid more interest on disruptions caused by localized events. Because it is normal to focus on what is current and frequent as such, because disruptions in supply chain was frequently caused by localized events such as the 2019 wildfires of Australia, 2011 Japanese earthquake and 2018 World Nuclear Association, researchers turn to pay less attention to SCDs caused by global events until the unprecedented COVID-19 pandemic disruption emerges whose effect on GSCs was not only of great magnitude but also put GSCs resilience on a test. This has become the boiling pot of SCs, pulling scholars and industry experts to research and write on it. (Queirov, Ivanov, Dolgui and Wamba. 2020.)

1.2 Research Aim and Research Questions

This research acknowledges the existence of disruptions within the supply chain be it internal or external disruptions such as breakdown of vital machinery or interruptions to the flow of raw materials or parts to a business respectively. Recognizing the research issue of supply chain disruption, the researcher will investigate means of curbing or mitigating such disruptions to ensure a resilience and responsive supply chain. COVID-19 is only the latest in an increasing number of unexpected disruptions that has been hitting the supply chain. It is of essence to recognize the fact from a supply chain perspective that through the process of recovery, it would be easy to overlook the root cause and gaps within the supply chain that may have destabilize the business(es) in the first place. Thus, working towards a resilient supply chain cannot be ignored in every future discussion for years to come since disruption seem to be the new normal in the realm of supply chain.

COVID-19 unlike most events which are geographically confined, has spread throughout the planet with total inability to predict when the pandemic will be contained. Also, COVID-19 pandemic does not only affect local supply chain but significantly affects the global supply chains (GSCs) at all tiers (Moritz, 2020). With the outbreak of COVID-19 pandemic, measures have been put in place to check and control the exponential spread of the pandemic. Such measures include restricted international flights, vessels placed under quarantine for weeks before released into ports and prioritizing movement of only essential commodities.

The above measures put in place by governments, both national and international authorities have created huge negative impact on global trade and supply chain almost threatening to bring the supply chain to a standstill as movement of manufactured goods and raw materials were slowed down as well as shortage of manpower. The major GSCs disrupted by the COVID-19 can be viewed from three angles in the supply chains namely; supply side disruptions which linked to disrupted commodities and supply chains including; High-Tech products (Apple, Samsung and LG), automotive parts, medicines and medical devices (active

pharmaceutical ingredients (API), Personal Protective Equipment (PPE), food supply chain, International logistics disruptions which includes; labor force shortage, commercial flights grounded, closed borders and trade restrictions and finally, the demand side disruption which includes; distorted demand in products such as medicines, (chloroquine and hydroxychloroquine), PPE and ventilators experiencing a sharp increase in demand while airlines industries, textile, apparel, and retailing are experiencing a sharp decrease in demand. (Xu, El Omri, and Kerbache, 2020.)

Supply chain is a necessity to humanity as it creates a smooth transportation and intermodal connectivity of raw materials, semi manufactured and manufactured goods within the domestic and international level thereby enabling the availability of products at the right time, place, and price. With Supply chain brought to a standstill it is as much a threat to humanity as the pandemic is to humanity as such there is the need to look for means to improve supply chain resilience and responsiveness to be able to pull through this pandemic and any such pandemic in the future.

Though every disruption comes with a different form of misery, list of causes and effect, they are similar in the context of supply chain in that every risk management involves prevention, detection, and response. So, the role of supply chain is to achieve flexibility and the ability to sail out of certain situations (supply chain resilience).

With globalization and digitalization, it is but necessary to evaluate the implication of digital transformation on supply chain (the use of technology in modern supply chain systems to ensure supply chain resilience).

Therefore, it is important for supply chain managers to understand the extent of the impact of SCDs especially one that is global and, what mitigating strategies can be implemented to make their SCs robust. Hence, this research aims at answering the following questions:

RQ1: What plans are being put in place to mitigate the impact of supply chain disruptions (Polycom Inc.)? and how technology is an indispensable tool for a resilience supply chains?

RQ2: What are the loopholes in the existing supply chain risk management

strategies exposed by the outbreak of COVID-19?

RQ3: What measures are being taken to improve on the existing supply chain risk management strategies?

1.3 Research Methodology and Data Collection Plan

The study encompasses two major parts: theoretical and empirical part. The theoretical section of the study comprises of a comprehensive literature review that mainly includes academic articles and some relevant textbooks.

1.3.1 Theoretical Study

To provide an insight to the research topic and to enable readers to properly understand the concept of supply chain disruptions and resilience, literature research was conducted whereby, the researcher used mainly textbooks and academic journals. While trying to use recent books it was difficult to avoid some older books due to the nature of the research.

Amidst gathering insight to the topic from relevant articles and textbooks, the subject matter was defined, and appropriate key words identified:

“Supply chain risks, supply chain risk management, supply chain disruption, supply chain disruption risk, supply chain resilience, supply chain resiliency, supply chain network resilience, supply network resilience and, resilient supply network”.

The above key words go a long way to ease the literature research as relevant literature were eventually easy to find since only literatures that are relevant to the research should be included in the review (Saunders et al. 2016, p. 72).

1.3.2 Empirical Study

There exist two main research strategies in the academic research world: quantitative and qualitative with a third one being the mixed research methodology which is also known as the hybrid methods (Saunders, Lewis and Thornhill, 2015, p. 165). Be it qualitative or quantitative, both are characterized by systematic

collection of data, systematic analysis of data and the existence of a clear purpose to find out things (Saunders, Lewis and Thornhill, 2015, p. 5 &165).

Despite the similarity in characteristics, there exist numerous differences between the two main approaches with the most outstanding difference found in the data collection techniques and data analysis procedure; whereas quantitative research approach focuses on numeric data with data collection technique/analysis procedure such as questionnaire/graphs and statistics respectively, qualitative research approach focuses on non-numeric data with data collection technique /analysis procedure such as interviews/categorizing data-words, images and video clips respectively (Saunders et al. 2015, p. 165).

The writer of this thesis decided to implement the hybrid research method to increase the validity of the study and to provide more comprehensive answers to the research questions since the use of mixed research method achieve deeper, broader understanding of the phenomenon or research problems being studied than either approach implemented alone (Hurmerinta-Peltomaki and Nummela 2006; Johnson and Christensen, 2004). With the mixed research method used since the 1950s but formally increasingly used from the later part of the 1980s by researchers (Cresswell,2003; Creswell and Plano Clark, 2007; Dunning, Williams, Abonyi, and Crooks, 2008) further justifies the perceived added value of such method and a such the researcher of this thesis decided to implement the unequal mixed research method leaning more towards the qualitative research method (Saunders et al. 2016, p. 172) since it offers the possibility to analyze written documents from the case company's archives relating to supply chain risk management as well as making use of both questionnaires and interviews. This consideration was made as it appropriately addresses the aim this thesis in a comprehensive manner which is analyzing supply chain disruption and resilience to discover how companies perceive this risk and efforts put in mitigating such (Saunders et al. 2015, p. 165-170). as well as it allows the researcher to understand the extent to which the findings are relevant in practice by including experts' own discourse (Aguinis, Werner, Abbott, Angert, Park and Kohlhausen 2010) in that while the quantitative data provide an overview of the study and its problem, the qualitative data look more

deeply at the respondent's perception.

With the understanding that qualitative research utilize the descriptive approach, the author of this thesis decides to go for a mixed thesis approach which allows the author to utilize the exploratory approach providing possibilities to utilize the advantages of flexibility and adaptability to change that comes with such approach as well as mitigating the disadvantages of qualitative research which includes its subjectivity, visibility and difficult to apply its inductivity.(Bryman and Bell 2011).

The researcher will use semi-structured in-depth interviews in data collection to give the respondents opportunities to express their opinion based on their experience (Silverman, 2011), as well as interview guide to direct the respondents (who will be chosen through purposeful sampling method to ensure credible and insightful information) towards issues of concern (Patton, 2002).

1.4 Conceptual Framework

The purpose of the conceptual framework is to visualize the different aspects that will be analyzed in this research work to achieve its objectives. It consist of the recognition of the existence of disruptions within the supply chain be it internal or external disruptions such as breakdown of vital machinery or interruptions to the flow of raw materials or parts to a business respectively, ways on how to handle supply chain disruption thereby ensuring a resilient and responsive supply chain i.e. Supply Chain Risk Management (SCRM), background of Polycom, supply chain risks that threatens Polycom and exiting strategies to handle such risks/loopholes and the implication of digital transformation on supply chain (the use of technology in modern supply chain systems to ensure supply chain resilience). Looking into how globalization has made technology an indispensable tool for a resilient supply chain and finally recommendations.

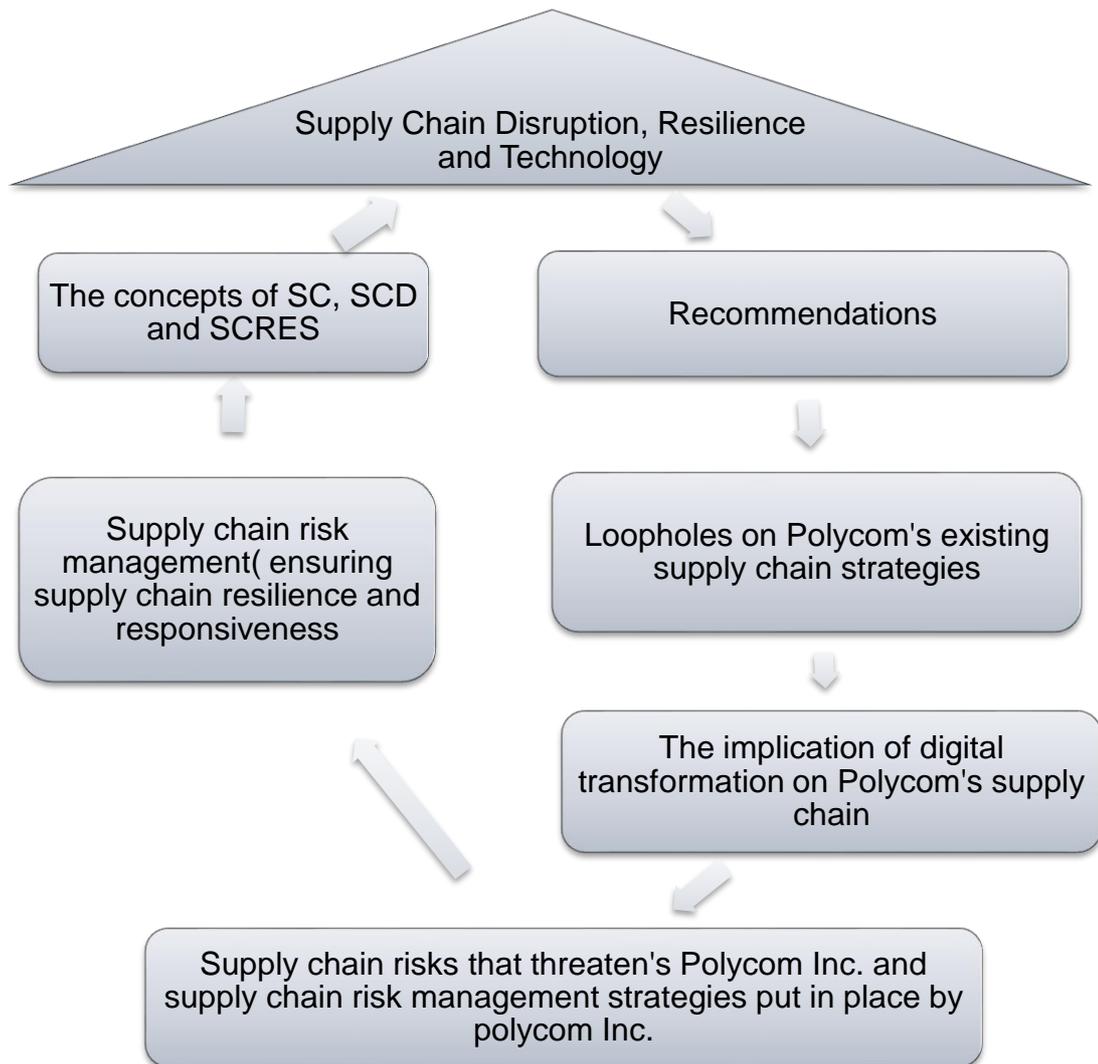


Figure 1 Conceptual framework

1.5 Definition of Key Concepts

This section briefly defines the main concepts that the reader needs to consider. In the later part of this paper (Theoretical Part), such concepts will be defined more accurately.

Supply Chain Management (SCM):

As per Tang (2006, 453), SCM is, “the management of material, information, and financial flows through a network of organizations (i.e., suppliers, manufacturers, logistics providers, wholesalers/distributors, retailers) that aims to produce and

deliver products or services for the consumers. It includes the coordination and collaboration of processes and activities across different functions such as marketing, sales, production, product design, procurement, logistics, finance, and information technology within the network of organizations”.

Supply Chain Risk Management (SCRM)

SCRM can be defined as “the management of supply chain risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity” (Tang, 2006, p 453).

Supply Chain Disruptions (SCDs)

As per Craighead et al. (2007, 132), SCD is” an unplanned and unanticipated event that disrupt the flow of goods and materials within a supply chain and, consequently, expose firms within the supply chain to operational and financial risks” (Brener, 31, 2015).

Supply Chain Resilience (SCRES)

SCRES can be define as “the adaptive capability of a supply chain to prepare for and/or respond to disruptions to make a timely and cost-effective recovery, and therefore progress to a post disruption state of operations- ideally, a better state than prior to the disruption” (Tukamuhabwa, Stevenson, Busby, and Bell, 2015, p. 8).

Supply Chain Complexity

Globalization and personalization trends breed complexity in supply chain which results to decline in SC responsiveness/flexibility evident in slow response, prolonged lead time and high inventory levels, etc. With no clear-cut definition of supply chain complexity, it can be explained by dividing it into network complexity, process complexity and product complexity. Network complexity-a kind of relatively static and lasting complexity reflected in the structure of supply chain network and the interaction between network nodes, process complexity-a kind of dynamic and changing complexity reflected in the large number of business process links, involved enterprises/departments and personnel, and products complexity are the

service objects throughout the supply chain, which is also the root of the existence of the supply chain reflected in the production complexity and the variety of products.(Xiaoxiao and Zikui, 2019.) Thus, SC complexity is” Supply chain complexity is an aggregate measure of the structure, type, and volume of interdependent activities, transactions, and processes in the supply chain” (Manuj and Mentzer 2008, p. 213) including the information, constraints, and uncertainties within which such activities, transactions, and processes take place (Manuj and Sahin, 2005, p. 62).

Supply Chain Flexibility/ Responsiveness

According to Manders, Caneiels and Ghijzen (2017), there is an increased need for SC flexibility induced by societal trends in the areas of; globalization (globalization has led to worldwide competition causing firms to outsource non-core activities to different regions worldwide while focusing on core competencies), technological development in the areas of information and communication technology (ICT), which induces globalization and real-time competition due to the possibility of fast and easy information exchange between and amongst firms and their customers, SCDs, continuous/rapid changes in customers’ needs and expectations (mass customization) in the arears of delivery time, quality, reliability, availability, product diversity and service, and Shorter product life cycle. Firms’ competitiveness with the above societal trends depends on its level of flexibility.

Supply chain flexibility can be defined as “the ability of the supply chain to change or react to environmental uncertainty, to meet the increasing variety of customer expectations without excessive costs, time, organizational disruptions or performance losses” (Manders et al. 2017). Thus, looking at the definition of supply chain responsiveness as per Qrunfleh and Tarafdar (2013), which defines it as SC capability to react quickly and effectively to customers’ needs it can be said that SC flexibility and responsiveness can be used interchangeably.

Supply Chain Agility

SC Agility should not be confused with SC responsiveness. SC agility refers to the ability of a company’s SC to produce and deliver a great variety of products to satisfy

customers' needs with short lead time. Thus, it is the company's capability to rapidly handle uncertainty by owning available options. As such, responsiveness is considered a consequence of agility. (Haya and Ayman 2019.)

Supply Chain Visibility

According to Somapa, Cools and Dullaert (2018), Supply chain visibility generally refers to the level of accessibility by SC actors to timely and accurate information considered useful to their activities. To increase demand forecast accuracy level, accelerate the adjustment of production plans to match changing demands, improve delivery performance and reduce inventory, SC visibility on customer demands and inventory levels must improve. SC visibility from first-tier supplier to end customers (End-to-end visibility) is necessary for the achievement of a higher market responsiveness as well as mitigating disruption risk in material and product flow. (Somapa et al. 2018.)

1.6 Delimitations

This research focuses on strategies that enhances SCRES against disruption risks: earthquakes, floods, hurricanes, terrorist attacks, economic crises, pandemics while concentrating on the COVID-19 Pandemic. It excludes SCRES strategies against operational risks and other risks: Uncertain customer demand, uncertain supply, and uncertain cost.

This research will not detail the use of technology in modern supply chain system but rather the researcher investigates how technology enhances and improves SCRES. Due to the restrictions on movement as one of the measures to curb the spread of the COVID-19 virus and the limited time required to finish the research, plus the existence of backlogs, the research focus on one case company and uses only questionnaire and online interviews and as such the results in this research might have some limitations when applicable to other firms in different industries.

1.7 Structure of the Study

This research is made up of five chapters presented in figure 2 below. The introduction Chapter presents an overview and background of the thesis as well as explains the methodology and data collection plan to be used in conducting this research. Chapter two deals with the main theories of this thesis. It introduces the concepts of SCR, SCDs and SCRES which are the main themes of this thesis as well as the theory of SC, SCRM and SCRM process which are the basis of supply management. Chapter three and four explains the methodology used in this thesis and analyze the findings producing results respectively while the last chapter of this thesis discuss on the recommendation to better the existing strategies of Polycom Inc. and conclusion.

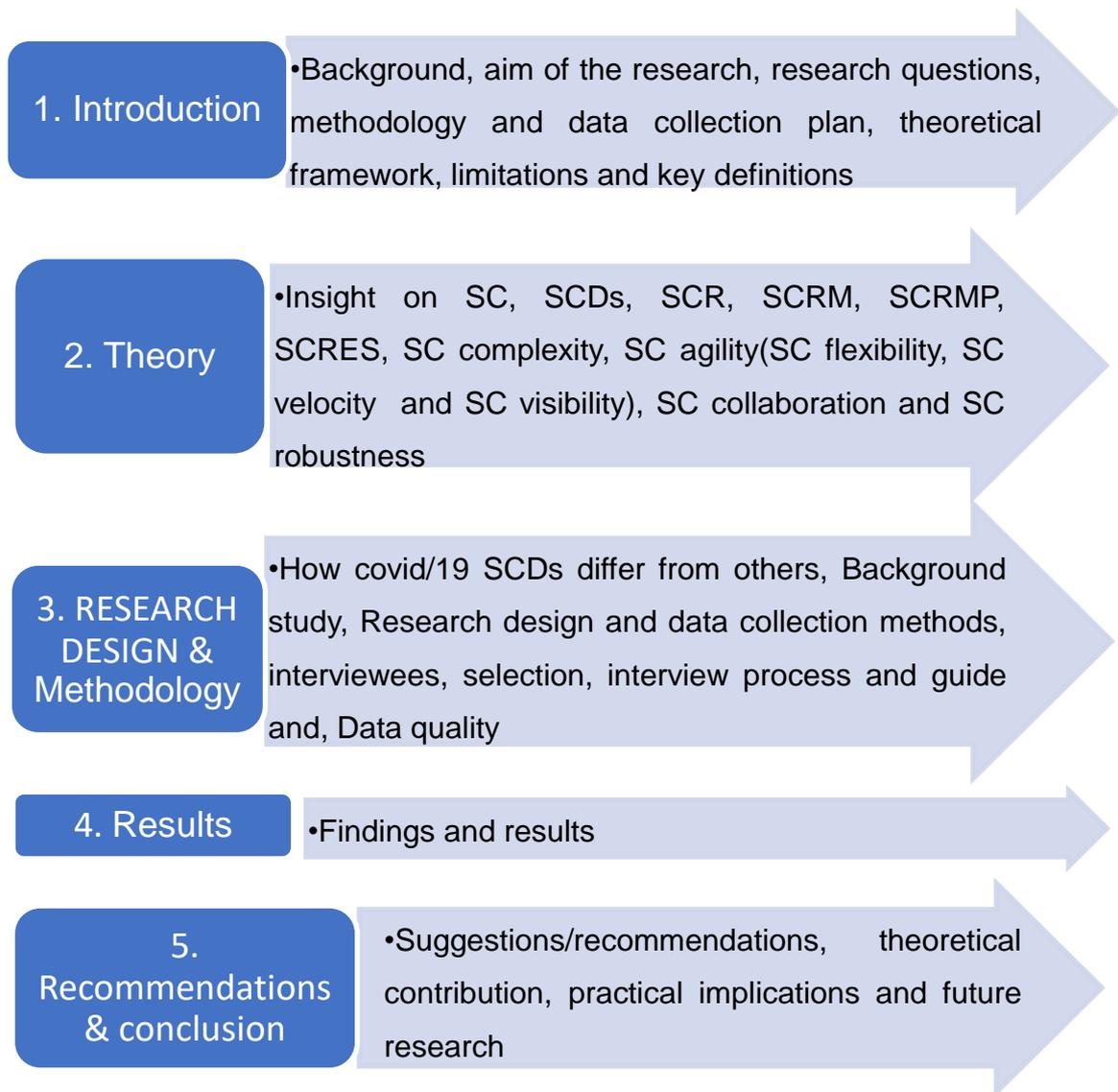


Figure 2: Structure of the thesis

2 SUPPLY CHAIN RISKS DISRUPTIONS AND RESILIENCE

This chapter will provide insight to the main concepts used in this paper.

2.1 *Supply Chain (SC)*

In a post pandemic world, companies need to make their supply network more resilient. According to Nakano (2020), the concept of supply chain can be divided into external and internal supply chains. Internal supply chains constitute the linkage among supply functions such as procurement, production, and logistics with the demand function such as sales. External supply chain constitutes an inter-organizational linkage including suppliers, finished goods manufacturers, wholesalers, and retailers' relationships. Supply chain can be traced back to 1975 when Banbury first used it to describe a connection of supply-related activities across multiple functions and organizations including sales - a demand related function to the supply related function with the underlining reasons being that the main functions of sales such as creating and stimulating demand and customer satisfaction are greatly influential to the supply functions. Demand related activities is the source of complexity, instability, and unpredictability to the supply side. (Nakano, 2020, p. 3-12.)

Currently, supply chain is becoming more and more complex and global than the traditional supply chain moving from the linear conception of supply chain relationship where SCM research focused on the dyadic relationship of supply chains to a more realistic and expanded relationship of networks recognizing the interdependence of heterogenous firms (Hearnshaw and Wilson, 2013). According to Harland et al. (2003), supply chain complexity has a direct impact on supply chain risks.

Supply chain complexity as shown on figure 3 below has resulted from trends such as globalization, personalized demand, product complexity, shortened lead time and e- fulfillment and as such impact company's flexibility, limit flexibility of supplier's responsiveness, increase management complexity, reduce responsiveness to

volatile market demand, decentralize company's procurement volume, reduce company's capital and boost inventory (Xiaoxiao and Zikui, 2019; Tobias, Anne and Christoph, 2019). This research view supply chain as a complex network of interdependent actors/entities

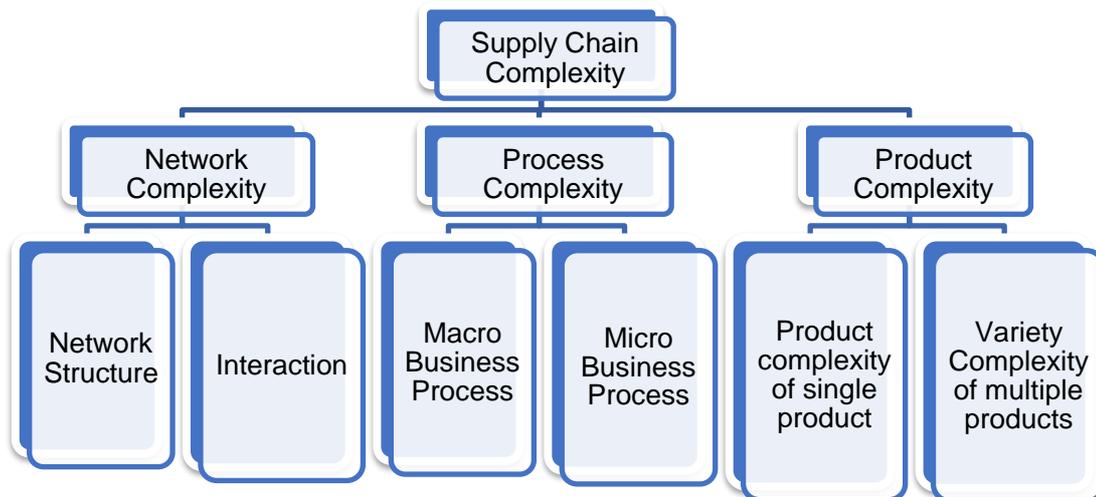


Figure 3: Supply Chain Complexity Architecture (Xiaoxiao & Zikkui, 2019, p. 973)

2.2 Supply Chain Risks (SCR)

SCR in the past decades has been define in connection of the likelihood/probability of occurrence for example Zsidisin (2003), defines SCR as the probability of an event occurring such as failure of individual supplier or the supplier market that leads to the inability of the buying company to meet customer's demand or even threatens customer life and safety while Colicchia and Strozzi (2012), defines SCR in terms of likelihood of occurrence and its impact. SCR as per Willaim, Zheng, Yildiz and Talluri (2015, 6), as shown on figure 4 below, SCR can be defined as "the likelihood and impact of unexpected macro and / or micro level events or conditions that adversely influence any part of a supply chain leading to operational, tactical, or strategic level failures or irregularities". To effectively strategize on how to develop a robust supply chain it is of essence to identify the different SCR. Generally, SCR can be categorized as internal (Operational) and external (disruption) risks

(Shahbaz, 2019). Specifically, SCR can arise from external relationships in the internal operations of a company and as such there exist organizational factors which are strictly internal, Industry factors which are factors not from the case company per say but from within the industry and outside the organization that are affecting the network and finally, the environmental factors causing external risks (Shahbaz, 2019).

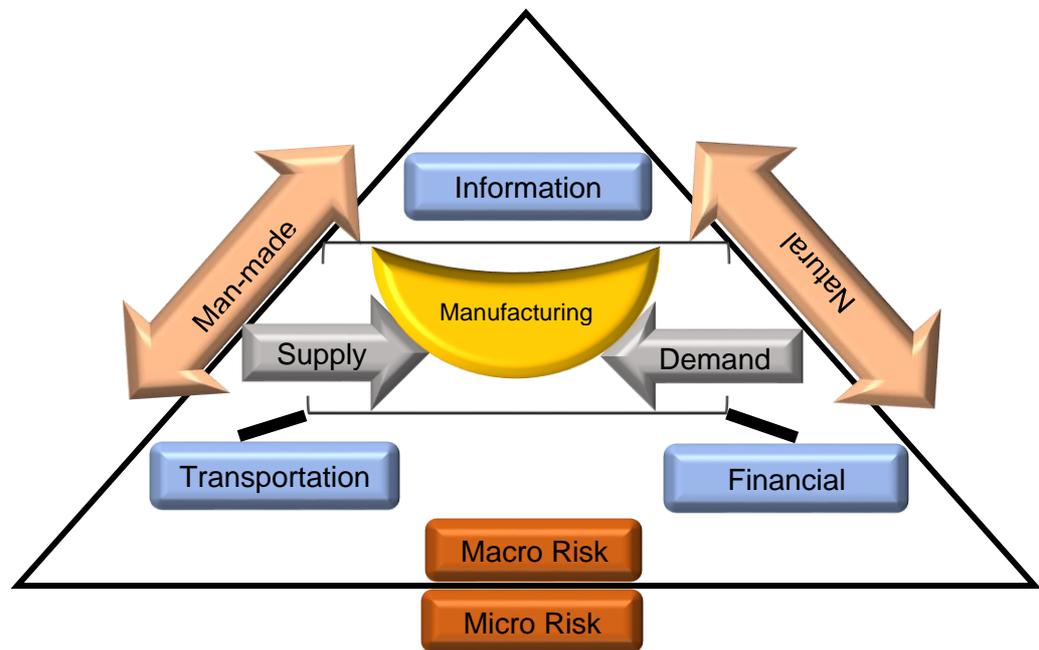


Figure 4: Supply Chain Risks (William et al. 2015)

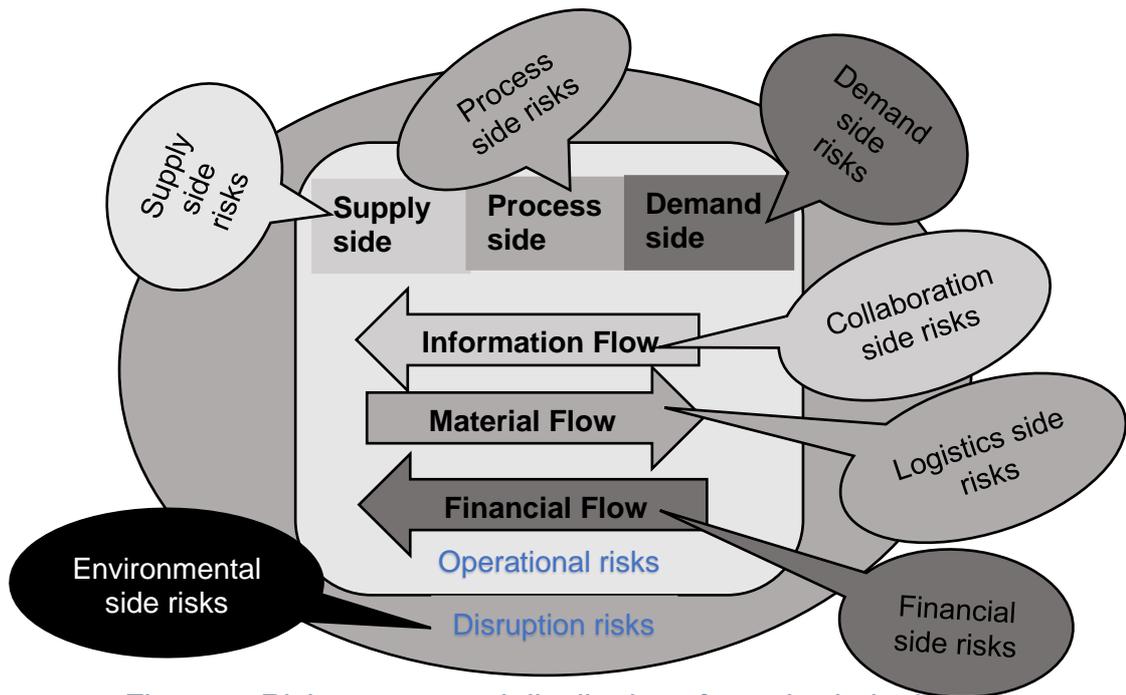


Figure 5: Risk sources and distribution of supply chain risks (Shahbaz, 2019)

As per figure 5 above, Shahbaz, (2019), holds that there exist seven types of SCR. Three sources (supply side, process side and demand side) of such risk relates to the organization factors, Industrial factors encompasses three other sources (information flow, material flow and financial flow) arising from the three flows that links SC partners, generates collaboration related risks, logistics related risks and financial related risks respectively. Disruption risks sourcing from natural disasters, political instability, terrorist attack, microeconomics uncertainties, social uncertainties, diseases, and epidemics/ pandemics constitute the seventh type of risk categorize as the environmental side risks. Thus, figure 4 above shows that macro risks constitute all the operational risks while micro risks centers around disruption risks.

2.3 Supply Chain Disruption (SCD)

As per Svensson (2003); Hendricks and Singhal (2003); Kleindorfer and Saad (2005), SCD is an unplanned and unanticipated event that disrupt the normal flow of goods and materials within the SC while Stauffer (2003), holds that SCD exposes firms within the SC to operational and financial risks. This brings us to the widely

used definition of SCD by Craighead et al. (2007, 132), that, Supply chain disruption is” an unplanned and unanticipated event that disrupt the flow of goods and materials within a supply chain and, consequently, exposes firms within the supply chain to operational and financial risks”. Thus, supply chain disruptions can be viewed as “Unexpected significant negative deviation(s) from process plans caused by one or more temporal events” (Berner, 2015, p. 33). Bode Wagner, Petersen, and Ellram (2011, 1), holds that SCD is an organizational phenomenon involving at least two firms doing business (dyadic relationship).

Yossi, James & Rice (2005,5), holds that disruptions with both high probability and low impact constitute part of the scope of daily operation management to ensure normal flow of business while disruptions with both low probability and high impact requires planning and special reaction that is outside the scope of daily operation management. Thus, indicating that SCD can either be operational disruptions which usually originate from internal events and sometimes external events relating to suppliers (Mizgier, Hora, Wagner, and Jüttner, 2015) and disruption risk which originate completely from external events such as natural disasters, political instability, etc. Operational SCD consists of equipment malfunction, system failures, uncertain discontinuity of supply (Keindorfer et al. 2005). Disruption risk can be separated from disruptions that arise from stochastic elements such as demand uncertainty by identifying it to be a low probability-high impact risks as opposed to high probability-low impact risks (Dolgui, Ivanov and Rozhkov, 2019, p. 2).

SCD is not only catastrophic but can sometimes fluctuates regular operations
 Disruption risk can be caused by either natural disaster such as the 2011 Kobe earthquake in Japan, the 2003 SARS outbreak in China, the 2004 tsunami in Indonesia, foot and mouth disease and bird flu, man-made disaster, terrorist attacks such as 9/11/2001 attack or economic crisis as opposed to operational risk constituting of the inevitable inherent uncertainties within the supply chain such as demand, supply, and cost volatility (Yu et al. 2009, p. 3). Gurnani et al. (2012), holds that changes /developments in the business environment in the areas of globalization, sourcing (outsourcing and single sources), and the focus of eliminating slacks from supply chains drives supply chain disruption. Global supply

chain complexity and uncertainty leads to frequent disruption events in supply chain management (Hosseini and Dolgui, 2019; Kim,chen and Liderman, 2015; Kamalahmadi and Parast, 2016). Supply chain efficiency, reliability and responsiveness are the key contributors to a firm's profitability. Existing research has shown interest in supply chains disruption and measures to be utilized by firms in designing a better and resilient supply chain capable of mitigating the effect of supply chain disruption since it is evident from past experience that such is inevitable although the probability of its occurrence is relatively small and the damage is difficult to quantify profitability but firms focus more on improving their efficiency by cutting supply chain operation costs and less attention towards improving their supply chains robustness and reliability. Most supply chain managers turn to ignore such risk and focus more on the risks arising at the operational level forgetting that the magnitude of such supply chain disruption if it does happen can be devastating not just to a firm but the whole supply chain network as is the case of the recent ongoing COVID-19 pandemic on the supply chain. (Lim, Daskin, Bassamboo and Chopra, 2010; Gurnani et al. 2012, p. 2; Yu, Zeng and Zhao, 2009, p. 3.) Thus, SCD can be said to have a ripple effect while operational risks lunch a bullwhip effect (Dolgui et al. 2019). Supply chain disruptions are unavoidable irrespective of their low occurrence probability and as such, all supply chains are inherently risky creating the need to research on factors that either contribute to the severity of a supply chain disruption or conversely dampen it severity. Such findings could be the basis of firms' decision making as to whether to implement certain operational and supply chain policies, practices, and initiatives or to avoid such.

2.4 Supply Chain Risk Management (SCRM)

Competitive business environment now adays has forced firms to expand their operations globally to be cost effective in the areas of suppliers, manufacturing plants, warehouse, and customer base. As a result, companies are faced with network complexity and risk vulnerability thereby increasing the desire for SCRES and SCRM to counter the complex SCR. (Simba, Niemann, Kotzé, and Agigi, 2017.) The objectives of SCRM can be viewed from two stand points which are the financial

and the business continuity viewpoints. From the financial viewpoint of SCRM, it is the management of cash-flow to ensure profitability while from the business continuity viewpoint of SCRM, it is the management of a business exposure to internal and external risks that can cause business disruption. Looking at these two perspectives of SCRM aim at building the capability to reduce costs and vulnerability while ensuring profitability, business continuity and sustainable growth. (Fan and Stevenson, 2018.)

SCRM is at the intersection of SCM and risk management meaning it should cover risk management and SCM (see figure 6 below)

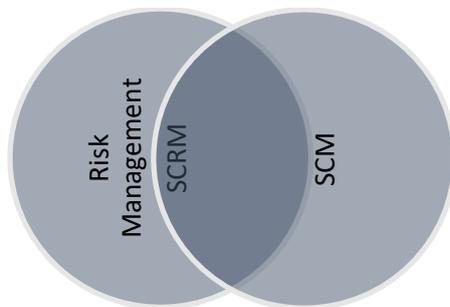


Figure 6: Components of SCRM

Risk management within supply chains is indispensable if a firm strive to achieve effective and efficient supply chains due to the presence of different uncertainties within the supply chain process. For this reason, researchers have endlessly focus on SCRM developing supply chain risk definitions, risk types, risk factors and risk management strategies. (Ho, Zheng, Yildiz, and Talluri, 2015.)

SCRM since 2003 has been defined to include the generic process while other researchers have defined it to constitute identification of risk factors and management/mitigation processes. Within the scope of identification and management process, Jüttner, Peck, and Christopher (2003); Jüttner (2005,124); Goh, Lim, and Meng (2007, 164-165), defines SCRM as the identification of risks within the supply network and management of risks for a supply chain through a coordinated approach amongst members of the supply chain for supply chain in other to reduce supply chain vulnerability. While Thun and Hoenig (2011, 243),

within the scope of identification and mitigation processes defines SCRM to be characterized by a cross-company orientation that aims at identifying and reducing risk not just at the company level but rather focusing on the entire supply chain. Within the scope of generic processes Norrman and Jansson (2004, 436); Tang, (2006a, 453), sees SCRM as the management of SCR through coordination or collaboration among partners in a supply chain implementing risk management tools to manage risks to ensure profitability and continuity.

SCRM as per Kersten et al. (2007), refers to that part of the SCM which covers all strategies and measures, knowledge, institutions, processes, and technologies that are appropriate and adequate technically, personally, and organizationally for risk management within the SC. Since the focus of this research is on global supply chain it is of essence to view SCRM definition at the global level and as per Manuj and Mentzer (2008), global SCRM can be defined as “the identification and evaluation of risks and consequent losses in the global supply chain, and implementation of appropriate strategies through a coordinated approach among SC members”. SCRM experience a diversity of scope as there exist no clear consensus on what it comprises of since some definition limits SCRM scope to rare but large impact events while others limit it to demand/supply uncertainties but whatever may be the case, efficient and effective supply chain risk management is one of the key prerequisites for a successful functioning of business operations within a contemporary business organizations for any drawbacks in SCRM may significantly impact the finance and reputation of the said business entity thereby making SCRM crucial for every business (Ivana, Marijana and Vladimir, 2018).

Fan et al. (2018), affirm SCRM as a multifaceted concept and holds that a holistic definition of SCRM should reflect a complete SCRM process, pathway to SCRM and the aims of SCRM as shown in figure 7 below. Thus, Fan et al. (2018, 6), defines SCRM as “the identification, assessment, treatment, and monitoring of supply chain risks, with the aid of the internal implementation of tools, techniques, and strategies and of external coordination and collaboration with supply chain members so as to reduce vulnerability and ensure continuity coupled with profitability, leading to competitive advantage”.

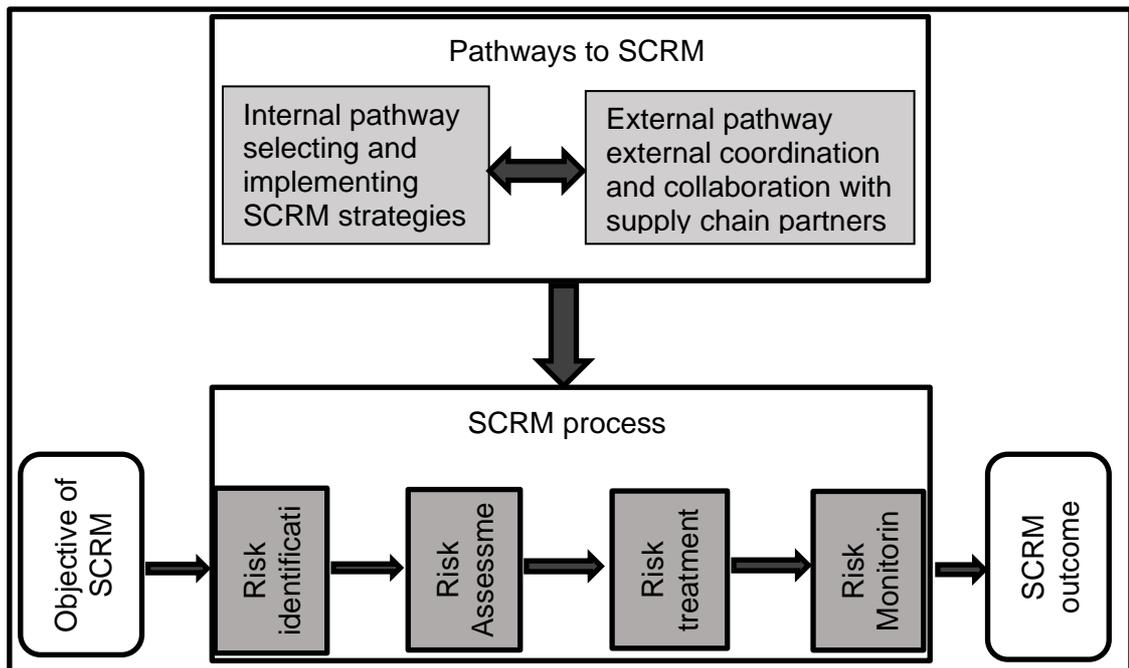


Figure 7: Objective-process-outcome (OPO) based SCRM conceptual framework (Fan et al. 2018)

SCRM facilitates SCRES (Simba et al. 2017). Stable, effective, and efficient supply chain is crucial for a business sustainability, financial growth, and reputation. To achieve this, resilience – SCRES (the ability of firms to continue with its business activities irrespective of threats it is facing) and vulnerability (the gravity of the impact that an external threat is representing to the firm) are the two basic influential factors that needs to be investigated. A proposed SCRM strategies can only be derive after implementing and executing the following systematic and structured approach that assist in enumerating the SCR and evaluating the severity and likelihood of the risk. Such process constitutes of the following steps: risk identification and risk measurement, risk assessment and evaluation, risk mitigation and contingency plans and finally risk control and monitoring (Ivana et al. 2018). As per Aqlan and Lam (2015, 3), risk management approaches are classified in the framework as risk avoidance, risk reduction, risk transfer, risk acceptance, Ignoring risk and risk exploitation.

2.5 Supply Chain Risk Management Process (SCRM) Process and Strategies

With the growth of globalization causing increasing SC complexity, there exist risk of SC failures which calls for the need for companies to plan for disruptions as well as contingency plans when designing or redesigning their SCs. In as much as the focus is on protecting the SC from risk that may negatively impact its performance and sustainability, supply chain practitioners after understanding the SC interdependence, need to first deal with the problem of identifying the risks. Only then can they proceed to dealing with the challenges of risk assessment to come up with the appropriate risk management strategy to be implemented just like Xie Tummala, and Schoenherr (2011, 477), who holds that Aside strategies that may be implemented to manage SCR, SCRM also constitute the SCRM process.

As per Jüttner, Peck and Christopher (2003), SCRM process constitute four different elements: (1) assessing the risk sources, (2) identifying the concepts, (3) tracking the drivers, and (4) mitigating the risks. Kleindorfer and Saad (2005), and Waters (2007) each came up with three components SCRM process: (1) specifying the sources of risk and vulnerability, (2) assessment and (3) mitigation and (1) risk identification. (2) risk analysis and (3) risk control. Halikkas, Kervonen, Pulkkinen, Virolainen and Tuominen (2004); Tummala and Tobias (2011); Bandaly, Satir, Kahyaoglu, and Shanker (2012); Simba et al. (2017), propose similar model of SCRM process that constitute (1) risk identification, (2) risk assessment, (3) decision and implementation of risk-management action and (4) risk monitoring. The four phases of SCRM process are discussed in the subsequent paragraphs.

Risk Identification

Risk identification is the basic phase in the risk management process in that it is at this point that the management team recognizes the existence of events that threatens the SC and seek for strategies to manage such scenarios proactively. It is a critical step in the SCRM process as it identifies vulnerabilities and the risks relationships be it internal and external to the firm. (Breuer, Siestrup, Haasis, and Wildebrand, 2013, p. 335.) Risk identification is important in that it reduces the challenges faced when developing relevant mitigating strategies (Simba et al. 2017)

It involves risk categorization- i.e., understanding both the universe of risk categories and the event and conditions that drives them in order to be able to develop effective and resilient SCRM tools (Bandaly, Satir, Kahyaoglu and Shanker, 2012), as well as identifying the risks sources which can be categorized into external risks (risks outside the firms control) and internal risks (risks within the firms control- arising from internal firms decisions and actions) (Zamora, Adarme and Palacios, 2012, p. 396).

There exist different tools and techniques to ease the risks identification process (Fan et al. 2018) such as the analytical hierarchy process (AHP) and failure modes and effects analysis (FMEA). FMEA is proactive tool for risk identification and assessment that requires SC managers to constantly evaluate processes to identify where and how disruption might occur as well as evaluating the impact of such failure to avoid them and to rectify the processes before risk occurs. (Hu, Hsu, Kuo, and Wu, 2009; Sachdeva et al. 2012, p. 835; Sharma and Bhat, 2014, p. 72; Xie et al. 2011, p. 476; Fan et al. 2018).

Risk Assessment

A comprehensive, rapid, and cost-efficient risk assessment (Zsidisin et al. 2004), is the next phase in the risk management process after risk identification. The risk assessment phase evaluates the potential impact of the identified risk on the company's performance using available data or expert judgement and scenarios (Cohen and Kunreuther, 2007). Hallikas et al. (2004), holds that two variables are being evaluated in the risk assessment phase of SCRM process which are: (1) The likelihood of occurrence of such risk (See Table 1 below) which can be measured using the historical data and can be reduced by implementing the preventive risk - management approach. (2) The magnitude of the impact of such risk on the SC performance should such adverse event occur (See Table 2 below) which can be measured using in monetary terms and can be decreased using the mitigation risk management approach.

Risk assessment is said to be subjective because it is based on the firm's own experience as well as the experience of other firms while the risk consequence

assessment is based on the firm's viewpoint since an event with a negative impact to one firm can have no negative impact on another firm (Zsidisin et al. 2004; Gaudenzi and Borghesi, 2006; Hallikas et al. 2004, p. 53).

SCR assessment strategy popularly and commonly used by researchers and firms is the probability-impact risk matrix (a combination of risk probability assessment and risk impact assessment) adopted by Norman and Lindroth (2002), (see figure 8 below), advocated by Blackhurst, Scheibe, and Johnson (2008), applied through research by, e.g., Hallikas et al. (2004); Chang, Xu, and Song, (2015), and implemented by Marke and Spencer (Khan, Christopher & Burnes, 2008). After evaluating both variables using the probability-impact risk matrix, the supply chain managers will determine the severity of the impact and as such determine the mitigation tool to be used (Bandaly et al. 2012).

| | | | | | |
|---------------|-----------------|------------|--------------------|-------------|--|
| Impact | High | | | | |
| | Medium | | | | |
| | Low | | | | |
| | Very Low | | | | |
| | | Low | Probability | High | |

Figure 8: The risk matrix (Norman & Lindroth, 2002)

Table 1: Probability assessment scale (Halikas, Karvonen, Pulkkinen, Urho, Virolainen & Tuominen, 2004)

| Rank | Subjective estimate | Description |
|------|---------------------|-------------------------------------|
| 1 | Very Unlikely | Very rare event |
| 2 | Improbable | There is indirect evidence of event |
| 3 | Moderate | There is direct evidence of event |
| 4 | Probable | There is strong evidence of event |
| 5 | Very probable | Event recurs frequently |

Table 2: Probability assessment scale (Halikas, Karvonen, Pulkkinen, Urho, Virolainen & Tuominen, 2004)

| Rank | Subjective estimate | Description |
|------|---------------------|--|
| 1 | Minor Impact | Insignificant in term of the whole company |
| 2 | Minor Impact | Single small losses |
| 3 | Medium Impact | Causes short-term difficulties |
| 4 | Serious Impact | Causes long-term difficulties |
| 5 | Catastrophic impact | Discontinue business |

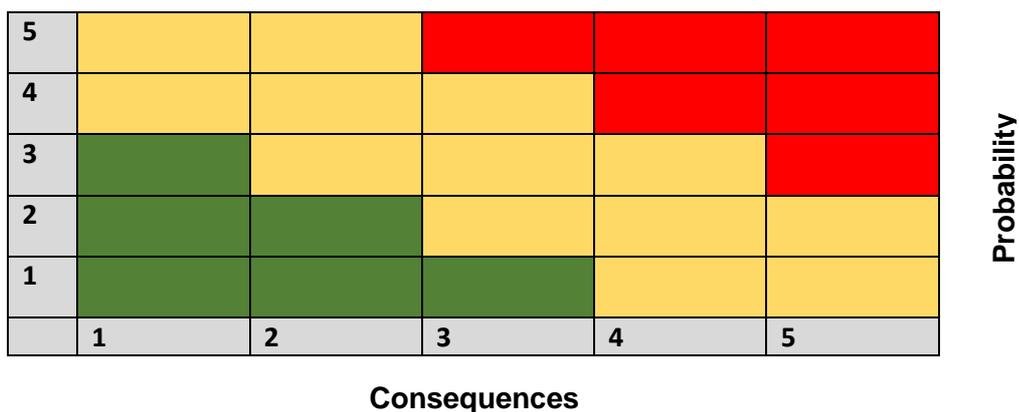


Figure 9: Risk prioritization graph

Figure 9 above is a risk prioritization graph that visualize risk intensity. As per figure 9 above, the green zones are minor risk that needs to be accepted and monitored, the yellow and orange zones are moderate and major risks that needs management

and monitoring, and the red zones are the critical risk that requires mandatory and extensive management and monitoring.

Decision and Implementation of Risk Management Actions

After understanding the risks, the firm is required to now take measures on how to operate amidst such risk. There exist different risk treatment measures available which include risk acceptance, risk avoidance, risk transfer, risk sharing and risk mitigation (Fan et al. 2018, p. 216). Such actions depend on the nature of the risk and the business environment for example, within a network environment risk transfer is often used in situations that the company taking the risk has a better coping mechanism than the company transferring the risk and as such reducing total risk. Thus, the basic idea is to find the optimal risk management strategies (see figure 10 below) to share and balance risks within a network environment. (Hallikas et al. 2004, p. 54.) The subsequent paragraphs will discuss the different risk treatments.

Risk Avoidance: Risk avoidance requires the organization to eliminate events that could trigger risk (Ritchie and Brindley, 2007), such as the discontinuation of certain products, suppliers, and markets (Hajmohammad and Vachon, 2016).

Risk Acceptance: Risk acceptance is subjective as it depends on the willingness of a person/company to engage in a risky venture irrespective of the uncertain outcome (Park, Min, and Min, 2016). Although companies might choose to accept a risk, such should not be ignored but rather be monitored continuously to ensure the accepted level of consequences do not escalate (Aqlan and Lam, 2015). During monitoring of the accepted risk, the company should put into consideration methods on how to avoid, transfer or mitigate such risk if the consequences exceed a certain level (Fan et al. 2018).

Risk Transfer: Risk transfer involves the complete or partial transfer of the risk impact to another party usually the insurance company (Diabat, Govindan and Panicker, 2012; Zhen et al. 2016). Risk transfer is common in situation of disruption risk with small probability and high impact than operational risks with high probability

and low impact (Aqlan et al. 2015).

Risk Sharing: Risk sharing is the act of a company reducing the impact risk by sharing it with another party be it a buyer or a supplier (Fan et al. 2018, p. 216) and it is appropriate for high probability and low impact risks with the purpose of reducing associated cost (Lai et al. 2009) and increase customer satisfaction (Sheller-wolf and Tayur, 2009).

Risk mitigation: Risk mitigation is applied usually in situation where the risk cannot be avoided, and the probability of occurrence is high while the impact level is low (Aqlan et al. 2015). This strategy brings down the risk to an acceptable level but while implementing this strategy on a particular risk, it should be noted that risks are interconnected in such a way that mitigating one risk type can alleviate another (Chopra and Sodhi, 2004).

| | | | |
|-------------|------|-----------------|-------------------------------|
| Probability | High | Risk Mitigation | Risk Avoidance |
| | Low | Risk Acceptance | Risk Transfer or Risk Sharing |
| | | Low | High |

Impact

Figure 10: Matrix of risk treatment strategies based on probability and impact (Fan et al. 2018)

Risk Monitoring

This is the last phase in the SCRM process, and it is essential in the sense that it ensures that the potential increasing trend in probability and consequences of the identified risk can be identified when such risk arises since the business environment is not static and as such the risk status too is not static and thus, requires continuous monitoring (Hallikas et al. 2004, p. 54; Fan et al. 2018, p. 216).

Risk monitoring is necessary for firms (Jüttner and Maklan, 2011, p. 253), as it determines changes to be made in the risk treatment actions, identifies new preventive measures, and predict possible risks (Simba et al. 2017, p. 5). Thus, risk monitoring as per Charkhab, Eslami and Dehnavi 2014, p. 420; Thun, Drüke, and Hoenig 2011, p. 5514) ensures a firm resilient within an uncertain/unstable business environment.

2.6 Supply Chain Resilience (SCRES)

Resilience refers to the adaptive capability/capacity of supply chains to respond to supply chain disruption (SCD) by timely recovery to the original or better still improved state (Tukamuhabwa et al. 2015). Mandal (2017, 192), view the concept of resilience more extensively not just in the economic/supply chain context but rather to also fit in ecological, social, and psychological context. Viewing SCRES from a multidisciplinary Perspectives, Ponomarov and Holcomb (2009, 9), defines SCRES 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 the desired level of connectedness and control over structure and function”. To incorporate most characteristics of resilience, with the acknowledgement of the fact that supply chain disruptions should be minimized cost effectively, SCRES can be define as “the adaptive capability of a supply chain to prepare for and/or respond to disruptions to make a timely and cost- effective recovery, and therefore progress to a post disruption state of operations- ideally, a better state than prior to the disruption” (Tukamuhabwa et al. 2015, p. 8). Thus, supply chain resilience and robustness’ can be differentiated as follows, while SCs resilience relates to the ability of SCs to recover their operations after suffering from disruption(s), SCs robustness relates to the ability of a SCs to continue with it planned performance after a disruption(s) (Jamal and Salomee, 2021).

SCD affects a company’s financial performance in the areas of shareholder value, share price and profitability. SCD affects the shareholder value in that the market has a negative view on SCD and as such firms that are experiencing disruptions turn to face a decrease in their stock prices leading to share price volatility due to

uncertainties about the firm's management capability and business strategies. SCD also impact profitability negatively in that firms experiencing SCD are also faced with decrease operating income, decrease return on sales, decrease returns on assets which are all determinants of profitability. (Gurnani et al. 2012.)

The volatile global business environment leaves supply chain vulnerable to disruption and operational risks and the economic effect of a weak supply chain performance makes research on resilient supply chain a topic of interest. As per Hohenstein et al. (2015)., supply chain resilience (SCRES) is the ability of the supply chain to be prepared for unexpected risk events, responding, and recovering quickly, potential disruptions to return to its original status-quo or improve to a new and more desirable state to increase customer service, market share and financial performance. SCRES incorporates both proactive and reactive strategies. A supply chain is said to be resilient if it has the elements of readiness in its proactive strategies which includes collaboration, human resource management, inventory management predefined decision plans, redundancy, and visibility as well as the elements of response, recovery, and growth in its reactive strategies (Hohenstein et al. 2015).

Ponomarov et al. (2009), holds that the three capabilities essential for SCRES are readiness, response and recovery and these capacities are interconnected through the elements (Control, coherence, and connectedness) that each capacity constitute. (See table 4 below). SCRES capabilities are actions executed at the different phases of a disruption which strategies put in place to prepare for, respond to, and recover from SCDs. These strategies are proactive in nature i.e., pre-disruption actions which constitute readiness and reactive in nature i.e., post-disruption actions which constitute response and recovery (Arsalan, Jaafar, and Ali, 2020). While Nils-Ole Hohenstein, Feisel, Hartmann, and Giunipero (2015), agree on a fourth Capability, growth which is a post disruption action that enables a firm to achieve a new and improved position after a disruption, Hollnagel (2011), insert a third strategy- concurrent strategy to the list of strategies (proactive and reactive) which is explained to relate to swift reactive thinking and first-response coping capabilities during the disruption. As such Ali, Mahfouz, and Arisha (2017), holds

that understanding of SCRES concept has evolve over the years from disruption having two phases to now having three phases namely pre-disruption phase/strategies, concurrent disruption phase/strategies and the post-disruption phase despite the fact that most literature implicitly identify the concurrent disruption phase and uses terms like first response and immediate response (Sheffi and Rice, 2005; Scholten, Scott, and Fynes, 2014), respectively to refer to it. As well as a move from two capabilities to four capabilities (See figure 11 below) and for a holistic view a SCRES dimensions and connections see figure 12 below.

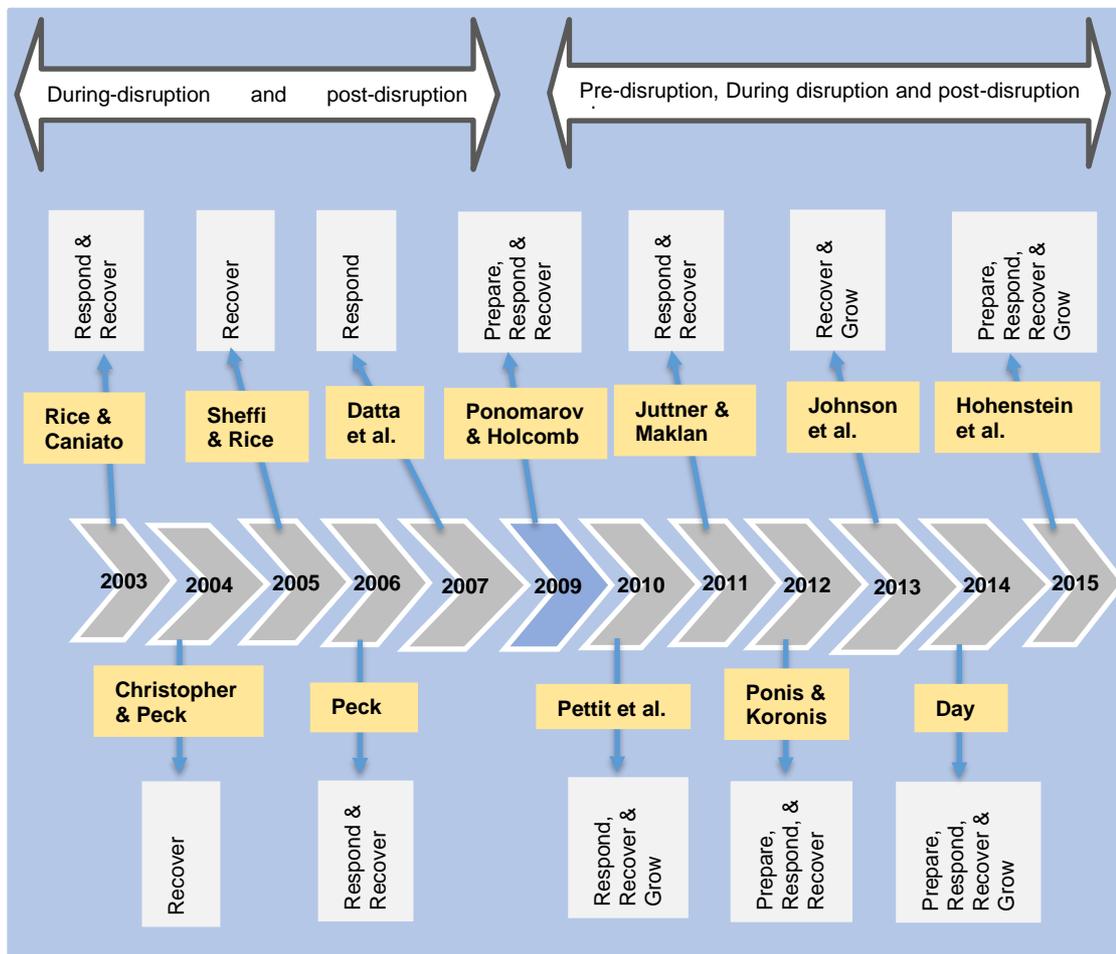


Figure 11: SCRES Phases timeline in definitions (Ali et al. 2017, p. 22).

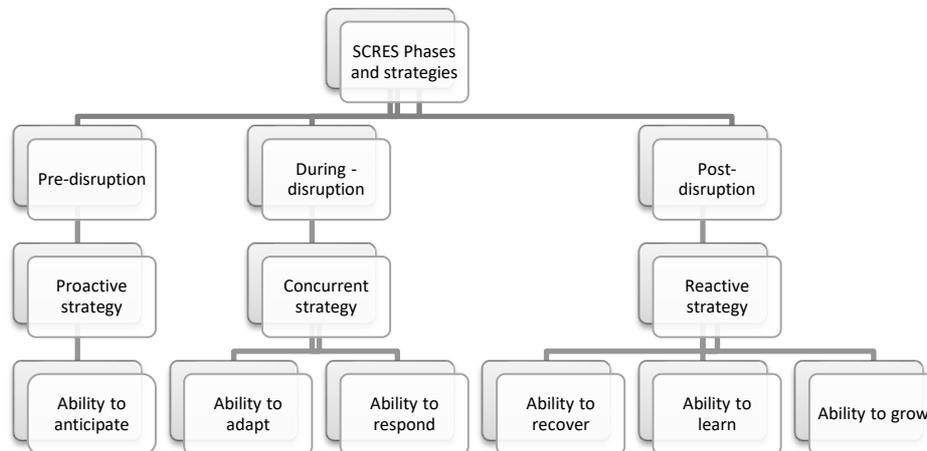


Figure 12: SCRES phases and strategies

A firm is said to possess readiness capabilities if its SC can recognize the possibility of an event occurring, anticipate the possible changes in the environment and implement proactive measures before rise any serious disruption (Arsalan et al. 2020). Nils-Ole et al. (2015, 105), identify the following readiness elements and sub elements needed to be able to achieve readiness capabilities. The firm should have competence in visibility(e.g. early warning indicators, communication, information sharing, real-time and financial monitoring), robustness, collaboration(coordination, cooperation, joint-decision making, knowledge sharing, supplier certification, supplier development), human resource management(employee training and education on how to deal with risky events, risk-sensitive culture and mindset, cross-functional teams, experienced employees for crisis management), inventory management(use of inventory and safety stocks to buffer disruptions and decrease the possibility of stockouts and lost sales), predefined decision plans(contingency plans and communication protocols to reduce response time and errors during implementation), and redundancy(production slack, transportation capacities, multiple sourcing and production locations).

Responsive capabilities are attached to a firm with the ability to be responsive amidst disruption (Arsalan et al. 2020). As per Nils-Ole et al. (2015, 105), responsiveness is achieved through SC flexibility (backup suppliers, easy supplier switching, distribution channels, flexible production systems, volume flexibility, multi-skilled workforces), SC redundancy (production slack, transportation

capacities, multiple sourcing and supplier locations), collaboration/cooperation amongst SC actors, and SC agility (Coordination, cooperation, joint-decision making, knowledge sharing, supplier certification, supplier development).

Recovery capabilities is the ability of a firm to regain normalcy after a disruptive event. Such capabilities are contingency planning, Knowledge management capability/human resource management (employee training and education, risk-sensitive culture and mindset, cross-functional teams, experienced employees for crisis management) and social capital (shared values, norms trust and joint effort towards mutually beneficial relationships) (Arsalan et al. 2020; Nils-Ole et al. 2015, p 105).

Growth capabilities is the ability to identify growth opportunities that may arise during the post-disruption phase and utilize them to shift the company to a new and improved position.

Table 3: Resilience-logistics capabilities matrix (Ponomarov & Holcomb 2009, p. 136)

| Resilience/capabilities matrix | Readiness | Response | Recovery |
|---------------------------------------|---|------------------------------------|--|
| Control | Logistic quality, efficiency, cost minimization, risk-hedging capabilities, back-ups of systems and processes | Timeliness, postponement | Cycle-time reduction, delivery competency |
| Coherence | Effectiveness of logistic processes, systematic contingency planning | Flexibility, agility, risk-sharing | Customer service, efficiency of warehouse operations, knowledge management |
| Connectedness | Information technology upgrades, supply chain relationship building | Information sharing | Highly integrated systems and processes |

Control is related to the direction and regulation of strategic and tactical actions within the SC. Planning and control being one of the nine components of SCM are responsible for moving a SC towards the right direction. A more resilient supply chain maintains more control of logistics capabilities when disruption occur. Coherence enhance meaning, direction and understanding during disruption to reduce uncertainty. It provides order and structure within the SC in times of disruption to reduce uncertainty. It enables companies to create and follow contingency plan. The level of resilience of the supply chain is relative to its level maintaining coherence of logistics capabilities when disruptions occur. Connectedness refers to the need for collaboration amongst SC actors in times a disaster to form a resilient community characterized by interconnectivity. With connectedness, there is openness and visibility across suppliers, manufacturers, distributors, retailers, and customers in a SC The level of resilience of the supply chain is relative to its level connectedness(integration) across logistics capabilities during disruptions. (Ponomarove et al. 2009.)

2.6.1 Critical Factors for Building Resilience in Supply Chain

From understanding the pre-disruption and post-disruption actions of a resilient supply chain that outline four resilient capabilities; readiness, responsive, recovery and growth, five components of SCRES are being seen as the critical factors for building a resilient SC. These components are visibility, velocity, flexibility, robustness, and collaboration. (Shih-Jung, Eldon, and Wei-His, 2021). Because these components of resilience are interconnected, it was proven by Shih-Jung et al. (2021), that SC collaborations is an exogenous driver of SCRES as it directly affects visibility, velocity, robustness, and SC performance under disruption. SC agility through its component of SC flexibility directly affects SC performance under disruption. flexibility is directly influenced by SC velocity and indirectly influenced by SC visibility. SC agility through its component of SC visibility positively influence SC velocity and SC robustness. Thus, it can be summarized that the three critical factors for building a resilience SC are agility, collaboration, and robustness.

2.6.1.1 Agility

A SC is said to be agile if it can respond swiftly to a changing and unpredictable business environment. Agility improves responsiveness in both risk mitigation and market response (matching supply to demand). In as much as an agile supply chain implies the end-to-end synchronization of the SC, an agile SC constitute of three components namely: flexibility, velocity, and visibility discussed in the subsequent paragraphs. (Shih-Jung et al. 2021.)

Flexibility: As a component of agility, it should be noted that flexibility is seen as a separate concept from agility in that a flexibility is an indispensable component of an agile SC, but agility is not a requirement for a flexible SC (Nils-Ole et al. 2015). Flexibility is a reactive adaptive capability that allows a SC to adapt to new and volatile requirements by so doing increase customer satisfaction because it is a five-dimensional capability; product flexibility(customization), volume flexibility, launch flexibility (new product introduction), access flexibility (distribution channels) and, responsiveness to target markets all geared towards customers satisfaction. Flexibility is achieved by having strong SC relationships, flexible contracts that makes room for changes in delivery schedules, manufacturing facilities capable of producing multiple products and multiskilled work force. (Nils-Ole et al. 2015.)

Velocity: As a component of agility that directly influence flexibility, it is the ability to ability to speed up reaction time in other to adapt to unexpected volatility in demand and supply to maintain competitive advantage by keeping up with the speed required to respond to customers, make purchase decisions and launch new products (Ali, Mahfouz, and Arisha, 2017). Velocity has the advantages of manufacturing lead-time reduction, increase product launch, and increase customer satisfaction (Nils-Ole et al. 2015).

Visibility: As a component of SC agility that indirectly influence SC flexibility through SC velocity (Nils-Ole et al. 2015), it is the level of accessibility by SC actors to timely and accurate information considered useful to their activities (Somapa et al. 2018), which includes identity, location, and status of entities in transit within the

SC (Nils-Ole et al. 2015). Visibility is achieved through connectivity made possible with the advent of information and communication technologies (ICTs), electronic data interchange (EDIs) and automatic identification technologies (Nils-Ole et al. 2015). Thus, the level of visibility is relative to the level of information sharing.

2.6.1.2 Collaboration

A collaborative SC is one that can respond to a disruptive event by cooperating with partners vertically (vertical collaboration) or horizontally (horizontal collaboration) along the SC through joint planning, sharing critical and useful information and, sharing intelligence to coordinate the immediate action (Ali et al. 2017). SC collaboration helps to build synergies amongst SC partners and requires real time information exchange and decision synchronization; and the basis for collaboration is for interorganizational partners to achieve mutuality of benefits (increase level of visibility, flexibility, and shorter lead times), rewards, and risk-sharing (Scholten, and Schilder, 2015). As per Cao, Vonderembse, Zhang, and Ragu-Nathan (2010), elements of collaboration include information sharing, goal congruence, decision synchronization, incentive alignment, resource-sharing, collaborative communication, and joint knowledge. Information sharing is the key element of SC collaboration as it is the element that integrate all other elements.

2.6.1.3 Robustness

Shih-Jung et al. (2021), holds that, robustness in SC is a proactive absorptive capability of resistance (through anticipating/forecasting possible future changes) and avoidance (through readiness/preparedness/resistance to forecasted changes). It is the ability of a SC to continue its operations during and after a disruption achieved by proactively configuring the SC network density and complexity, critical location, product design, supply base strategy and, segmenting the SC over a wide range of possible scenarios thus, designing a value-creating SC network structure that can withstand and cope with disruption (Ali et al. 2017).

3 RESEARCH DESIGN AND METHODOLOGY

This section of the research will discuss the selected research methodology and how the research was carried out. The first subsection will describe the selected research design used in answering the research questions of this research. Followed by an insight to the data collection methods used (why chosen the data collection method, how the data was collected, and the steps taken by the researcher to ensure credibility of the results).

3.1 Case Description and Context of the Study

This section will analyze ways in which the SCDs caused by COVID-19 pandemic differ from other disruptions, providing a background study to the case company as well as justifying why the researcher choose the unequal mixed research methods in executing this research.

3.1.1 How COVID-19 SCD Differ from Others

The COVID-19 pandemic exhibits some significant differences when compared with other supply chain disruptions (see table 1 below). These differences have called for supply chain managers and researchers to revisit the SCM strategies. As the COVID-19 pandemic has been an eye opener to the existing SCM strategies loopholes. the subsequent paragraphs will discuss the different dimensions in which COVID-19 differs from other SCDs and how they are different as per Moritz (2020) Geographically, COVID-19 pandemic is widespread and global, impacting all regions causing global disruption while most other disruptions are confined to a locality or region. With every region worldwide simultaneously affected with COVID-19, transfer of resources as aid is practically difficult as opposed to other disruptions where resources are transferred from the non- affected regions to the affected regions

Secondly, COVID-19 pandemic is widespread in scope impacting every sector as

well as both goods (like toilet paper) and services (haircuts, restaurant meals). Knock on closure of sporting events, cruise ships, schools/universities, etc. while other disruptions are limited in scope with fewer industries affected (i.e., a hurricane disrupts the petrochemical industry). COVID-19 brings global SC to a standstill since every sector is affected and companies are interdependent. COVID-19 pandemic has a ripple effect on SC.

Thirdly, looking at the demand and supply volatility, COVID-19 pandemic impacts demand, and possibly supply while other disruptions most often impact supply and rarely but sometimes demand. COVID-19 impacts SC chain greatly as the demand for services declines e.g., the cancellation of international flights for both safety measures as well as declining demand. With COVID-19, the shift in demand of certain items has led to shortages, rationing, prioritization and reduction in the number of stocks keeping units (SKUs).

Also, on the level of historical data and experience and prior planning, COVID-19 pandemic is one of a kind in the history of mankind with little or no planning and no experience available while other disruptions occur with existing disaster planning and prior experience is available. Lack of experience with such SCD made prior planning inefficient.

Furthermore, looking at the difference based on financial system, COVID-19 exhibits high correlation with global financial system while other disruptions exhibit low to moderate correlation with global financial system. COVID-19 can be compared to the 2007/2008 global financial crisis. But they differ in that with the financial crisis, demand was less while supply was more while COVID-19 impact global stock markets as well as forcing central banks to implement unprecedented measures to assist the economy.

More so, while COVID-19 pandemic calls for long-term emergency service needs (i.e., hospital beds, ventilators), other pandemic requires short-term needs for emergency services (i.e., flood rescues). COVID-19 pandemic is longer and uncertain. and as such makes the SC uncertain.

Finally, on the level of human impact and behavior, COVID-19 pandemic comes with widespread human impact, with unknown duration and unknown impact. While with other pandemics comes with invisible/unknown public fear risks, human impact with limited duration. Public fear is short-term, and most risks are visible (i.e., experiencing a tornado or earthquake). Some sectors experience the bull whip due to human behavior and not actual increase in demand.

Table 4: How COVID-19 differ from other SCDs (Moritz 1-4, 2020)

| Dimension | Other Disruptions | COVID-19 |
|-------------------------------|--|--|
| Geography | Mostly confined to a locality or region | Widespread, global impacting all regions |
| Scope | Limited scope. Affecting fewer industries | Widespread scope affecting every sector |
| Demand and supply | Most often impact supply | Impact both demand and supply |
| Prior Planning and Experience | Available planning and prior experience | No prior planning and experience |
| Financial System | Low and moderate correlation with global financial system | High correlation with global financial system |
| Duration | Short-term need for emergency service | Long-term need for emergency service |
| Human Impact and Behavior | Localized human impact with limited public fear is short-term. Most risk are visible | Widespread human impact with unknown duration and unknown impact. Public fear is long term and risks are unknown |

3.1.2 Background Study

The focal company of this research is Polycom Inc. Polycom Inc. now a subsidiary of Plantronics Inc., under the giant name of Poly is a telecommunication company aimed at developing solutions to the different means of communication (audio,

video, and content-documents). It was founded in December 1990 by Brian L Hinman and Jeffery Rodman with headquarters in Santa Cruz, California, U.S.A.

Before acquisition, Polycom Inc. existed as an American multinational company producing audio conferencing speaker phones, content sharing, video conferencing, video network and bridging and, system monitoring and management products with the audioconferencing speakerphones being its first product to be marketed. By 2018 Polycom Inc., had 3451 employees with a revenue and net income of US\$1.2 billion and US\$203.9 million respectively.

Between January 1998 and January 2018 Polycom made 15 acquisitions (see Appendix 1). In April 2016 Mitel Networks was about acquiring Polycom Inc., for \$1.96 billion but the Mitel deal didn't pull through as they went for an all-cash offer of \$1.7 billion from Sirirs Capital Group in July 2016. In December 2018 Plantronics Inc., an American electronic company producing audio communication equipment for businesses and consumers agreed to pay \$36million in Chinese bribery settlement connected to Polycom Inc, after announcing in March 2018 its intentions to acquire Polycom Inc., for \$2billion. In 2019 Plantronics Inc., acquired Polycom Inc., under the name Poly with headquarters in San Jose and Santa Crus, California. Poly is a multinational company with offices located in 35 different countries, more than 6500 employees and more than 1500 patents valid worldwide. It has an annual sale of \$2billion and 500 companies rely on its products and services. (Poly 2020; Polycom 2020.)

The aim of this research as described in the research aim and research questions chapter is to bridge the gap between existing SCRES strategies and post COVID-19 efforts in industries to develop a more resilient/robust supply chain through the exploration of challenges faced by industries during the COVID-19 crisis and suggest proactive strategies that can be implemented by supply chain managers to eliminate/mitigate future risks/disruptions using Polycom Inc. as the case company. Thus, the importance for supply chain managers to understand the extent of the impact of SCDs especially one that is global and what mitigating strategies can be implemented to make their SCs robust. The research focuses more on gaining a

deeper understanding on Polycom Inc. SCRM /SCRES during covid-19 as well as giving it a global touch. As such, an unequal mixed research method leaning more towards the qualitative research method was chosen it well suits the above-described empirical part of the research.

3.2 Data Collection Methods

The commonly used methods in the empirical part of a research, is either quantitative or qualitative whereby, the quantitative research method quantifies the defined variables (such as behaviors) in the research with the purpose of supporting or disproving a hypothesis about a specific hypothesis. Thus, there is a need for a quantifiable (huge) data to prove patterns in the research. Whereas the qualitative research method discovers and provide insights to some real-life phenomenon which can become a possible hypothesis for prospective quantitative research. Thus, the research population is usually smaller than that of quantitative research but must be carefully selected to satisfy a given quota.

This research uses the unequal mixed research methods that leans towards the qualitative research method and as such the data collection methods used are the Individual semi-structured in-depth interview and questionnaires. The subsequent subsections will discuss the individual semi-structured in-depth interview, questionnaire, the sample and sampling methods of the respondents and the interview process and interview guide.

3.2.1 Questionnaire

The response to the questionnaire was obtained from the supply chain analyst of Polycom Inc. who has approximately 10 years' experience in the field and with the company. The questionnaire focusses on two aspects of risks which are the consequences of every event or action taken by the company and the probability of such happening as well as some open risk management related questions. Aside the open questions mostly related to the environmental risks, the responses were grouped into four main sections related to the different risk types namely, demand

and supply side risks, logistic risks, and financial risks. Such were rated on a scale from 1–5. The scale was as follows: 1- No effect, 2- Minor, 3- Moderate, 4- Major, 5- Catastrophic and 1- Very small, 2- Minor, 3- Moderate, 4- Major, 5-Very large for consequences for the company and probability of occurrences respectively.

3.2.2 Individual Semi-structured In-depth Interview

This study focuses on understanding the level of company resilience in the light of SCD's with particular focus on the COVID-19 pandemic and Polycom Inc. as well as suggest proactive strategies that can be implemented by supply chain managers to eliminate/mitigate future risks/disruptions. This requires inside information on how the company deals with such issues (SCD's) to become resilient which cannot be acquired by mere observation but rather through information from experts in SCM within the company. This is the reason why individual semi-structured in-depth interview and questionnaire was chosen as the most suitable method for data collection.

The individual semi-in-depth interview method of data collection allows the expert to express themselves freely, deeply, and subjectively on how they implement certain SCRM strategies and the outcome of such strategies. The interviews are being conducted in a manner that create the conversation. Although no specific order is being used in asking the question, an interview guide is being used to ensure that every important topic is being covered. Thus, the interview with the supply chain analyst was different from that of the IT specialist.

3.3 Interviewee's Selection

For data collection, the researcher needed data sources. Respondents to interviews and questionnaires were the data sources for this study. The researcher applied purposive/judgement/selective/subjective sampling technique. Purposive sampling technique is a sampling technique commonly used with qualitative research to select information-rich respondents associated to the research topic (Patton, 2001). Usually, the selected respondents are conversant and or have experience with the

research topic (Patton, 2002), and such selection is based on the researcher's judgement.

To select a credible respondent, the researcher from the purposive sampling design used expert sampling and Criterion sampling which involves respondents who can provide insight response through their knowledge, experience, and expertise about the topic and some pre-established criteria for selection respectively. The predetermined criterion is that the respondent needs to have been with the company for at least 7 years (minimum time to have experience at least one SCD) and should work within the SC or the IT department of the company.

At the end of the sampling process, the researcher had a total number of two respondents. One respondent from the supply chain department and one from the IT department.

3.4 Interview Process and Guide

Due to travel restriction caused by Covid-19 pandemic both interviews were conducted online through Microsoft meeting as well as the questionnaire which was done online using google forms. Because the respondents were all vested with the topics as professionals, their responses were so feasible and conversational and took approximately 40mins each.

During the interviews, all topics in the interview guide were covered and in situations where the interviewer was not quite satisfied with the response because it was either shallow or not touching the exact area of interest, the interviewer would ask a follow-up question to get a more specific or in-depth information (Patton, 2002). Both interviews were conducted in English. To ensure that every critical information was not overlooked or left out and to keep both the interviewees focused on the interviews, both interviews were recorded with the consent of the interviewees (Sullivan, 2010; CSR-Center for Strategic Research Boston, 2006). To stay on course, an interview guide was used that constitute important questions within the research question while to avoid short and shallow answers, the why- questions

were avoided but not eliminated and mostly descriptive questions were being used.

3.5 Data Quality

Although the research method used in conducting this research is a mixed (hybrid) research method, the researcher did not utilize statistical procedure to arrive at its findings but rather engaged in interpretivism (interpretive research method). With interpretivism same data can result to different conclusions from different researchers and as such ensuring trustworthiness/rigor is challenging (Pratab, 2018). The subsequent paragraphs will discuss measure put in place by the researcher to ensure the trustworthiness and relevance of this research.

First, the researcher provides the reader with detail description of the research process as well as all data used in arriving at the conclusion to enable the possibility of the study being repeated in similar setting and context (Lincoln & Guba, 1985). Also, movement restrictions and social distancing requirement made it impossible for the researcher to conduct a triangulation across methods (Wallendorf and Belk, 1989), but rather the researcher conducted online interviews that were recorded and later transcribed. To ensure quality and credibility, the choose the respondents using purposive sampling to select information-rich respondents associated to the research topic (Patton, 2001), and who are conversant and or have experience with the research topic (Patton, 2002).

4 FINDINGS

In this section, the results of the study will be discussed with the focus on answering the research questions. The first section of this chapter (4.1 - 4.3) will answer RQ1, while the second section of this chapter (4.4) will answer RQ2.

4.1 Supply Chain Risks that Threaten Polycom Inc.

From the questionnaire and the interviews, the researcher identified the supply chain risks that threatens Polycom Inc. and the existing mitigating strategies.

Like every other company operating now a days in the global business world both internal (Operational) and external (disruption) risks threatens its operations but what differentiates them is the probability of occurrence and the level impact such has on a particular firm. Although this study center around SCD at Polycom caused by the Covid-19 pandemic (external risk), it is worth noting that Polycom also face operational risks in the running of its day-to-day activities. The subsequent paragraphs will identify and analyze the risks (internal and external) that threatens Polycom based on their probability of occurrence and their impact on the company using matrix derived from the response of a questionnaire done by the supply chain analyst at Polycom.

4.1.1 Demand Related Risks

Demand related risks illustrate the level of efficiency in a company's forecast. The risk matrix on figure 13 below, derived from table 5 below illustrates that the company is good at its forecasting game in that looking at the matrix, it ranges between minor and moderate risks with no critical risk. Most of the demand related risks are of lower probability of occurrences but moderate to major impact. With such level of demand related risks, it is of importance for the company to practice continuous monitoring and management of such risks to avoid them from becoming critical risks which are expensive to manage and monitor and require immediate and mandatory actions.

Despite the zero critical risk relating to demand as per the matrix, the possibility a critical demand risk cannot be eliminated and as such demand related risks needs management attention. Thus, Polycom Inc. experience demand related risks.

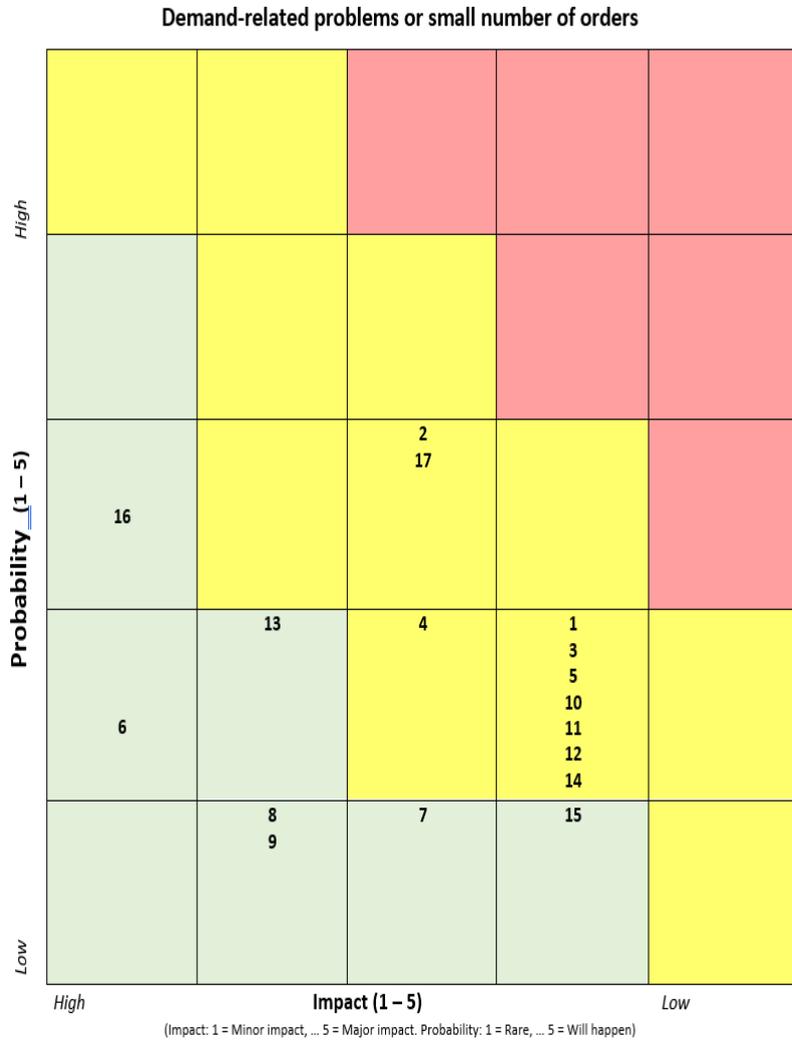


Figure 13: Demand-related problems or small number of orders matrix

Table 5: Demand-related problems or small number of orders data

| Identified Risk | Impact | Probability |
|---|--------|-------------|
| 1. Demand in the business sector generally decreases or the growth of the sector unexpectedly ceases. | 4 | 2 |
| 2. A declining trend begins in a region with a significant number of end clients (the clients of the company's client). | 3 | 3 |
| 3. The competitive strength of the client's products diminishes. | 4 | 2 |
| 4. Orders are larger than predicted. | 3 | 2 |
| 5. Orders are smaller than predicted | 4 | 2 |
| 6. The client's new product model or its timing in the market fails. | 1 | 2 |
| 7. An end client does not trust the client's network capacity. | 3 | 1 |
| 8. The ownership of the client company changes, or the client becomes merged with another company. | 2 | 1 |
| 9. The client reduces the number of suppliers, e.g. in order to increase delivery size. | 2 | 1 |
| 10. The client's demands pertaining to technology or volume change and the company is unable to meet the new requirements. | 4 | 2 |
| 11. The company loses the client's trust as a result of insufficient delivery reliability. | 4 | 2 |
| 12. The company loses the client's trust as a result of issues related to quality. | 4 | 2 |
| 13. The company loses the client's trust as a result of disclosure of confidential information. | 2 | 2 |
| 14. The client chooses a more competitive supplier from the outside of the network; for example, a large international corporation is expanding its market share. | 4 | 2 |
| 15. The position of the company in the client's network deteriorates due to a lack of resources for internationalization required by the client. | 4 | 1 |
| 16. The company expands to the international market with the client, but the demand does not meet the expectations. | 1 | 3 |
| 17. The company's volume of orders is reduced because problems pertaining to delivery or capacity occur in the network. | 3 | 3 |

4.1.2 Logistics Related Risks

As per table 6 and the matrix below on figure 14, it is evident that Polycom Inc faces threat from logistics related risks due to insufficient stock to fulfil demand as is the case during the Covid-19 pandemic where the company experience a huge amount of backlog of approximately 80 million dollars due to lack of inventory during the pandemic and temporary capacity shortage to meetup with delivery time. Logistics related risks at Polycom as per the matrix has a high probability of occurrence and a significant level of impact but still not in the red zone (critical zone). As such, the company needs to re-strategize, monitor, and manage its logistics related risks as majority of such are within the yellow zone with a few within the green zone.

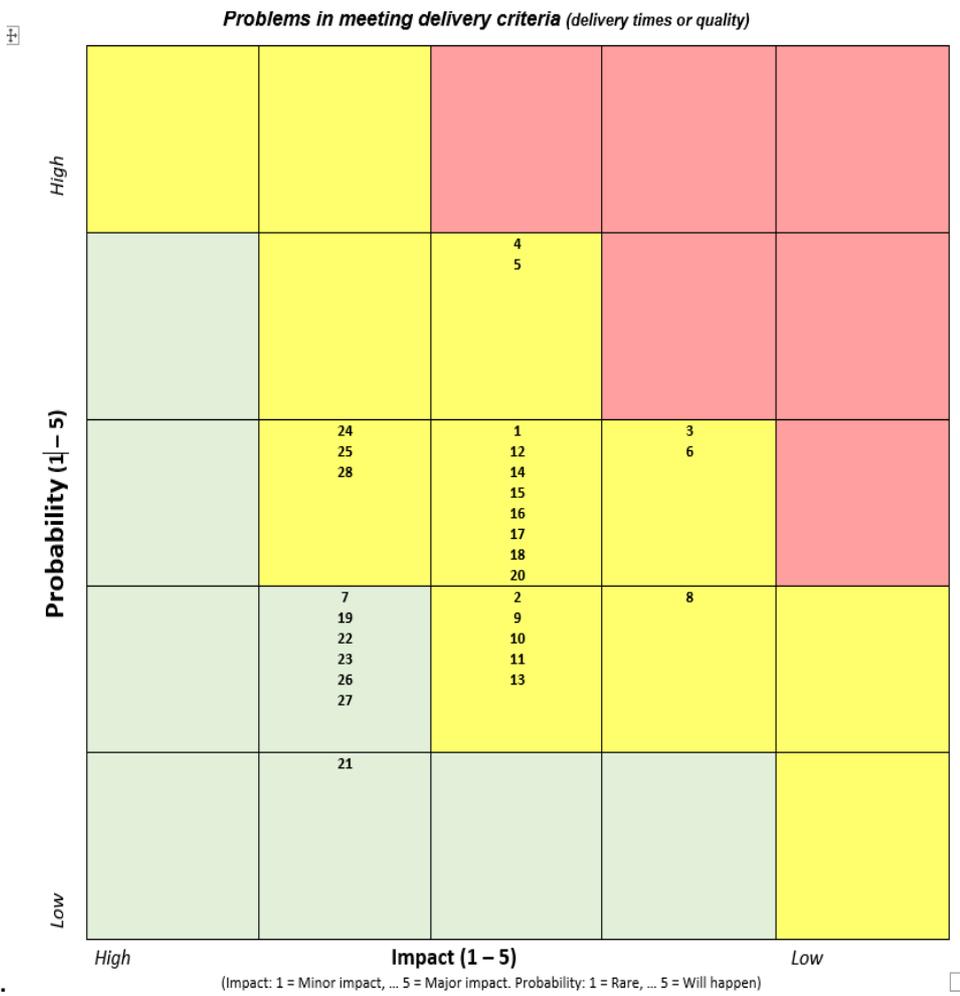


Figure 14: Problems in meeting delivery criteria (delivery times or quality) matrix

*Table 6: Problems in meeting delivery criteria (delivery times or quality)
data*

| Identified Risk | Impact | Probability |
|--|--------|-------------|
| 1. Defaults in product planning cause problems in meeting delivery expectations. | 3 | 3 |
| 2. The company's ability to manage projects is insufficient for large-scale deliveries and deliveries requiring extensive knowledge of technology. | 3 | 2 |
| 3. Errors and usability of the company's ERP system negatively impact the meeting of delivery requirements. | 4 | 3 |
| 4. Insufficient stock prevents the fulfilment of delivery requirements. | 3 | 4 |
| 5. Deliveries are delayed due to a temporary capacity shortage (insufficient machinery or staff capacity). | 3 | 4 |
| 6. Long-term machinery or staff capacity is insufficient to meet increasing production. | 4 | 3 |
| 7. Recurring unexpected problems and interruptions in production resulting from, for example, long setup times or new product models | 2 | 2 |
| 8. Insufficient production equipment service reliability and performance (possibly no redundancy, expensive replaceable parts, they cannot be procured quickly enough or difficult to repair). | 4 | 2 |
| 9. Production delivery cycle is too long, or its predictability varies greatly. | 3 | 2 |
| 10. Too vast product range makes production process difficult to control. | 3 | 2 |
| 11. The company experiences problems in meeting the client's quality criteria. | 3 | 2 |
| 12. Raw material in stock is useless (outdated) or otherwise inappropriate for the end products. | 3 | 3 |
| 13. The fulfilment of delivery criteria is difficult due to staff incompetence. | 3 | 2 |
| 14. Problems in recruiting competent workforce. | 3 | 3 |
| 15. The company loses a key person or persons. | 3 | 3 |

| Identified Risk | Impact | Probability |
|--|--------|-------------|
| 16. The company is unable to meet new tighter delivery times set by the client. | 3 | 3 |
| 17. Problems occur in the network resulting from inaccurate forecasts. | 3 | 3 |
| 18. Deliveries are delayed or erroneous due to incompatible information systems of the companies. | 3 | 3 |
| 19. The client's product life cycles (ramp-up/ramp-down) do not match plans. | 2 | 2 |
| 20. Significant quality problems are not detected prior to delivery to the end client. | 3 | 3 |
| 21. Client product specifications are inaccurate or erroneous. | 2 | 1 |
| 22. The network is unfamiliar with the usage environment of the end product. | 2 | 2 |
| 23. Information regarding changed product requirements is not communicated in the network. | 2 | 2 |
| 24. Delivery problems arise from the delivery reliability of the company's subcontractors. | 2 | 3 |
| 25. Delivery time of the company's subcontractors or material suppliers is too long. | 2 | 3 |
| 26. The availability of a critical (affordable, hard-to-find or hard-to-replace) material has not been secured and the material is unavailable when needed. | 2 | 2 |
| 27. Issues in the availability of external services example, planning, information systems, maintenance or subcontractors' machinery or production methods). | 2 | 2 |
| 28. A partnership fails (e.g. a material supplier is unable to comply with contract terms or is out of business or the subcontractor's predetermined reserve or extra capacity is inadequate). | 2 | 3 |

4.1.3 Financial Risks

The risk matrix on figure 15 derived from table 7 indicates the threat from finance related risk on Polycom which are mainly from the increasing price of raw materials and labor costs exhibiting high probability of occurrence with 4 points and a significant impact to the company of 3 points. Most of the finance related risk with high impact such as rapid increase in interest level and wrong investments have low probability of occurrence. Thus, Finance related risks requires Polycom’s monitoring even though they fall within the green and yellow.

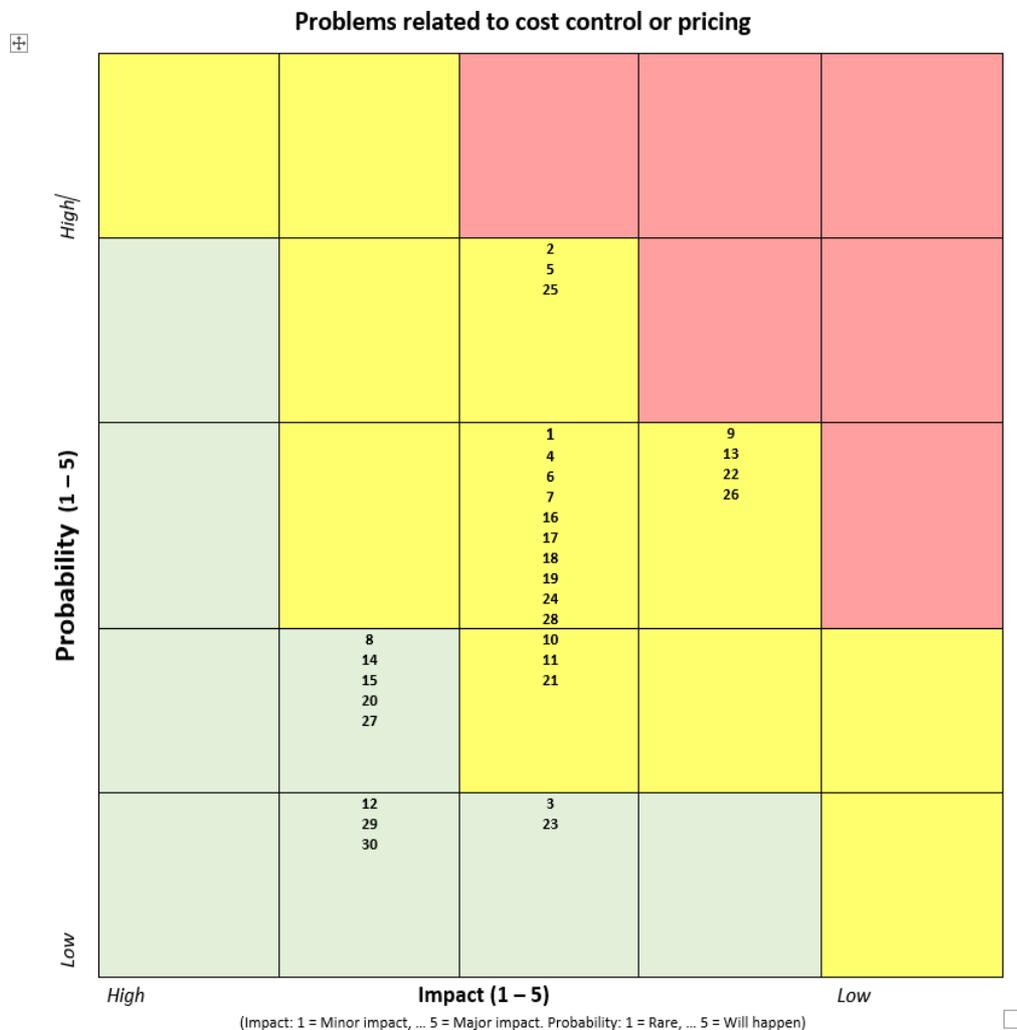


Figure 15: Problems related to cost control or pricing matrix

Table 7: Problems related to cost control or pricing data

| Identified Risk | Impact | Probability |
|--|--------|-------------|
| 1. Cost accounting is providing unreliable information on output-based costs. | 3 | 3 |
| 2. The price level of raw materials or procured components rises significantly. | 3 | 4 |
| 3. The company does not receive a price benefit for acquisitions as the main acquirer. | 3 | 1 |
| 4. The price level of the company's subcontractors increases. | 3 | 3 |
| 5. Labour costs increase. | 3 | 4 |
| 6. Expenses do not correlate with volume fluctuations. | 3 | 3 |
| 7. Low predictability of demand causes extra costs. | 3 | 3 |
| 8. Quality defaults cause wastage expenses. | 2 | 2 |
| 9. The production equipment of the company is incapable of cost-effective production. | 4 | 3 |
| 10. Working capital becomes too large as the business volume increases. | 3 | 2 |
| 11. As a result of larger wholes, working capital increases. | 3 | 2 |
| 12. Responsibility for buffer stocks is shifted from the client to the company. | 2 | 1 |
| 13. Investments become too large in proportion to the resources of the company. | 4 | 2 |
| 14. Internationalisation or pressure to internationalize cause great investment needs. | 2 | 2 |
| 15. The cycle of investments is accelerated. | 2 | 2 |
| Identified Risk | Impact | Probability |
| 16. A wrong type of investment is made. | 3 | 3 |
| 17. Investments are focused on too narrow a field of expertise, for which there is no use in the future. | 3 | 3 |
| 18. Investment criteria prove to be erroneous, i.e. estimated investment income or expenditure is not realized as estimated. | 3 | 3 |
| 19. Expansion investments increase the company's debt-equity ratio. | 3 | 3 |
| 20. A client-specific investment is made, for which, after a product has failed, there is no use. | 2 | 2 |
| 21. The company is pressured to make larger investments. | 3 | 2 |
| 22. Interest level increases rapidly. | 4 | 3 |
| 23. Exchange rate fluctuations cause interest losses or margin problems. | 3 | 1 |
| 24. Financing is a significant bottleneck in the development and expansion of the company. | 3 | 2 |
| 25. The pricing policy of the company fails. | 4 | 2 |
| 26. Price competition in the sector gets out of control. | 4 | 3 |
| 27. The client has great control over the product price. | 2 | 2 |
| 28. Prolonged decline of prices weakens the profitability of the company because the company is unable to rationalize its operations at the same pace. | 3 | 3 |
| 29. The client requires an unrealistic price reduction on a short notice. | 2 | 1 |
| 30. The company is unaware of the additional value of the product to the client. | 2 | 1 |

4.1.4 Environmental Risks

Environmental is also another risk that threatens Polycom although the probability of occurrence is very low and the impact on the company be it positive or negative is very high. Although there have existed other environmental risks in the past years that affected Polycom, those environmental risks were mostly geographical, and the effect were insignificant because Polycom Inc. was able to source from the non-affected regions. With the current Covid-19 Pandemic the risk is at the critical zone (red zone). It is one of a kind in the history of mankind with a very high impact on different SC aspects such as labor / material shortages and demand volatility.

4.2 Polycom Inc. SCM Strategies

This section of this chapter will discuss Polycom Inc SCM strategies in the areas of Manufacturing, Logistics/inventory management and sourcing/supplier relationship strategy.

4.2.1 Manufacturing

During the interview the topic of manufacturing was approached and discussed to understand what kind of manufacturing Polycom Inc. is practicing and the impact of such manufacturing decision on the company SC during the COVID-19 Pandemic. It was gathered that Polycom Inc. is practicing offshore manufacturing. Polycom never had any manufacturing plant before becoming a subsidiary of Plantronics Inc. but rather all its manufacturing activities were being outsourced to other companies like FOSCAM. Thus, Polycom Inc. comes in with the technology on video collaboration and telephony while the outsourced company takes care of the manufacturing of the needed equipment's. When Polycom Inc became a part of Plantronics Inc. in 2019, manufacturing became a subject of greater concern to Polycom because Plantronics whose main area of business was the headsets owned its manufacturing plant offshore and lately, the come company has come up with a strategy to find ways to start the manufacturing of video conferencing equipment's which now only refurbish conferencing equipment. Polycom Inc as a subsidiary to Plantronics Inc. does not have any domestic manufacturing facility but

rather has a single manufacturing plant offshore in Mexico- Tijuana that manufactures headsets, and it is amongst the biggest employer in that part of Mexico.

Due to fact that COVID-19 was a global pandemic that hits every nation and as such caused nations to shut down factories to contain the disease, Mexico was not left out as it shut down every factory that were considered non-essential manufacturers. Mexico being the sole manufacturing plant to Plantronics/Polycom Inc., a shutdown of this plant creates a major SCD to the establishment which managed to proof to the Mexican authority that the headsets were also essential equipment as it allows people to continue working from homes to keep the economy going. As such, the headset manufacturing plant in Mexico was operational during the pandemic but on a reduced scale of 60% to maintain a safe distance in the factory as well as a relay of the manufacturing plant in terms of workflow system. Thus, Polycom Inc. practice centralized manufacturing as opposed to decentralized manufacturing with a single manufacturing plant in Mexico.

4.2.2 Logistics / Inventory Management

Polycom Inc. operates a separate service department that mostly deals with warranty agreement that contributes hugely to the company's finance as it brings in almost 70 million US dollars per quarter. With such warranty service, Polycom during sales of a product to an end user, the end user is made an offer to buy a warranty which can either be a full or partial coverage on damages to the products within a given period from the date of purchase. Based on the agreement (e.g., 30 days replacement or advanced replacement), the company receives the defective product and send a refurbished product to the customer but if it is a dead-on arrival case then a brand- new product is resent to the customer and the defective product would be received by the company from the customer. This service sector of Polycom Inc. ensures that the replacement time span indicated in the warranty agreement are met. As such Polycom inc. has built a robust reverse supply chain system where they have warehouses located in the key regions that are responsible to fulfill the orders of all service agreements that the company has made with its

customers. This sector that does not only keeps the company afloat but also helps maintain a long-lasting relationship with customers which highly succeed from the company's high degree of responsiveness made possible by good inventory and logistics management.

Polycom Inc. as above mentioned, concentrates its manufacturing on one plant located offshore as such the company needs to have an efficient logistics/inventory management strategy to avoid SCD in the flow of goods. To achieve this, the company has logistics hubs in the areas where they carry out business all over the world where products are being shipped to from the production plant in Mexico. The largest logistics hubs are in Mexico itself and Czech Republic. Also, there are logistic hubs in Thailand, China, and Mainland America- San Diego.

The company has partners who owned warehouses that manages the company's inventory. With such partners the company has pipeline inventory. Before the pandemic the company had a lot of pipeline inventory with its partners and since such does not bring in revenue to the company but rather increase costs, the company decided just before the pandemic to reduce such inventory by selling some at a cheaper rate and others were bought back (buybacks) by the company. This act of the company cut down operational cost (cost of holding goods) to millions of dollars. The decision by the company to reduce inventory was done on a wrong timing in that just soon after the decision the pandemic hits. With the pandemic, orders for products increased and the increase could not match the available pipeline inventory from where the company could have sourced from. This trade-off decision between inventory and risk was a failure in that it contributed to the company having huge amount of backlog of approximately 80 million dollars due to lack of inventory during the pandemic. Thus, inventory is a necessary evil in modern day SC.

4.2.3 Sourcing / Suppliers Relationship

Polycom Inc. practice both single sourcing and multiple sourcing in their procurement. While single sourcing strategy involves a single supplier for a

particular component, multiple sourcing strategy involves two or more suppliers for a particular component or material. Even though many components needed by Polycom Inc. during its manufacturing are sourced using a multiple sourcing strategy some highly strategic, expensive, and difficult to manufacture components are sourced using a single sourcing strategy such as the chips. With single sourcing more than one supplier exist in the market but only one happens to meet the product specification desired by the company. Despite the risk associated with single sourcing there exist instances where Polycom Inc. must go in for single sourcing as in the case of chip which is a highly strategic component for the manufacturing. To implement this single sourcing strategy effectively to avoid opportunistic behaviors, Polycom Inc. creates strategic partnership with such suppliers which goes a long way to create higher level of trust and cooperation. One of Polycom Inc. strategic partner with whom they have built a long-term non arm's length relationship is Celestica Co. Ltd located in Thailand and produces computer, electric equipment, telecommunication, and medical devices. Thus, establishing strategic partnership with some of its suppliers is important to the sustainability of the company in that supplies are always guaranteed due to the strong collaboration between the two firms.

4.3 The Implication of Digital Transformation on Polycom 's Supply Chian.

Technology has played a great role in the resilience of Polycom's SC in that it has increase the level of visibility along the SC. There has been a continuous growth in the technological aspect of Polycom's supply chains which has upgraded from premise database to cloud database system.

Originally, Polycom Inc used PeopleSoft Software to manage its human resource, Finance, supply chain, customer relationship, and enterprise performance (HRMS, FMS, SCM, CRM and EPM respectively). Because PeopleSoft was bought over by Oracle and Oracle could not support PeopleSoft, Polycom had to purchase a new ERP (Enterprise Resource Planning) system to fill the gap, and this was Oracle Revision 12 commonly known as R12.

In addition to the central Software, Polycom Inc has a peripheral systems that links to the central ERP system such as the Salesforce management system for customer relationship management (CRM), Cybele Software for information access and system integration as well as warehouse management system (WMS) own by Polycom's logistics provider that communicate with Polycom's ERP system providing Polycom Inc. with a robust ERP system that integrates all parts of the business in a manner in which transaction done in one department is automatically updated in every other system/department within the company they increasing visibility within the company.

The implication of digital transformation on Polycom's SC includes increase flexibility while making the company's data accessible, provide opportunity and direction to work in an integrated manner, shortened delivery time improved demand forecast with the use huge database and simulation and a better customer relationship interaction.

4.4 Loopholes on Polycom's Existing Supply Chain Strategies

From the above findings on the existing mitigating supply chain strategies of Polycom's Inc., this paper identifies some loopholes in such strategies which answers the second research question

Looking at the above SC strategy of Polycom which includes, single sourcing for strategic components and multiple sourcing for other less strategic products, Offshore manufacturing and outsourcing, and pipeline inventory with partners who own warehouses as a way of securing stock, it is evident that there exist some loopholes in the existing SC strategies of Polycom Inc., which create space for a lag in its level of SCRES as has been proven by the difficulties faced during the COVID-19 pandemic as they faced SCD during this period. The subsequent paragraphs will discuss the loopholes existing in Polycom's existing SC strategies.

Firstly, Polycom Inc. has not just offshore manufacturing but also just a single manufacturing plant located in Mexico which though has the advantage of reduced production cost (overhead cost) especially from cheaper labor cost in Mexico that

reduces the variable cost as units produced increases, it presents a loophole in its SC strategy in that it reduces its level of resilience in that should the facility become unavailable because of disaster such as flood, earthquake, hazardous material release or disease/pandemic then there will be a disruption in its SC. As such, the SC strategy of single manufacturing and offshore manufacturing with the absence of domestic manufacturing does not cover contingency planning.

Secondly, Polycom Inc. Sourcing strategy generally looks good because most components are sourced from multiple suppliers although there exists a certain component (chip) that is only sourced from a single supplier which poses a threat to the SC should anything happen to the supplying firm especially since the chip is the most essential/critical component of Polycom's products. With the case of a single supplier which Polycom salvages by creating a strategic relationship with the supplier, it still poses a loop in its strategy due to a high level of dependency. Also there exist a loophole in Polycom's SC strategy in the level of traceability in the origin of products in its supply chain which is the third tier as this limits Polycom's understanding of products that are affected should something happens to a certain region.

Finally, Polycom's existing SC strategy experiences a loophole in its logistics/inventory management domain in that being a company that has only one manufacturing plants owned by the company and other manufacturing companies that supply products to the company but not owned by the Polycom (Celestica in Thailand) inventory management should be prioritize. The company should ensure that stock is always available irrespective of the fact that holding inventory increases cost and creates redundancy because holding inventory always ensure availability of products. Failure in inventory management is proven during the COVID-19 pandemic in that due to the lack of inventory because Polycom bought back most of the pipeline inventory held by its partners while some of the inventories were sold at a cheaper cost, when the COVID-19 pandemic hit, Polycom had lots of orders which they could not fulfill and as such had back orders (backlog) worth 80 million dollars

5 RECOMMENDATIONS AND CONCLUSION

This chapter will answer the third research question while making suggestions on how Polycom Inc. can improve its SCRES as well as concluding statements.

5.1 *Recommendation*

The measure taken by Polycom Inc to improve its existing supply chain risks management strategies is by increasing the number of strategic partners. They are building more collaborative relationship with partners/suppliers they previously had arms-length relationship with. This is to increase responsiveness and visibility in their supply chain.

Domestic manufacturing is critical to maintaining emergency supplies which thus increase the degree of responsiveness of a company. Responsiveness of a supply chain being one of the prerequisites of a resilient and robust supply chain. Polycom Inc. with only one manufacturing plant in Mexico which makes it an offshore manufacturing cannot boast of achieving responsiveness in situations like the COVID-19 pandemic if the Mexican government choose not to categorize their product as essential products during the pandemic. I would suggest that Polycom Inc. should invest in domestic production to increase its level of responsiveness.

Polycom Inc. practice sole, single, and multiple sourcing. In the case of Sole and single sourcing they engage in strategic partnership / collaboration with their suppliers to build trust and loyalty with their suppliers so that in situations like the COVID-19 pandemic which reduced production in almost every company, Polycom was sure to be prioritized in its supplier's list of customers based on its relationship with the supplier. Polycom has very limited strategic relationship with suppliers of product that they source from multiple suppliers which made sourcing of such components difficult during the pandemic. Looking at the above and because visibility is a prerequisite for a resilient supply chain, knowing that collaboration with suppliers increase visibility I would suggest an increase the number of suppliers with

strategic partnership/ collaboration.

For Polycom Inc. to be proactive in its risk management strategies, I would suggest that they should invest in simulation creating different disruption scenarios to estimate how such can affect the company's operations and create measures to mitigate or avoid such effect.

The huge amount of backlog during the COVID-19 pandemic indicates that the company did not have enough stock in holding to satisfy customer demands. As such, I would suggest Polycom Inc. increases its level of inventory.

5.2 Discussion and Conclusion

It is worth noting that SCD can affect one or more SC links (supplier relationships and sourcing, procurement and purchasing, inventory management, demand planning, manufacturing, warehousing, and transportation) depending on the nature of the disruption. The big question behind resilience is, if companies understand the potential risks within their supply chain and if they have proactive measures (Contingency plans) in place based on such risk profile?

Even though every disruption is different and constitute different set of risks, it is still possible for companies to prepare for the most likely types of disruptions and to estimate how such can affect the company's operations. Thus, every company needs to build a resilient supply chain. A company is said to be resilience if it can recognize, react, and recover and grow from a disruption in supplier network in a timely manner. To effectively achieve this, the company needs to have preplanning (proactive measures), real-time information sources and fast decision skills from existing data. Thus, visibility across the SC network at every tier and the ability of a firm and its partners to react to opportunities/exceptions/disruptions in a consistent, unified, swift, and collaborative manner to achieve customer satisfaction and limit SC costs is the backbone of a resilient supply chain. Thus, agility, collaboration and robustness are the main factors essential for a resilient supply chain. Now a days SCRES does not only constitute effective risk management ability but goes further

to include the ability to be better positioned than competitors in risk management strategies in such a way that a disruption can even pose an added advantage to the company rather than a complete disadvantage.

This research also contributes to the theory of supply chain resilience by exploring the gap difference between a pandemic related supply chain disruption and other supply chain disruptions and how existing supply chain risks management strategies can be re-strategize to be robust and resilience in every disruption situation by simultaneously considering the possibility of a pandemic related SCDs and other SCDs

The results of this study have several practical implications for managers and firms, and higher educational institutions and training bodies. According to the results of this study it is recommended that managers and firms should put in the same attention, effort, and resources in SCRM measures aimed at mitigating pandemic related SCDs as they do for other SCDs because of the catastrophic impact if such occur though not frequently as other SCR. Such recommendations include increased number of strategic partners as opposed to arm's length partners, multiple sourcing as opposed to single sourcing, domestic manufacturing as well as offshore manufacturing and always holding inventory. Becoming more resilient in SC has become a strategic priority for firms and they turn to academia for a solution. As per the finding of this study, higher education institutions can assist firms in their quest to improve resilience by giving more attention to techniques for improving supply chain resilience antecedents in their supply chain management curriculums.

In a nutshell, it can be said that Polycom Inc. now a subsidiary to Plantronics Inc. has a resilient/robust SC despite the existence of some loopholes as proven from the research findings and the impact of the COVID-19 pandemic which hits every company around the globe. It was discovered in the findings that Polycom Inc. just before the COVID-19 pandemic overlooked the necessity of holding stock (inventory) but rather attempted to lean more on JIT (just in time) production to reduce expenses derive from inventory and to increase income. As such, the company faced the consequences of lack of inventory to satisfy customers demand

during the pandemic which disrupted production and movement of goods leading to backlogs worth approximately 80 million dollars. The findings also highlighted the loophole that exists in Polycom Inc. manufacturing in that it practiced only offshore manufacturing and outsourcing with no domestic manufacturing which has shown a negative impact on the company's SCRES as seen in the situation of the COVID-19. Aside from the weaknesses that existed in Polycom's inventory management and manufacturing strategies, the findings also showed that Polycom Inc. needs to build more strategic partnerships with its suppliers and reduce arm's length relationships.

Despite the above-mentioned loopholes in Polycom Inc. SCRES the company still has a good level of resilience that with the COVID-19 pandemic that has mainly had a negative impact on most companies Polycom Inc. was able to pull through and is now in a better position than before in that, its revenue has increased by about 30%, increase in employees' bonuses, payback of most of the company's loan, increase in share prices and buybacks. Thus, Polycom Inc. exhibits the existence of all the critical supply chain resilience factors of agility, collaboration and robustness in its SC and shows signs to have positively gone through all the three phases (react, recover, and growth) of a disruption by anticipating, quickly adapting, and responding, recovering, learning, and growing through the COVID-19 pandemic SC disruption.

This study sheds light on the gaps that exist in SCD and SCRES and how managers can assist their firms in improving supply chain resilience with consideration of pandemic-related disruption. However, using only one case company to collect data collected at a single point of time is a limitation to the study. Further research is encouraged to test the findings of this study using longitudinal data collected from multiple firms in other industrial sectors in different countries, which could increase the generalizability of the results obtained in this study. This research does not detailly analyze the implications of technology on supply chain resilience. This constitutes an important research avenue that is yet to be explored.

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APENDICES

Appendix 1: Polycom Inc acquisitions between 1998 and 2018

| Acquisition date | Company | Acquired company business |
|------------------|-----------------------------------|---|
| January 1998 | ViaVideo Communications Inc. | appliance-based video communications systems |
| December 1999 | Atlas Communications Engines, Inc | integrated access device and DSL routers |
| February 2001 | Accord Networks | provider of next-generation rich-media network products |
| April 2001 | Circa Communications | IP telephony products |
| October 2001 | PictureTel | PC-based video communications systems |
| December 2001 | ASPI Digital | installed voice systems |
| June 2002 | MeetU | web collaboration software |
| January 2003 | VCAS software from AGT | video scheduling and management software |
| January 2004 | Voyant Technologies | voice conferencing and collaboration network solutions |
| August 2005 | DST Media | China-based video networking company |
| January 2007 | Destiny Conferencing | immersive telepresence |
| March 2007 | SpectraLink and KIRK telecom | workplace wireless telephony |
| March 2011 | Accordent Technologies | rich media streaming and management solutions |
| October 2011 | ViVu Inc | video collaboration software |
| January 2018 | Obihai Technology | VOIP audio solutions |

Appendix 2: Interview Guide

What is Polycom Inc all about?

How many manufacturing plants/locations does Polycom Inc. has?

What sourcing strategy does the company uses?

What is covid-19 impact on Polycom Inc.?

Was there any form of layoff due to the pandemic?

Did the company anticipate a pandemic? If No, what strategies has been develop during the Covid-19 pandemic?

What kind of modern technologies are being used by Polycom to enhance supply chain resilience?