Building Resilient Supply Chains: A Risk Management Approach in the Microchip Industry Post-COVID-19

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I would want to take this opportunity to extend my most sincere appreciation to everyone who helped me finish this dissertation during the course of its completion. I show my sincere thanks to my supervisor as he provided guidance, support and construct feedback throughout this journey. I also would like to provide a special thanks to my family and networks for their continuous encouragement and patience during this process. Lastly, I am grateful to my classmates whose contributions have significantly enriched my understanding of building resilient supply chains in the microchip industry.

Abstract

With a focus on weaknesses revealed by COVID-19 and geopolitical tensions, this research looks at supply chain resilience in the microchip industry. It evaluates present risk management systems, points up supplier unreliability issues, and suggests open-minded, distinct plans to improve resilience, thus guaranteeing stability among potential global disturbances in the supply network of “semiconductor industry”.

The research methodology chapter of the study has excavated different methodological tools which are used in the research for the development of the results. The approach and design of the methodological structure were highlighted in the chapter, followed by the research design that is explanatory for the subjective understanding of the values. The data collection process that was used is the secondary method and this has helped in the process of analysis of existing data, which projected extended results.

The literature review also explored challenges in the logistics chain of the “semiconductor industry” such as geographic concentration, demand volatility, and lead time issues. It explored existing risk management frameworks, the Theory of Constraints, and the industry's shift towards resilience and technological advancements.

The findings chapter explored supply network management practices in the “semiconductor industry” that focused on resilience strategies, risk management frameworks, and challenges like supplier unreliability. It emphasised the significance of adaptive strategies and reshoring for enhancing supply chain resilience.

In analysis, semiconductor supply chains highlight adaptive strategies, digitalisation, and decentralisation. It compares findings with existing literature. It emphasised vulnerabilities such as supplier unreliability and geopolitical tensions while exploring industry responses to crises.

The final chapter is based on the conclusion and recommendation of the research by which the overall prospective of the research outcomes was established. The chapter also stated the linking with the objectives and the recommendations, which are actionable and specific to the issues stated in the present research. The chapter has also highlighted the limitations and future research scope, which has developed values for the future implications.

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CHAPTER 1: INTRODUCTION

1.1 Research Problem and Significance and Background of Research Study

1.1.1 Research Problem

Systemic upheavals, most notably the COVID-19, have had a substantial influence on the “semiconductor industry”. Problems have arisen in the supply chain of microchips as a result of variables such as geographical concentration, unreliability of suppliers, and greater demand swings. According to Coherent Market Insights (2024), the “semiconductor industry”'s growth was reduced from 12.5% in 2019 to 0.8%-0.10% in 2020 due to the COVID-19 epidemic. The worldwide deficiency of semiconductors had far-reaching economic consequences, impacting many industries that depend on these essential components, and persisted for more than three years, as reported by the Semiconductor Industry Association (2024).

The need for microchips is on the rise because of technological improvements and consumers' increasing dependence on electronic gadgets, making this an especially urgent issue right now. Despite legislation like the “U.S. CHIPS and Science Act”, which aims to increase country’s in-house production, it is predicted that by 2032, the US share of the semiconductor building industry will only reach 14% (“semiconductor industry” Association, 2024). The analysis states that the United States share would have dropped even further to 8% by 2032 if CHIPS had not been enacted (“semiconductor industry” Association, 2024). Compared to the investment rate before the CHIPS Act, when the US would have received just 9% of worldwide capital expenditures, the US is expected to get 28% of these investments (Varadarajan *et al.* 2024). Concerns about the security and resilience of the supply connectivity are further deepened by geopolitical tensions and possible threats, such as China's invasion of Taiwan.

In order to tackle these urgent issues, this research will examine the present state of risk management frameworks and “supply chain management” techniques in the semiconductor sector. This research aims to strengthen tolerance against upcoming worldwide disruptions by providing ideas for establishing adaptive and diverse supply networks and addressing critical concerns, including supplier unreliability. Insights derived from the research will be useful for stakeholders in navigating the intricate semiconductor supply chains and reducing the likelihood of systemic crises.

1.1.2 Research Significance

The COVID-19 outbreak and ongoing geopolitical tensions have revealed significant weaknesses in the supply chain for semiconductors, which this study seeks to address. This study sheds light on the challenges faced by the "semiconductor industry" by looking at current structures for evaluating risks and supply chain management. Insights from the results will help industry players build supply chains that are more robust and flexible. This study is focused on improving the industry's resilience to future disturbances so that a crucial part of the worldwide economy may remain stable.

1.1.3 Background of the Research Study

The report examines the ongoing risks in the semiconductor supply chain stemming from prior disruptions such as the 2020–2023 worldwide chip shortage. The COVID-19 outbreak and geopolitical tensions worsened this shortfall, revealing supply chain difficulties. While previous studies have studied these disturbances, resilience techniques remain under-researched. To help the semiconductor sector face future difficulties, it's vital to address these gaps and strengthen supply chain resilience in a volatile environment.

1.2 Research aim and objectives

The main intention of this study is to is to analyse and propose different strategies for the enhancement of resilience in the microchip industry supply chain through different risk management practices, as it addresses the vulnerabilities highlighted in COVID-19.

- To assess the existing state of supply chain management practices in the global microchip industry.
- To assess the effectiveness of the existing risk management framework supply chain used by the microchip industry.
- To identify key challenges faced by the microchip industry for the maintenance of supply chain resilience in terms of supplier unreliability.
- To develop recommendations for building of adaptive as well as diversified supply chain network that can better withstand future global disruptions.

1.3 Research Questions

1. How has COVID-19 transformed the existing COVID-19 supply chain management practices in the microchip industry?
2. What is the risk management framework that is currently being employed by the microchip industry to increase supply chain resilience?
3. What are the primary challenges that have emerged in the microchip industry for the maintenance of supply chain resilience?
4. What is the next step of development for building an adaptive and diversified supply chain network that can guard against future global disruptions?

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The “semiconductor industry’s” supply connectivity faces critical challenges in resilience and risk management, requiring strategic analysis of constraints and implementation of advanced technological solutions.

2.2 Existing supply chain management practices in the global microchip industry

The supply chain supervision procedures of the worldwide microchip industry have changed a lot over the years, showing both their strengths and their weaknesses. Taiwan will produce over 92% of sophisticated semiconductors (sub-10 nanometre nodes) in 2023 due to the industry's extreme specialisation; this concentration of production has advantages and disadvantages (Jones et al., 2023).

Despite its long-standing reputation for cost-effectiveness, the conventional "just-in-time" (JIT) inventory system proved to be severely flawed during the most recent worldwide disruptions (Coslett, 2022). Although JIT has traditionally enhanced capital efficiency and decreased warehousing costs, it exposed manufacturers to supply shocks, which caused significant shortages in industries such as consumer electronics and automobiles. One example of the domino effect of supply chain vulnerabilities is the $210 billion in revenue that major car manufacturers lost in 2021 because of chip shortages (White, 2021).

Vertical disintegration in the industry has allowed for tremendous technical improvement and cost optimisation (Liu *et al.* 2021). Different businesses now specialise in design, manufacture, testing, and packaging. Nevertheless, due to this specialisation, there are now several possible sites of failure and intricate interdependencies. Compounding these vulnerabilities is the difficulty of responding rapidly to changes in demand caused by the prolonged manufacturing period of microchips, which usually ranges from 12 to 16 weeks (Industry ARC, 2021).

A focus on supply chain resilience, rather than efficiency alone, has emerged in recent years. Although there are substantial financial ramifications to these shifts, multi-sourcing strategies and regional manufacturing capabilities are becoming more popular among companies (Guo *et al.* 2024). The industry is also using AI and advanced analytics to improve demand forecasting and inventory management. However, these technologies are still limited in their usefulness due to the complexity and volatility of global marketplaces.

Another obstacle is the impact on the environment, as making semiconductors uses a lot of energy and water (Mohsin *et al.* 2023). Companies are making investments in sustainability projects, but it's still tough to balance industrial demands with environmental responsibilities.

Maintaining the efficiency gains from specialist manufacturing while strengthening supply networks is a problem. This might necessitate substantial investment in various geographic areas as well as major revisions to long-standing procedures.

2.3 Effectiveness of the Existing Risk Management Framework in the Supply Chain of Microchip Industry

The efficiency of risk management mechanisms in the “semiconductor industry”'s supply chain paints a complicated picture of both successes and serious shortcomings. The industry has created complex risk assessment tools and mitigation efforts, but recent global events have highlighted fundamental flaws in these systems.

A noticeable strength is the industry's use of advanced modelling and continuous surveillance technologies. AI may improve semiconductor manufacturing processes by up to 30% while also enabling early detection of possible disturbances (Data Bridge Market Research, 2024). These technologies have effectively anticipated and controlled various smaller-scale supply chain disruptions, particularly those involving supplier quality concerns and logistical constraints.

But when it comes to addressing systemic problems, the industry's risk control procedures have shown to be woefully inadequate. Smart electric vehicles and mobile phones, communications networks, and Internet of Things (IoT) gadgets are just a few of the many end applications that are driving the enormous need for semiconductor-powered goods (KPMG, 2022). Sales in the industry hit a record $556 billion in 2021 and are expected to exceed $600 billion in 2022, according to KPMG (2022). The frameworks' inadequacy in handling compound hazards—the result of several risk factors converging at once—is shown by this volatility.

While the existing system places a premium on financial risk measurements, it has occasionally sacrificed operational resilience. Many businesses value cost efficiency and margin preservation over supply chain redundancy and geographical heterogeneity (Bellucci and Rungi, 2024). This technique, while advantageous for short-term income, has created dangers in long-term viability.

Another significant flaw is the framework's management of geopolitical threats. While the concentration of production in certain locations is economically beneficial, it has resulted in enormous susceptibility to political conflicts and regional instability. Many systems lack solid contingency measures for abrupt geopolitical upheavals.

2.4 Key challenges faced by the microchip industry for supply chain resilience

Building and preserving supply chain resilience presents numerous important microchip industry difficulties with ramifications for many spheres of the world economy. Among the most important difficulties is geographic concentration. Together, controlling a sizable share of the worldwide semiconductor foundry business are South Korea (30%) and Taiwan (22%) (ROC Taiwan, 2023). This concentration generates significant systematic hazards even when it helps to provide economies of scale and specialist knowledge. Natural catastrophes, geopolitical conflicts, or local disturbances in these areas can have catastrophic knock-on repercussions all over the world supply chain.

Demand volatility and forecasting accuracy are other issues the industry faces. In the “semiconductor industry”, demand forecasting mistakes were made during COVID-19 (Piedrafita Acin, 2023). Capacity planning and inventory control find a difficult environment created by this instability; typically, this leads to either catastrophic shortages or expensive overstock.

Another significant difficulty is long lead periods for facility building and production equipment. Usually requiring a significant time and billions in expenditure, building new semiconductor production facilities makes it challenging to react fast to supply interruptions or market shifts (Young, 2021). Although some businesses have been motivated to keep more inventory levels by this difficulty, this strategy poses capital efficiency and probable obsolescence problems.

Additionally, complicating supply chain resilience is the growing complexity of semiconductor goods. Modern chips can need hundreds of various materials and techniques, any of which might be a supply chain point of failure (Miller, 2022). But this complexity has also inspired supply chain management innovation, producing more advanced tracking and monitoring systems. Another continuous difficulty is labour shortages in specialist technical professions (Borrachero Prieto, 2022). Though their efficacy varies by area and industry, this has spurred good advancements in automation and workforce development initiatives.

Although the industry's strong reliance on specialist suppliers for equipment and crucial components exposes more risks, this specialism has also encouraged technical development and quality standards enhancement. Businesses have to weigh the advantages of close supplier connections against the dangers of depending just on one source.

2.5 Theory of Constraints (TOC)

The supply connectivity problems in the “semiconductor industry” are well-aligned with the Theory of Constraints (TOC) (Azaria, Ronen and Shamir, 2023). The concept points up the two most important bottlenecks in the semiconductor supply chain: geographical concentration and prolonged lead times. The main industry limitation is East Asian concentrated manufacturing capacity, which restricts the system's general performance independent of other developments.

Acting as a capacity buffer or "drum" in TOC words, the second limitation shows itself in manufacturing lead times. While they show the "elevate" phase of TOC, the AI-driven improvements—30% efficiency gain—cannot completely overcome the main geographic limitation (Data Bridge Market Research, 2024). The demand volatility issue stems from TOC's "rope" idea, whereby the tempo of production should be matched with market demand, yet extended lead periods make this synchronising problematic.

Remarkably, the theory's focus on ongoing development fits the industry's embrace of improved modelling and monitoring technologies—though these developments are secondary to the main spatial and temporal restrictions.

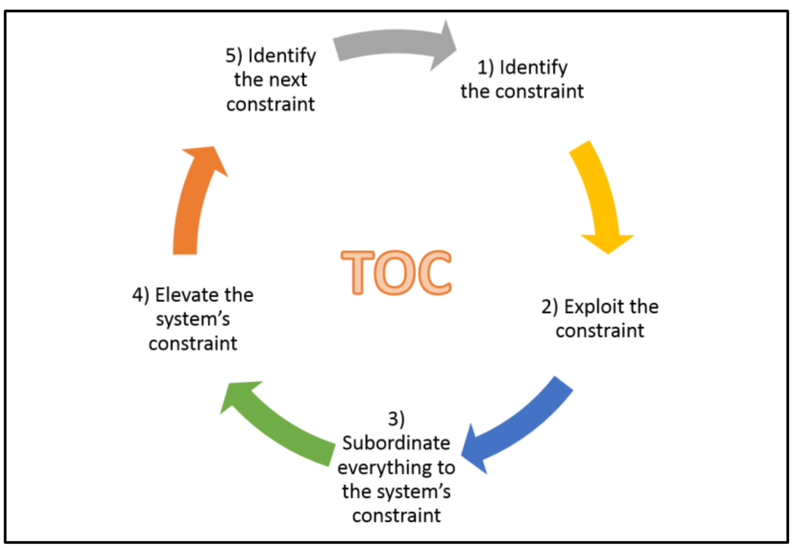

Figure 2.1: Theory of Constraints

(Source: Azaria, Ronen and Shamir, 2023)

2.6 Conclusion

Addressing geographic concentration and lead time constraints while leveraging technological advances will be crucial for building a more resilient semiconductor supply chain.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Research Approach and Design

The research approach is the method of collecting and analysing data for the development of efficient understanding. The research approach is of three different types, which are 'deductive approach, inductive approach and abductive approach' (Hall, Savas-Hall and Shaw, 2023). The '***inductive approach'*** is selected for the present research as it begins with the established observations and, based on that, it develops new theories, which are efficient for the understanding of supply network resilience and risk management. The inductive approach has the capabilities of hypothesis-driven analysis, which ensures the systematic evaluation of disruptions, risk factors and mitigation strategies (Thierry, 2023). This helps in the resolution of the problem that was encountered in the rationale of the research. The deductive approach and abductive approach have the nature of developing theories in the initial stage, and this contradicts the present research values. On the other hand, the inductive approach supports the qualitative understanding by exploring the theories which are more necessary for the testing of supply chain resilience in the post-COVID-19 microchip industry. Apart from the selection of the inductive approach, the research also selected interpretivism philosophy for the subjective understanding of the information that was collected.

The research design is another important component of the study, which is the strategy for answering the research questions (Kekeya, 2021). The research design is of different types like descriptive, exploratory and explanatory (Toyon, 2021). However, in the present research, the ***explanatory research design*** is used, which supports the effectiveness of qualitative data. The selected design is efficient in the exploration of causes and effects, which are beneficial for the analysis of the supply chain disruptions in the microchip industry. The explanatory research design delivers clarity on the complex relationships between the risks and the resilience strategies, which made it suitable for the present research. Exploratory and descriptive research is not efficient for this research as the present research requires in-depth subjective study, which is only supported by the explanatory design, and therefore, it is the suitable choice for the study.

3.2 Research sampling & Description and sources of secondary data selected

The research sampling is the process that has been used in the study for identifying the required papers which are necessary for the evaluation of the research. In the present research, the secondary data collection process was used for the implication of the knowledge from the existing findings. A random sampling method is followed for the excavation of the secondary sources. Six authentic papers were selected for the excavation of the research, which is the actual sample size of the research. The overall population of the papers that were selected for the study was 30 and after the inclusion and exclusion screening, 6 of the papers were selected, which are relevant and accurate for the present study.

Inclusion criteria	Exclusion criteria
Papers that are included in the research are from the years 2021 to 2025.	Papers older than the year 2021 are excluded from the research.
The English language is only included in the study.	Other languages except English are excluded from the research.
Peer reviewed sources are only selected for the research.	The papers which are not peer-reviewed are excluded.

Table 3.1: Inclusion and exclusion criteria

(Source: Author)

The data collection process has gone through differential screening methods for the analysis of the relevance of the present study. Every research question is specifically explored, and based on the key searching strategy, the data collection process was initiated. The data was collected from all the authentic sources like Google Scholar and ResearchGate so that the result which is produced has extended values. The secondary data collection method was followed so that the time and cost efficiency is retained in the study and the effective result is developed from the overall analysis. The data analysis that was used is the secondary qualitative data analysis, which is supported by the thematic analysis for the excavation of the results. The thematic analysis was used as the process uses six definite stages such as, familiarisation with the data implementation of initial codes, identification of the themes, reviewing of the themes, naming of the themes and report-making for the evaluation of the research findings, and this is valuable for the present study.

3.3 Quality of secondary data

The secondary data used in this research is ensured through credibility, relevance, accuracy and timeliness. The research has relied on journal articles from sources like Google Scholar and Research Gate, which state that the data are authentic and government-approved. The sources that were used are reliable as they provided evidence-based insights which are valuable for the understanding of supply chain disruptions and risk management frameworks. For the assurance of the data accuracy, the data are cross-verified from multiple sources, which has ensured consistency in the findings. Furthermore, in the research, the CASP tool is used for the extensive refinement of the data based on the checklists, and this has stated the data that are collected are of high quality and relevant to the present study. Timeliness is another critical factor in the justification of the quality and in the present research, the time range limit was set through the inclusion and exclusion criteria that highlighted the efficient use of data from the required timeline. The research has maintained the structural imposition into the overall research, and this summarises the high data quality with the enhanced values of the presentation.

3.4 Secondary Data Ethical Measures

The ethical measures in the use of secondary data for the research focus mainly on ensuring credibility, transparency and compliance with the data protection regulations. At first, it was checked that all the data sources were properly cited and referenced for the acknowledgement of the authorship and to avoid plagiarism. This statement maintains academic integrity and respects intellectual property rights. The second is the reliance on publically available data from reputed sources like government agencies and peer-reviewed journals that have ensured the authenticity of the data collected. It was also ensured that in the present research confidential and proprietary data are not used, and this ensured adherence to the ethical research practices. The copyright statement was efficiently verified before the selection of data so that no misleading or dissemination occurred with the biased information. Personally identifiable information was also not used in the study so that the study retained its ethical values in the overall research development process. The ethical measures that were used in the study have ensured that the research is valuable in the overall context of practical and future implications.

CHAPTER 4: RESEARCH FINDINGS

4.1 Introduction

The researcher assesses study findings in this chapter. The researcher developed topics according to the various goals. The researcher attempted to successfully answer study questions and research objectives by gathering various papers based on various themes.

4.2 Results

Theme 1: Evaluation of Supply chain management practices in the global microchip industry

Authors	Methodology	Key Findings
Ashraf *et al*. (2024)	Secondary qualitative	The study mainly outlines the role of microchips in the digital era and examines the semiconductor supply network in Pakistan. The main findings include major bottlenecks in raw material procurement, fabrication, testing and distribution. Vulnerabilities in the supply chain threaten production stability. The authors suggest that collaboration, technological advancements and policy interventions are necessary for enhancing efficiency, national security and economic stability in the microchip manufacturing industry.
Ishak *et al.* (2023)	Primary quantitative	The study reveals that supply chain resilience significantly impacted multinational semiconductor firms in Malaysia during the pandemic, while agility had a lesser effect. Despite prolonged chip shortages, adaptive strategies helped to mitigate disruptions. The findings provide information about effective supply chain management during crises. The study also recommends that the industry should explore demand-driven planning for climate adaptation to enhance supply chain resilience in different semiconductor industries.

Table 4.1: Thematic tables for Theme 1

(Source: Author)

The discussion of Ashraf et al. (2024) and Ishak et al. (2023) highlights the critical role of resilience in overcoming challenges in manufacturing and supply chain management. Ashraf et al. (2024) focused on the feasibility of microchip manufacturing in Pakistan. It mainly emphasised the necessity for advanced technology, local production, and government support. On the contrary, Ishak *et al*. (2023) highlight in which way supply network resilience strategies in the time of pandemic affected firm performance in the “semiconductor industry” in Malaysia. These studies stress the significance of adaptive strategies and the integration of practical knowledge for success in these high-tech industries.

Theme 2: Effectiveness of the existing risk management framework supply chain used by the microchip industry

Authors	Methodology	Key Findings
Xiong *et al.* (2024)	Secondary qualitative	The study highlights which way geopolitical tensions and public health crises have disrupted the semiconductor supply chain and exposed vulnerabilities. It emphasises resilience strategies like decentralised networks and innovative management practices. The review also identifies research gaps and advocates for improved adaptability to ensure long-term supply chain sustainability in a global environment.
Tse et al. (2024)	Secondary qualitative	In this paper, the researcher examines the response of Huawei to US semiconductor sanctions. It highlights its successful product launch with SMIC's 7 nm chips. Moreover, the stock market reaction showed positive impacts on suppliers and customers of Huawei and SMIC, with median share price increases of upto 2.52%. On the other hand, customers of Huawei did not react positively. The findings offer information into supply chain resilience and the propagation of positive news and geopolitics restrictions.

Table 4.2: Thematic tables for Theme 2

(Source: Author)

Xiong *et al.* (2024) and Tse *et al.* (2024) emphasise the significance of resilience in the supply chain, specifically in light of geopolitical challenges and technological disruptions. Xiong *et al.* (2024) highlight future research directions such as decentralisation and digitalisation to enhance 'supply chain resilience'. Moreover, Tse *et al.* (2024) focus on how a market reacts to the product release of Huawei and SMIC's breakthrough to illustrate supply chain resilience. It also highlights propagation effects among logistics connective partners.

Theme 3: Identification of key challenges faced by the microchip industry for the maintenance of supply chain resilience in terms of supplier unreliability

Authors	Methodology	Key Findings
Pinto (2024)	Secondary qualitative	The article examines reshoring in the semiconductor industry amid globalisation decline, world political tensions, and logistics chain disruptions. It highlights the potentiality of reshoring to enhance global value chain efficiency while addressing challenges such as labour shortages and geopolitical instability. The research focuses on the impact on high-tech industries of the U.S.-China trade war that assesses the feasibility of reshoring in today's economic and political landscape.

KEK *et al.* (2023)	Secondary qualitative	The researcher mainly found this paper on semiconductor supply chain disruptions, specifically from COVID-19, using Anylogistix's digital twin simulations. The findings reveal SSC remains vulnerable, requiring innovative resilience strategies. The digital twin model aids in prediction, evaluation, and recovery planning and supply chain visibility. Moreover, the suggested methods can help businesses enhance resilience frameworks. It improves preparedness for future crises and strengthens the supply chain efficiency.

Table 4.3: Thematic tables for Theme 3

(Source: Author)

Pinto (2024) examines reshoring in the "semiconductor industry", considering the impacts of world political mismatches and labour shortages, specifically from the U.S.-China trade war. In contrast, KEK et al. (2023) focus on supply chain disruptions due to COVID-19, using digital twin simulations to assess vulnerabilities and enhance resilience. Both of these studies emphasise the necessity for innovative strategies to address semiconductor supply chain challenges.

It can be summarised that this chapter presents research findings on supply chain management in the "semiconductor industry". It highlighted resilience strategies like adaptive approaches during crises and the effectiveness of existing risk management frameworks. The key challenges such as supplier unreliability and disruption, with a focus on restoring digital twin models for enhancing resilience.

CHAPTER 5: ANALYSIS OF THE FINDINGS

5.1 Evaluation of Findings

The findings mainly emphasise the importance of resilience in overcoming the challenges faced by the semiconductor supply chain, especially after interruptions such as, the 'COVID-19 pandemic'. These studies aligned with the existing literature, highlighting the vulnerabilities caused by supply chain concentration, the unreliability of suppliers, and geopolitical tensions, as identified in the research problem. Ashraf *et al.* (2024) and Ishak *et al.* (2023) stress the need for adaptive strategies, like local production and demand-driven planning. These resonate with the shift towards regional manufacturing and multi-sourcing strategies mentioned in the literature. Moreover, the findings from Pinto (2024) and KEK *et al.* (2023) help to understand the necessity of innovative resilience strategies like reshoring and digital twin simulations.

5.2 Relation of Research Questions to research findings and literature

In this part it was evaluated the way the findings of the research and literature addressed the research questions of the dissertation.

The results from Ashraf *et al.* (2024) and Ishak *et al*. (2023) align with different key issues discussed in the literature review on the supply chain of the semiconductor or microchip industry. Ashraf *et al.* (2024) highlight critical vulnerabilities in the microchip supply chain, such as bottlenecks in procurement, fabrication, and distribution. It mirrors the concerns raised in the literature regarding the complexity and specialisation of the industry (Jones *et al*. 2023). These bottlenecks threaten production stability, a challenge that is exacerbated by the long production lead times of microchips, which can take up to 16 weeks (Industry ARC, 2021). In this case, both in results and the literature emphasise the necessity for greater collaboration, technological advancements and policy interventions to address these issues and improve efficiency.

In the findings, Ishak *et al.* (2023) found that resilience strategies reduced disruptions during the pandemic. Similarly, the literature review stresses the growing significance of resilience over efficiency. This shift towards supply chain resilience is driven by the necessity to mitigate disruptions such as, chip shortages that caused substantial losses in revenue (White, 2021). Ishak *et al*. (2023) highlight the impact of adaptive strategies, specifically in demand-driven planning, that aligns with the advocacy of literature for multi-sourcing strategies and regional manufacturing capabilities to improve resilience.

Apart from that, the literature also emphasises the shift of the industry from a "Just-in-Time" model that was exposed as flawed during disruptions. This is similar to the findings in the results that suggest the significance of adaptive strategies and integration of practical knowledge in improving semiconductor supply chain management, mainly in response to crises. The growing reliance on AI and advanced analytics to better demand forecasting, as mentioned in the literature, complements the findings of Ishak *et al.* (2023), who also advocate for improved planning to enhance resilience. In this case, both the literature review and findings were answered by the RQI, which was related to supply chain management practices in the global microchip industry.

Both the literature review and the theme analysis investigate how well the "semiconductor industry"'s supply chain manages risks. Although they have some shared ground, such the need of resilience methods and the effects of geopolitical threats, their scope, methodology, and emphasis are different.

The literature study is an all-encompassing analysis of the industry, drawing attention to the good and bad aspects of risk management. It recognises that better operational efficiency and less disturbance on a smaller budget have resulted from the use of AI-driven monitoring systems and enhanced risk assessment tools (Data Bridge Market Research, 2024). But it also criticises the industry for not dealing with structural concerns, such as the unpredictable supply chain caused by rising demand for semiconductors (KPMG, 2022). Bellucci and Rungi (2024) state in their literature study that long-term sustainability has been degraded due to the prioritisation of financial risk measurements above operational resilience. Furthermore, it highlights how unprepared the industry is for geopolitical threats of harm, considering how dependent it is on concentrated manufacturing centres and how weak its backup plans are.

In contrast, resilience tactics in the face of geopolitical tensions and supply chain interruptions are more narrowly examined in the theme analysis. In line with the literature review's criticism of the industry's excessive dependence on concentrated manufacturing. Xiong *et al.* (2024) highlight digitalisation and decentralisation as crucial steps to improve supply chain flexibility. Similarly, Tse *et al.* (2024) illustrate how SMIC's 7 nm chip launch had uneven impacts on stakeholders—boosting supplier assurance but failing to reassure customers—through an empirical case study of Huawei's response to U.S. semiconductor sanctions. By looking at how the market really responded, this study provides a more complex view of supply chain resilience.

Both the literature review and the theme analysis acknowledge resilience's importance; however, the former examines systemic risks and industry-wide vulnerabilities from a macroeconomic perspective, while the latter zeroes in on responses at the business level and market dynamics. An overarching criticism of financial risk prioritisation and geopolitical fragility is offered in the literature review, while case-specific insights into how corporations negotiate these problems are offered by the theme analysis. The risk management framework of the “semiconductor industry” can be better understood by combining these viewpoints.

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CHAPTER 6 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

It was concluded from the overall research that the research explored the risk management ways for the building of resilient logistics chains in the microchip industry after the COVID-19 pandemic. The research was excavated by the implication of the secondary research development method, which has focused on authentic sources for the collection of existing insights. The research objectives and questions are analysed well in the previous sections by which the efficient result was developed. The ***first objective*** was based on the excavation of the existing state of logistics chain administration practices in the global microchip industry. This objective was met in the ***first theme*** of the research, where the statements of two different authors evaluated it. As per the excavation of the result of the first objective, it was highlighted that the main issue in the existing process was a major bottleneck in the raw materials procurement, fabrication, testing and distribution. However, in the theme, it was reflected that the demand-driven planning for climate adaptation and enhanced supply network elasticity has the ability to overcome these existing supply chain issues.

The ***second objective*** of the research has demanded the excavation of the effectiveness based on the existing risk management framework which the supplier connectivity uses in the microchip industry. The specific objective is met in the ***second theme*** of the research, where the effectiveness of the frameworks is stated, which had extended values in the existing supplier management chain of the microchip industry. In the theme, it was evidenced that strategies like decentralised networks and innovative management practices were beneficial for the effectiveness of the frameworks. On the other hand, it was also ensured in the theme that the propagation of positive news was essential for the existing management framework of the microchip industry supply chain.

The ***third objective*** was focused on the identification of the challenges faced by the microchip industry for the maintenance of supply chain resilience in terms of supplier unreliability. In this response, the ***third theme*** has excavated different challenges that affected the supply chain resilience, and among those, the most important challenges are globalisation decline, geopolitical strains, and logistics chain disruptions. It was also evidenced in the theme that the supply network disruption, the recognised issue, was formed mainly from the COVID-19 situation, and this has implicated challenging situations for the industries.

However, the ***fourth objective*** has reflected the necessity of developing recommendations which would mitigate these challenges and develop better supply chain resilience in the microchip industry. In the present chapter, the ***recommendations for the business applications*** were established by which the companies will develop scopes for better business scenarios. With the explicit thematic analysis and with the excavation of different studies, it was ensured that the companies need to explore the climate conditions and geopolitical situations before the development of the supply chain management initiatives. The presented research has developed certain insights that reflect different values based on the microchip industry benefits and for the benefit of other companies that are trying to develop their supply chain resilience.

6.2 Recommendations for Business Application

Diversification of the suppliers and manufacturing hubs

The microchip industry must reduce its dependency on concentrated manufacturing regions like Taiwan and China by the diversification of its suppliers across global locations. Nearshoring and resourcing initiatives should be implemented for the mitigation of geopolitical risks and bottlenecks in the supply chain. The same implication was done by the company like Intel by which it has achieved $2.2 billion in the year 2022 (Intel, 2023). A similar implication is important for microchip companies so that geopolitical issues are resolved with efficient supply chain resilience.

Adaptation of digital supply connectivity technologies

The businesses in the sector need to integrate digital solutions like ‘artificial intelligence’, ‘blockchain’ and ‘digital twins’ so that the ‘supply chain visibility’ is enhanced and risk administration is established in the process. It was evidenced that AI-powered predictive analytics forecasts demand fluctuations and potential disruptions, which allows for effective decision-making. Digital twin stimulates the supply chain operations by the testing of resilience strategies and by the identification of vulnerabilities before the disruption takes place. Many companies like Microsoft and General Electric use these digital twin implications for the prediction of the disruptive situation (Yakovenko and Shaptala, 2024). A similar implementation should be implicated by the microchip companies for better analysis of the issues and for better decision-making initiatives.

Strengthening the public and private partnerships

The collaboration between the governments and the semiconductor companies is essential for the securing of the supply chain against the global risks. The government should have introduced incentives for domestic semiconductor production with investments in R&D so that supply chain resilience is retained in the regions. It was noticed that Intel has collaborated with the US government through the CHIPS and Science Act, which represents the expansion of semiconductor manufacturing (Intel, 2024). This kind of initiative needs to be initiated by the microchip companies so that evidential supply chain supports are obtained from the collaborations.

6.3 Limitations and Implications for Future Research

The research is developed efficiently with authentic and validated data, but some of the limitations were retained in the study. The first key limitation of the research is the reliance on secondary data, which may not fully capture the latest industry-specific challenges and responses from the key stakeholders in real-time. The absence of primary data, like the insights from the interviews and surveys, limited the study's ability to provide firsthand insights into risk management strategies. Moreover, it was noticed that the research has focused on the post-COVID-19 disruptions, but it has failed to explore the long-term structural shifts in the industry, like the evolving role of governmental policies and technological advancement, which has also developed limitations in the study.

For future research, the primary data collection process, like expert interviews and industry surveys, can be used for deeper insights into the ways by which the companies adopt their supply chain strategies. The development of future research could also explore the impact of cutting-edge technologies like quantum computing and AI-driven automation on supply chain risk management for enhanced precision of the topic exploration. Moreover, the comparative studies based on the different industries can also develop future implication values that would help the research to be successful in the landscape.

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