RISK MANAGEMENT IN SUPPLY CHAIN (MANAGING UNCERTAINTY IN SUPPLY CHAIN)

by

Santosh Kumar (PGDM, BE-Mechanical)

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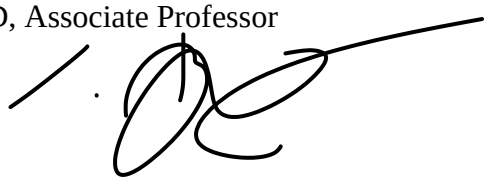

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Admissions Director

Dedication

First and foremost, I would like to dedicate this research to my late father, whose unwavering love and support has enabled me to be in the stage where I am currently. Though he left us when I was doing my engineering but his true love & trust in me have been a constant source of motivation and inspiration throughout my academic journey. Second is my mother whose sacrifice, guidance and encouragement have made this achievement possible, and I am forever grateful to my parents for all that they have done. Their support has been invaluable in helping to overcome any obstacles that came my way, and their guidance has shaped me as a sensible person and a good learner.

Next is my wife Suman & my two children & Kashwi & Kashwin. It is because of their endless love and support that I have been able to stay motivated during the past years. Thank you, my wife, for cheering me up when I was down, and for supporting our family through this whole journey. Without your patience and encouragement, and belief in my abilities, I would never have been able to reach the pinnacle of my education and complete my life goal. You have inspired me to exceed my expectations and hold myself to higher standards.

I would also like to acknowledge my mentor, Prof Saša Petar, PhD, who has been an invaluable guide and advisor throughout my research. His expertise, feedback, and constructive criticism have been instrumental in shaping my research skills, and I am grateful for the opportunity to learn from him. His mentorship has helped to become a better researcher and scholar, and I recognize that without their guidance and support, this dissertation would not have been possible.

Acknowledgements

Acknowledgments are an essential part of the thesis as it allows us to express gratitude to those who have contributed to completing this work. Therefore, I would like to take this opportunity to acknowledge and express my sincere appreciation to the following individuals and organizations who have supported throughout the completion of my thesis.

First and foremost, I would like to thank my thesis mentor, Prof Saša Petar, PhD, for his invaluable guidance, support, and encouragement throughout my research journey. His expertise and feedback have been instrumental in shaping my ideas, refining my arguments, and improving the overall quality of my work. I am genuinely grateful for the time and effort he has invested and his unwavering support during the challenging times.

Furthermore, I would like to thank my current organization, professional colleagues and references who have provided a stimulating academic environment and valuable feedback on my work. Their contribution in completing the survey and their encouragement have kept me motivated and focused throughout the research journey for this paper.

Thanks to the participants who voluntarily participated in the study/survey, as well as to all my family members and friends who were constantly surrounding me.

I would also like to thank the Swiss School of Business Management for allowing us this opportunity to explore the possibility of researching and writing this thesis. The school's efforts and guidance are essential in completing this journey.

ABSTRACT

**RISK MANAGEMENT IN SUPPLY CHAIN
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IN SUPPLY CHAIN)**

SANTOSH KUMAR
2025

Dissertation Chair: Iva Buljubasic, PhD, Associate Professor

Post covid, Supply chain risk management has been increasingly paid attention by most of the researchers and industrialists. Of late this has become a more popular area of research. This research proposal aims at defining supply chain management and the risks/uncertainties associated with supply chain (SCRM).

This research proposal is classified into six major categories: I. Introduction of Supply chain & Risk Management, Problem statement/major challenges, Objective/purpose of research, II. Preliminary Literature review, III. Research methodology, approach & strategy, Research design, Research Study Period, Schedule, Data Collection & Research Design Limitations, IV. Survey Results, V. Discussion on Survey Results, VI. Summary & Recommendations for future Research & Conclusion.

After having more than 20 years of personal experience in the supply chain & gone through all the secondary data available on Supply chain risk management, I realize that still lot of risks/uncertainties are available in this domain, which needs to be anticipated & potential solutions need to be found to lessen the impact of these risks on the business. This research will help the supply chain professionals to foresee potential risks & challenges & also be ready to deal with them.

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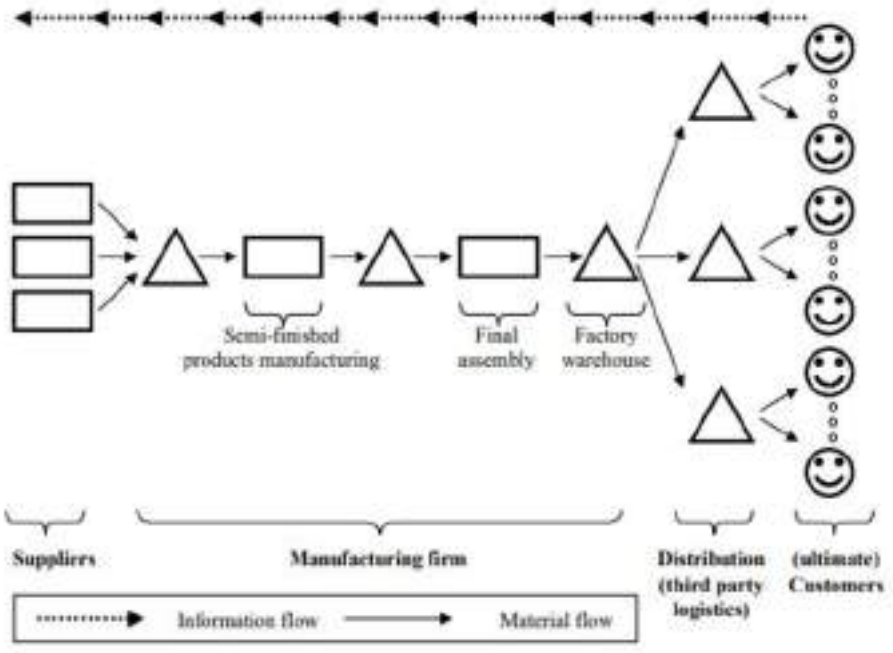
CHAPTER I:

INTRODUCTION

1.1 Introduction: Supply Chain

A Supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves. Within each organization, such as a manufacturer, the supply chain includes all functions involved in receiving and filling a customer request. These functions include, but are not limited to, new product development, marketing, operations, distribution, finance, and customer service.

Picture 1.
A typical example of a supply chain



Source: Hartmut Stadtler: Supply Chain Management-An overview,2008, p.10

Supply chain management is “the management of material, information and finance through a network of organizations”. A typical supply chain begins with the ecological, biological, and political regulation of natural resources, followed by the human extraction of raw material, and includes several production links (e.g. component construction, assembly, and merging) before moving on to several layers of storage facilities of ever-decreasing size and increasingly remote geographical locations, and finally reaching the consumer.

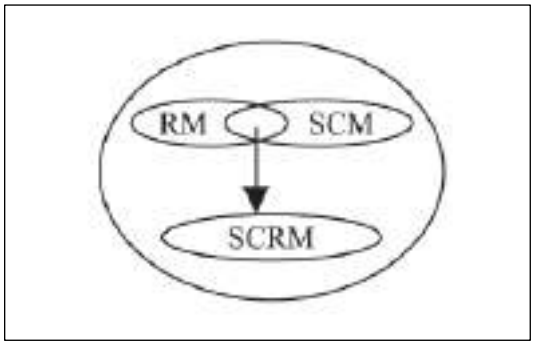
1.2 Global Supply Chain

Global supply chain management is a process that helps plan and successfully execute goods and services distribution from manufacturers and consumers across developing countries worldwide. This system helps integrate multiple networks of manufacturers, suppliers, retailers and warehouses to source the right type of goods with the right quantity and quality. Global supply chains paired with software provide advantages for organizations across multiple industries like manufacturing, mining, food and beverage, textile, electronics, oil and gas, and more.

1.3 Introduction: Risk Management in Supply Chain

Supply chain risk management (SCRM) is “the management of supply chain risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity” (Brindley, 2004).

Picture 2. Supply chain risk management



Source: Supply Chain Management: An International Journal; Volume 14 · Number 4 · 2009 · 247–252

The risk in supply chain management originates from two key areas: supply and demand. The next level of equal importance is environmental, political, process and security risks. Political and environmental risks may always remain amorphous and refractory to adequate quantification. Security risks are even more volatile but on a far higher priority level.

Global supply chains today are subject to more risk factors than localized supply chains of the past. These risks include supply chain disruption, supply delays, demand fluctuations, price fluctuations, and exchange-rate fluctuations. There's no denying the fact that supply chain disruptions affect the global economy at large. The following are some of the major disruptions affecting global supply chains.

Picture 3. Global Supply chains Key Challenges

Source: https://www.selecthub.com/supply-chain-management/global-supply-chain/

Port Congestion - Port congestion is a top challenge for supply chains. It occurs when a ship arrives at port but can't load and unload due to capacity, causing congestion. Once congestion occurs, it creates a backlog of orders that delays shipments and delivery.

Surging Freight Costs - Rising shipping and freight costs are major reasons why inflation increases. According to IMF research, when freight costs double, the inflation rate increases by 0.7%.

Scarce Material – Post Pandemic, material scarcity concerns have been increased drastically, especially the semiconductors.

Production Delays – It's a part of supply chain and there are multiple reasons to it. Some of them are valid reasons as well.

Workforce and Labor Shortages - Labor demand is also at critical levels, and organizations can't find laborers to match their needs. Even though wages are climbing, vital positions remain unfilled as modern operations require a technology skillset.

Some of the recent factors which have resulted in the above major disruptions in supply chain are: -

a. Medical reasons - Covid-19 Pandemic
b. Organizational/bad management/structural reasons - Suez Canal obstruction (March'21)
c. War activities/pirates/political instability - Russian invasion of Ukraine (2022)

a. The COVID-19 pandemic has challenged supply chains more seriously than ever before. In 2020, shortages in the supply of many goods were among the most prominent topics in the media, policy discussions and everyday conversation. Demand structure changed drastically. The supply side witnessed closed factories and empty store shelves. Prior to the pandemic, we concentrated on developing agile, lean, sustainable, green, optimized, and efficient supply chains. During the pandemic, we have not forgotten these subjects; however, our concerns have changed drastically. With its global impact and long duration, the pandemic has altered demand structure more significantly than it has supply structure, and it has affected even financial systems. Unlike other disruptions, the COVID-19 pandemic came with no contingency plan or prior experience. In other words, it caught us off guard.

b. The blockage of the Suez Canal by a massive container ship called the Ever Given has become a worldwide shipping crisis. The ship, nearly 200 feet wide and 1,300 feet long, easily took up the width of the channel. The Suez Canal is an Egyptian waterway connecting Europe and Asia, responsible for facilitating about 12% of all

global trade. As one of the world's busiest trade routes, the canal obstruction had a significant negative impact on trade between Europe, Asia and the Middle East. The event delayed goods, which impacted industries with existing shortages, such as with semiconductors, thereby influencing markets already at risk of collapsing. A consultant at another firm noted that even a short-term disruption at the Suez Canal would have a **domino effect/Chain reaction** for several months along the supply chain, an effect already apparent in the weeks following the incident. This prevented an estimated US$ 9.6 billion worth of trade. The incident resulted in shipping delays of everyday items for customers around the world. It is estimated that during blockage the value of the goods delayed each hour at US$ 400 million.

c. **On 24 February 2022, Russia invaded Ukraine** in a major escalation of the Russo-Ukrainian War that began in 2014. The Russia-Ukraine war is having an outsized impact on the global supply chain, impeding the flow of goods, fueling dramatic cost increases and product shortages, and creating catastrophic food shortages around the world. While the main focus remains as it should on the tragedy of human loss and the destruction of Ukrainian territory, the Russian invasion has triggered sanctions and other obstacles that have hampered critical logistics and trade route operations. The resulting ripple effects are threatening the supply of key food resources like wheat and raising the possibility of global famine. Simultaneously, disruption to the flow of electronics, raw materials, and parts supplies emanating out of China and other locales has seriously impeded global trade positions, forcing companies to recalibrate and in some cases, wholly reconsider their long-standing supply chain and partner ecosystems.

1.4 Research Problem

Contemporary supply chains are facing myriad types of risks caused by unprecedented risk factors. This condition motivates us to develop a contemporary supply chain risk typology to help identify and monitor newly surfaced risks and reveal emerging

topics and research collaborators to help foster impactful research in supply chain risk management (SCRM). The likelihood and consequence of supply chain disruptions are increasing because of contemporary supply chains that are more complex and extended than ever.

The early 21st century has marked the major supply chain disruption that have accentuated vulnerabilities for individual firms and for the whole global industries- in late 2000, Ericsson the Swedish telecom company reported that the year-end losses of $2.34 billion for the cellular phone division is due to its supplier's factory caught on fire, in 2001 due to supplier's bankruptcy Land Rover discharged 1400 employees from their job, in 2006, Dell cancelled order for four million notebook batteries which was manufactured by Sony due to fire accident (Chopra and Sodhi., 2004; Christopher, 2004; and Sodhi et al., 2012). Thus, World auto industry was shaken by Japanese Tsunami in 2011 for several months. The telecom gear maker Nokia shut down their Chennai plant in 2014 due to no orders from Microsoft (Bijoy, Nokia to shut down its Chennai factory, The Hindu Newspaper October 2014). These supply chain disruptions have impacted the organizations in a long term as well as created the bad brand image among the society. Statistics revealed that 60 percent of the organizations approved their supply chains are in danger due to disruptions (Sodhi et al., 2012).

The latest survey on supply chain resilience during the COVID-19 pandemic shows the number of companies that experienced supply chain disruptions in 2020 was five times higher than that in 2019. The COVID-19 pandemic has disrupted all parts of supply chains due to unprecedented world responses to control the virus, ranging from border closure, statewide lockdown, and workforce limitation. As a result, we have seen logistics problems, panic buying, and a drop in production capacity, to name a few disruptions that happened altogether. These systemic risks are relatively new, leading to the firm's inability to mitigate the impact appropriately. This phenomenon illustrates that contemporary supply chains are facing myriad types of risks caused by unprecedented risk factors.

1.5 Major Challenges

The following are the seven major challenges in supply chain management (Source: 7 Main Challenges in Supply Chain Management - David Lans)

Risk Management - Due to constant change in the market, coming from a variety of sources such as consumer demands, political agendas and global sourcing, would cause major issues to the operations.

1. **Supplier Relationship –** In today's highly competitive market, suppliers are key to the success of the business, especially in the niche products.
2. **Quality Customer Service** - The supply chain management is centralized on the needs of the customers. It is about giving the right quantity and the right quality of the product for the right amount of money. All this, in perfect timing and setting.
3. **Unforeseen Delays -** Procurement of materials and products may be easy, but the delivery may not always be 100% on time, especially with time differences and a variety of shipping time frames. When items are sourced from different countries, delays like this are very common.
4. **Qualified Personnel -** Over the years, it has become a challenge to find talent interested and passionate about this line of work. Personnel hired in this field must have an understanding about the duties and responsibilities needed.
5. **Costing -** Globally the costs of raw materials, energy and labor have increased due to economical constraints. In order for operations to continue production and provide customers with good quality items at affordable rates, adjustments must be made to keep operations running.
6. **Fast-Changing Markets -** With technological advancements changing our markets every day, it is quite difficult to stay in pace and adapt to the variety of innovations in the market. But because the goal is to stay efficient in these changing times, companies would have to be more flexible.

1.6 Purpose of Research

Supply chain management (SCM) is the process by which supply chain activities are managed to have an advantage over competitors as well as maximize the value of our customers. It basically represents the efforts by which the supply chain management solutions help to develop and manage supply chain activities in the most efficient way. When we talk about supply chain management, we also pertain to product development, sourcing of materials, production of quality goods, logistics and delivery to customers.

The primary aim of Supply Chain Risk Management is to identify the risks and develop the action plan to lessen the impact of the risk level. However, developing an effective SCRM model is always a paramount task and requires skills and proficiency in various streams. In such a highly VUCA business environment, practitioners and researchers have put a higher level of attention to supply chain risk management.

Supply chain resilience is an ability to recover from an undesired performance level to a planned performance level by taking actions towards recovery or adaptation. Preparedness, alertness and agility are the three pillars of supply chain resilience. Their aims are to minimize the effects of the disruption and ensure recovery as quickly as possible**.**

1.7 Significance of the Study

The long-term goal of the research is to identify potential risks of Supply chain in Manufacturing industries through a structured approach & develop a model for solving supply chain uncertainties/risks. This study will first review various types of supply chain risks and their characteristics. Based on this understanding, a classification method will be developed to categorize various uncertainties of supply chain. In the second stage of this study, solution to potential risks of supply chain will be proposed based on a comprehensive review of current industry practices and academic researches.

The objective of this research is to provide a comprehensive review of literature and industry practices in relation to Supply Chain uncertainties and outline a conceptual framework for its potential solutions.

Particularly, the research has the following sub-objectives:

1. **To provide a comprehensive review of Supply chain risks & uncertainties in manufacturing industries in India (VUCA world).**

2. **To review current manufacturing industry challenges in the entire value chain.**

3. **To outline potential solutions based on research & experience of manufacturing professionals.**

The result of this study will be valuable to the supply chain professionals to foresee any risks & be proactive to deal with the situation & lessen the adverse impact on the business.

CHAPTER II:

REVIEW OF LITERATURE

2.0 Preliminary Literature Review

Supply chains must consider all the potential risks and uncertainties, which impose diverse ways of handling. Addressing current and potentially future challenges impel us to rethink resilience, robustness, and risk management concepts in the supply chain management domain. While the efforts of minimizing supply chain risks were on our agendas before the pandemic also, but the thought process was little different. Prior to the pandemic, terrorist attacks, fires at plants and the loss of important suppliers were commonly discussed disruptions. However, these and other disruptions discussed in the available literature are generally local or regional, rarely impact demand structure, have a limited duration, and occur after predictable risks, such as strikes or bankruptcy. A preliminary literature review shows that past studies are primarily focused on understanding and modeling a constraint, mainly either on the supply side or on the demand side. Recent situations have taught us that disruptions simultaneously can happen on both the sides that too for a longer time period. What is missing from past studies is a comprehensive and structured approach in managing the uncertainties in supply chain.

2.1 Types of Risks in the Supply Chain (Source: precoro.com)

2.1.1 Supplier Risk-

- Supplier Reliability - The ability of suppliers to meet delivery schedules and provide consistent product quality.
- Financial Stability: Suppliers facing financial difficulties can disrupt the flow of goods.

- Geopolitical Risk: Political instability, such as trade wars or sanctions, may impact the ability to source goods from certain regions.
- Single Source Dependency: Relying on one supplier for critical materials makes the supply chain vulnerable if that supplier faces issues.

2.1.2 Logistical Risk-

- Transportation Disruptions - Delays due to weather, natural disasters, or infrastructure issues can affect delivery times and costs.
- Port or Border Delays - Customs issues, inspections, and port congestion can delay shipments.
- Capacity Shortages - High demand or low carrier availability can cause transportation shortages or delays.

2.1.3 Demand Risk-

- Market Fluctuations - Sudden changes in consumer demand can lead to overstocking or stockouts.
- Forecasting Errors - Inaccurate sales or demand forecasts can lead to inefficiencies in production and inventory management.

2.1.4 Technology Risks-

- Cybersecurity - Attacks or data breaches can disrupt supply chain management systems and lead to financial and reputational damage.
- System Failures - Malfunctions in inventory management systems, order processing, or communication systems can disrupt operations.
- Technological Change - The failure to adopt new technologies or maintain old systems can create vulnerabilities.

2.1.5 Regulatory Risks-

- Compliance with Laws - Changes in labor laws, environmental regulations, tariffs, and safety standards can add costs or limit sourcing options.
- Trade Barriers - Shifts in trade agreements, tariffs, and customs regulations can affect the movement of goods across borders.

2.1.6 Environmental Risks-

- Natural Disasters - Earthquakes, floods, hurricanes, and wildfires can disrupt production, transportation, and distribution.
- Climate Change - Long-term changes in climate patterns can affect raw material availability or cause operational disruptions.

2.1.7 Financial Risks-

- Currency Fluctuations - The value of foreign currencies can impact the cost of goods when trading internationally.
- Inflation - Rising costs for raw materials, labor, or logistics due to inflation can squeeze margins.

2.1.8 Operational Risks-

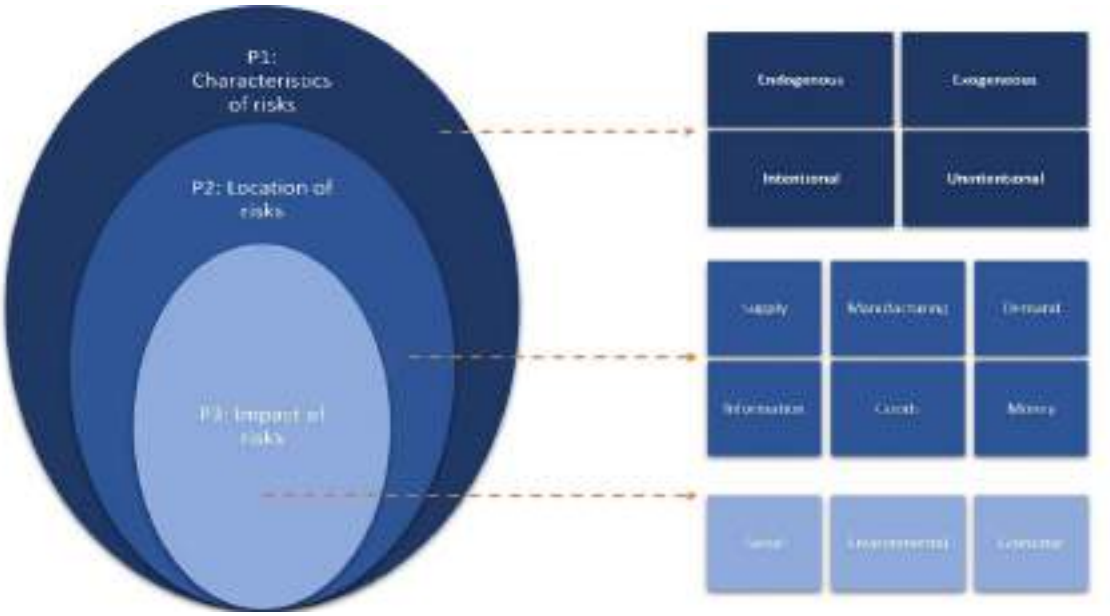
- Labor Strikes: Disruptions in labor, such as strikes or protests, can delay production or transportation.
- Quality Control: Issues with product quality can lead to customer dissatisfaction, returns, or brand reputation damage.

2.2 New Supply Chain Risk typology

SCRM is a process of managing risk probability, risk propagation, and risk impact (Zsidisin and Henke 2019). Guided by this conceptual view, a preliminary

proposition is developed to build the risk typology that supports those three dimensions of SCRM process. In this proposition, supply chain risks can be classified based on three perspectives: **the characteristics of risks, the location of risks, and the impact of risks.** The characteristics of risks would help assess the risk probability. The location of risks would help analyze the risk propagation. Finally, the impact of risks would help quantify the extent of damages resulting from the materialization of risks.

Picture-3: New supply chain risk typology



Source: [A decade of progress in supply chain risk management: risk typology, emerging topics, and research collaborators (tandfonline.com)]

CHAPTER III:

METHODOLOGY

3.0 Methodology

This thesis is a concise and coherent summary of the proposed topic "**RISK MANAGEMENT IN SUPPLY CHAIN".** The research methodology will be focused at connecting the manufacturing industry experts/professionals within the private/government sectors in India.

3.1 Research Approach & Strategy

Qualitative research is the process of collecting, analyzing, and interpreting non-numerical data, such as language. The primary research method for this study is Qualitative Research. The research methodology has been selected after referring to many literature reviews, more than 20 yrs of personal experience of manufacturing industries (both Indian & global multinationals) and journals.

Qualitative research is used to understand how an individual subjectively perceives and gives meaning to their social reality. For the same online survey will be conducted from all possible manufacturing industries. Interview of manufacturing veterans would also be conducted. The data collected will be analyzed to find patterns and generate themes of the common challenges/risks and find possible solutions. Surveys will be conducted to cover a wider audience with fixed set of questions (both Qualitative and Quantitative) to get clear understanding of the ground reality. A mix of both Primary (Surveys) and secondary sources (various magazines and journals) will be used since the population size is vast and people from different manufacturing industries may not be covered.

3.2 Research Design

Table-1: The research design is as follows:

Ser #	Consideration	Type	Remarks
1	Type of Data	Inductive Qualitative	
2	Source of Data	Primary	Secondary Data is available from fellow researchers and will be used if data points are found suitable
3	Data Collection Methodology	Online Survey & Interview	Cross Sectional
4	Type of Analysis	Qualitative	
5	Type of Research	Survey Research Inductive Qualitative	
6	Type of Sampling	Probability Sampling	Simple Random Sampling
7	Study Population	Manufacturing industry experts/professionals of India	

3.3 Research Method

One of the fundamental responsibilities a researcher has when conducting a study is to ensure that the appropriate research methodology aligns with the research. I selected a qualitative research methodology instead of a quantitative or mixed-methods approach. The intention of my research is to know the various types of supply chain challenges/risks in manufacturing industries in India and find out its potential solutions.

Researchers who follow quantitative research methodology employ certain characteristics towards their study. Researchers using quantitative methodology have adopted a positive philosophy, where the data are deductive and objective (Salvador, 2016; Saunders et al., 2015b). Researchers who follow a quantitative methodology adhere to data collection techniques that are stringent, random, numerical, and use close-ended

questions to deduce relationships among multiple variables (Salvador, 2016; Saunders et al., 2015b). Data collection methods that researchers implement for quantitative studies are from validated surveys or experiments (Salvador, 2016; Saunders et al., 2015b). The survey results allow the researcher to analyze numerical data when determining relationships among variables (Alwin, 2016).

Another type of research methodology is the qualitative method. Researchers who use a qualitative methodology for their study apply an interpretive philosophy, where the data are inductive and subjective (Salvador, 2016; Saunders & Townsend, 2016). Qualitative researchers comply with data collection techniques that are non-standardized, exploratory, and interpretive through open-ended questions during interviews (et al., 2016). Researchers use the information gathered from interviewees to develop insights into how or why procedures are applied (Hamilton & Finley, 2019). A qualitative methodology was justified for this study because I incorporated surveys to collect opinions of various manufacturing professionals & understand their diverse challenges.

3.4 Research Study Period and Schedule

Table-2: Research Study Period and Schedule

Activity	Timeline
Questionnaire Finalization	1 month
Data Collection	4-5 month
Data Analysis	1 month
Thesis Writing	1-2 month
Final Review & presentation	1 month

3.5 Data Collection Procedures

Data collection through web-based surveys is popular among researchers because online surveys can reduce associated research costs, mitigate human error in statistical tabulation, promote individual confidentiality, and increase participation (Evans & Mathur, 2018; McInroy, 2016 et al., 2016). Despite the recognized benefits of an online survey, researchers must be aware of Internet-based questionnaires' disadvantages. Some of the disadvantages of online surveys include minimal response rate, connectivity issues from participants, and selection or response biases (Fricker, 2017; McInroy, 2016; Saleh & Bista, 2017).

Acknowledging both the advantages and disadvantages of internet-based questionnaires, the data collection technique selected to obtain data for this research consisted of online questionnaires. Surveys were disseminated through WhatsApp, personal email or hyper-linked on social media networks for the targeted participants to access the online questionnaire.

Google Forms was the online platform of choice for survey circulation. Google Forms is an internet-based survey tool that is secure, easy to use for both the researcher and participants, allows versatility in developing questionnaires, and creates valuable reports for further analysis (McDowall, 2018). This study's survey questions consisted of 2 sections comprising 19 questions in all. After each participant completed the online survey through web-based Google Forms, a technique referred to as snowball sampling was the primary engagement strategy to reach the target population. Snowball

sampling is when participants from the selected population circulate the survey to other members within the same community (Valerio et al., 2016). The online survey was conducted between December'24 & January'25. A total of 210 entries were received in the online survey.

3.6 Research Design Limitations

A study's limitations are circumstances that place a constraint on a researcher's research because of uncontrollable factors (Edmonds & Kennedy, 2017). There were two identified limitations to my research. The first limitation is lack of holistic knowledge about supply chain: Most of the manufacturing professionals (in their initial & mid carrer levels) still believe that Supply chian primarily revolves only around the suppliers & not the complete value chain. The second limitation included the willingness of manufacturing progfessions to participate voluntarily. Because participation was voluntary, some professionals may not want to participate or histatte to open up about their supply chain challenges & strategies for mitigating those challenges.

CHAPTER IV:

RESULTS

4.1 Introduction

Chapter IV presents the result of the data collection and analysis. The findings of the survey online questionnaire have been represented statistically (for Multiple choice questionnaire) and corresponding pie charts to help understand the findings. Findings from the short answer questionnaire has been summarised in bullet points. The next chapter V discusses the results of Chapter IV in detail.

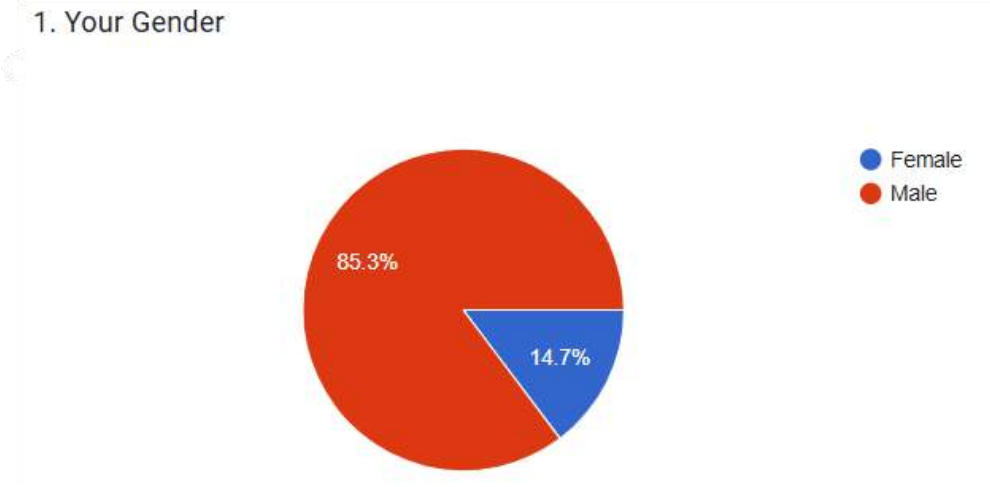
This chapter has been divided into 3 sections after the introduction. The first section contains details about the demographic data of participants in the online survey. The next section talks about the Organization Profile & Supply Chain Risks. Last section talks about summary of the responses received from the short answer questions.

4.2 Demographic data

This section of the chapter describes the demographic data of the participants of the online survey. Survey Online Questions SOQ 1 – SOQ 5 were dedicated for demographic data of participants. Important demographic data has been enumerated in the proceeding paragraphs.

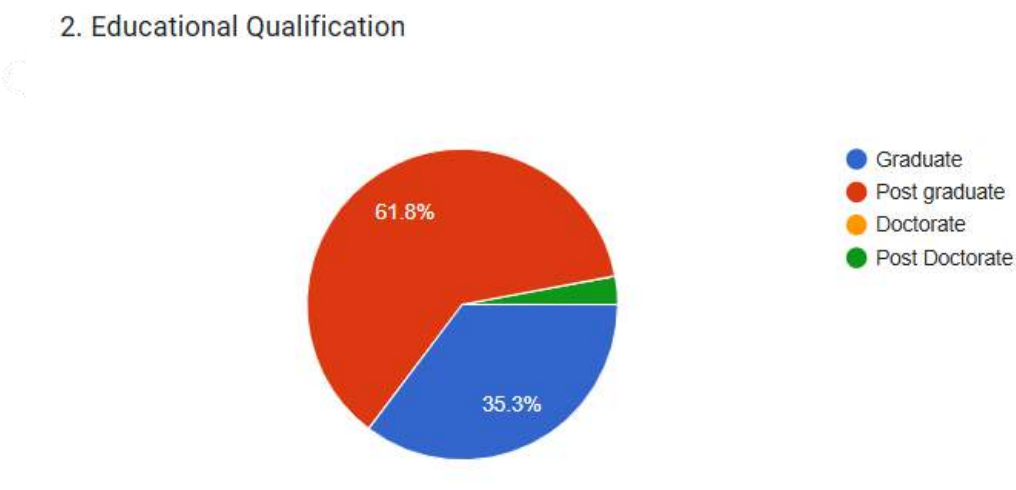
4.2.1 Gender

Question (SOQ-1) recorded the gender brackets of participants of the online survey. The details are appended below: -



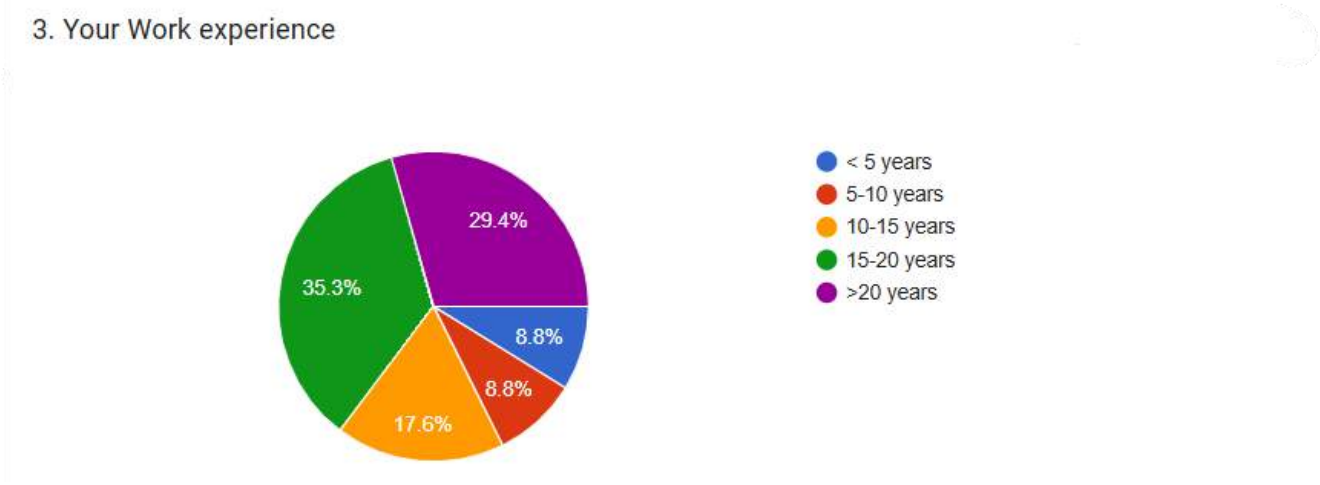
4.2.2 Educational Qualification

Question (SOQ-2) recorded the highest educational Qualification of participants of the online survey. The details are appended below: -



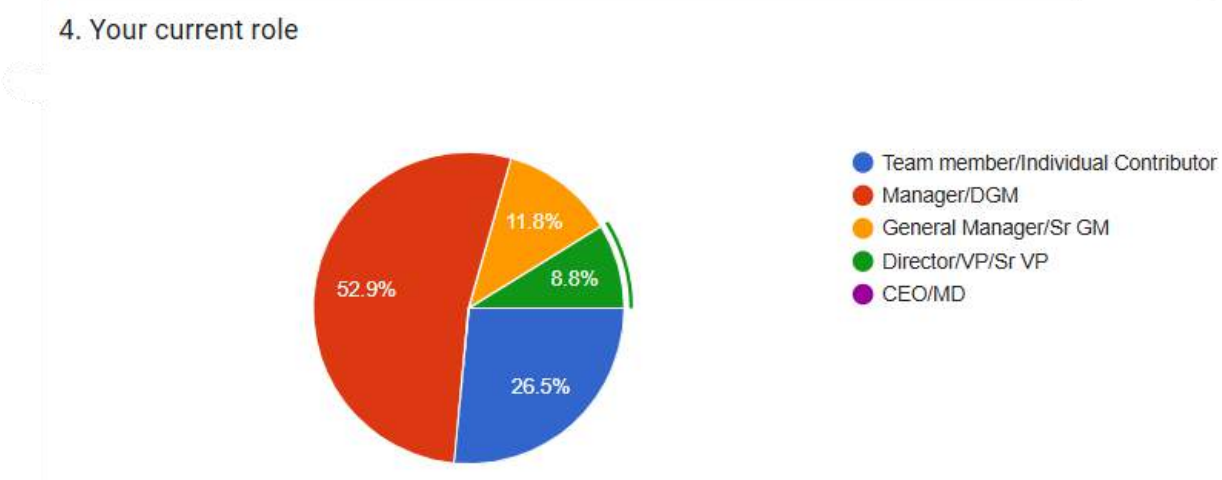
4.2.3 Work Experience

Question (SOQ-3) recorded the work experience of participants of the online survey. The details are appended below: -



4.2.4 Current role in the organization

Question (SOQ-4) recorded the participant's current role in the organization. The details are appended below: -



4.2.5 Current function (within Supply Chain) in the organization

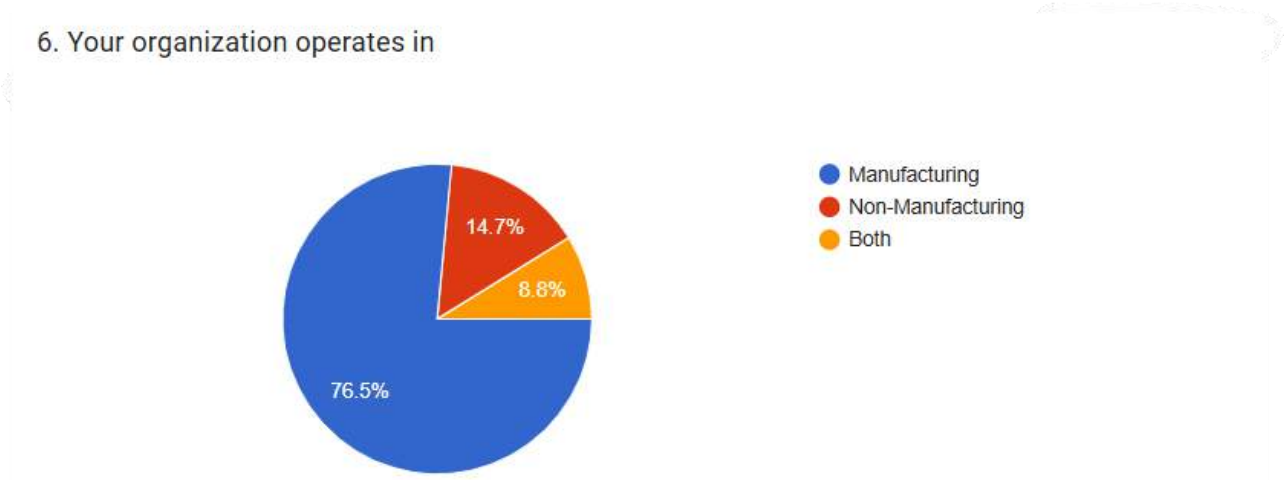
Question (SOQ-5) recorded the participant's current function (within Supply Chain) in the organization. The details are appended below: -

4.3 Organization Profile & Supply Chain Risks

This section of the chapter describes the Organization profile, how often Organization is conducting supply chain risks, % of risks in Supply Chain Management and can these risks be managed? Survey Online Questions SOQ 6 – SOQ 10 were dedicated around this topic. Survey results are enumerated in the proceeding paragraphs.

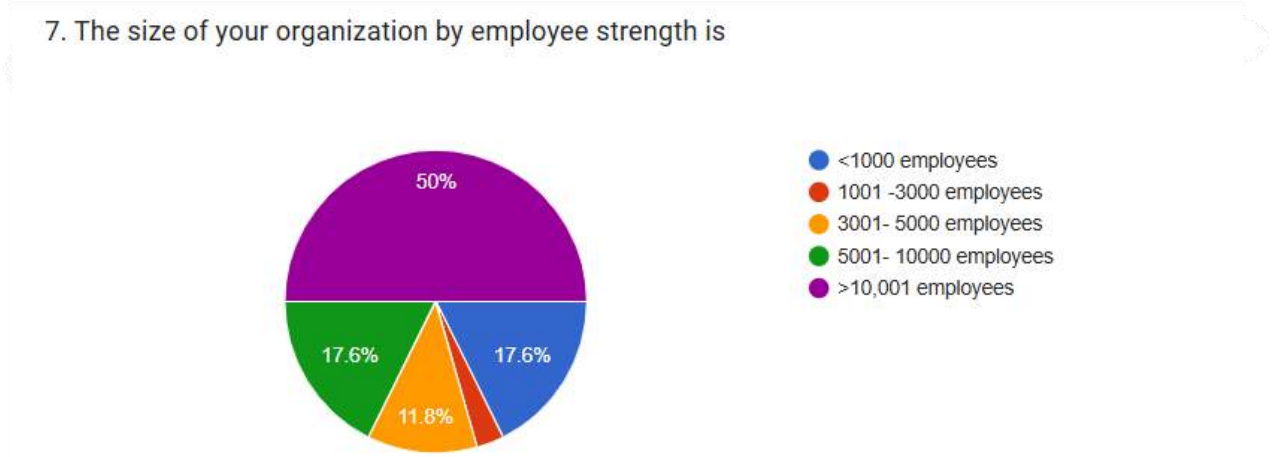
4.3.1 Your organization operates in

Question (SOQ-6) recorded the participant's organization's profile. The details are appended below: -



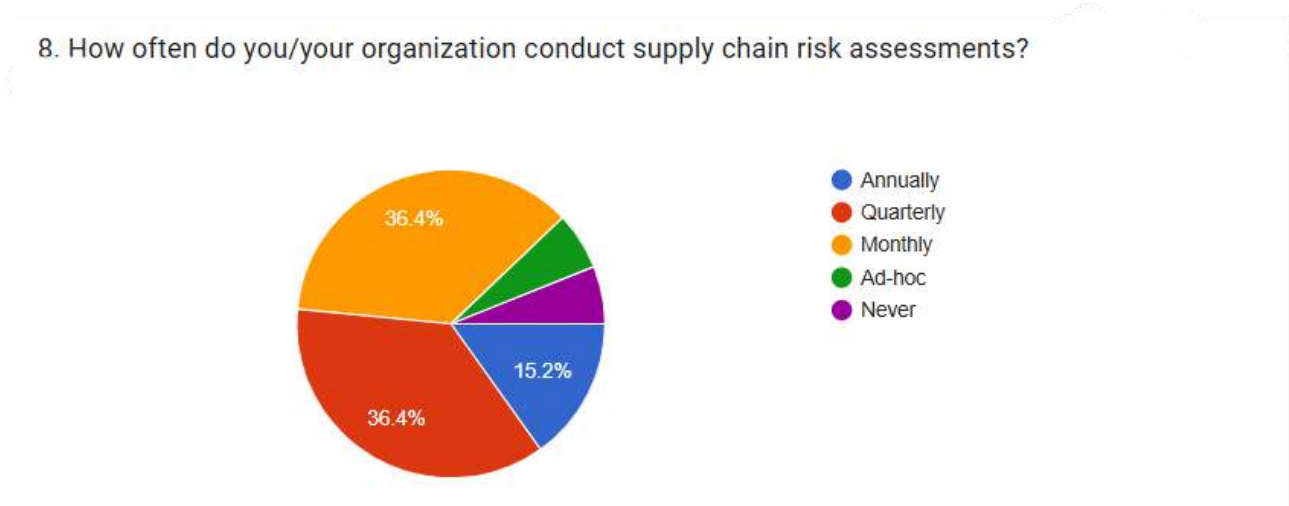
4.3.2 The size of your organization by employee strength is

Question (SOQ-7) recorded the participant's organization's profile. The details are appended below: -



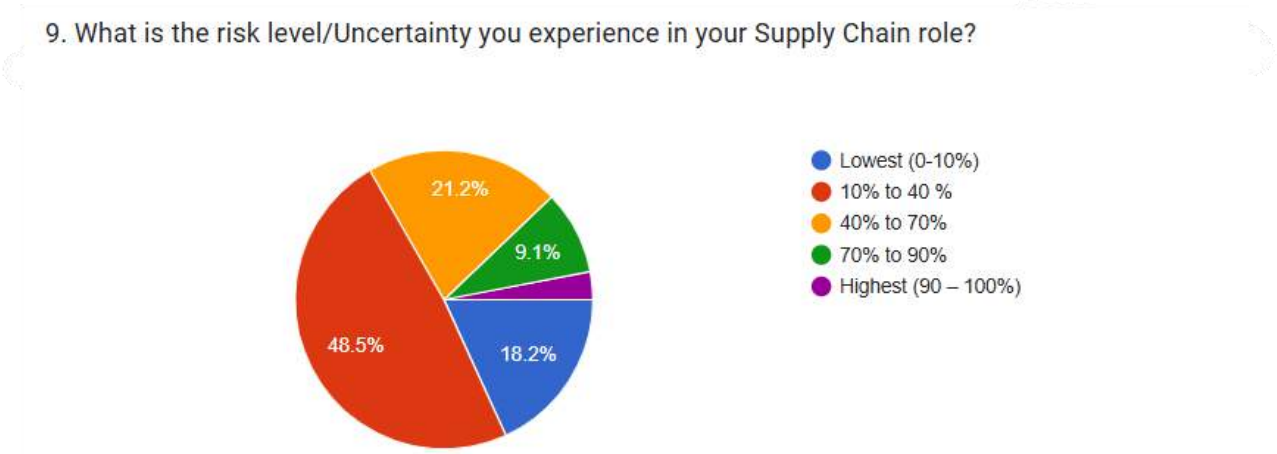
4.3.3 How often do you/your organization conduct supply chain risk assessments?

Question (SOQ-8) recorded the participant's organization's supply chain risk assessment frequency. The details are appended below: -



4.3.4 What is the risk level/Uncertainty you experience in your Supply Chain role?

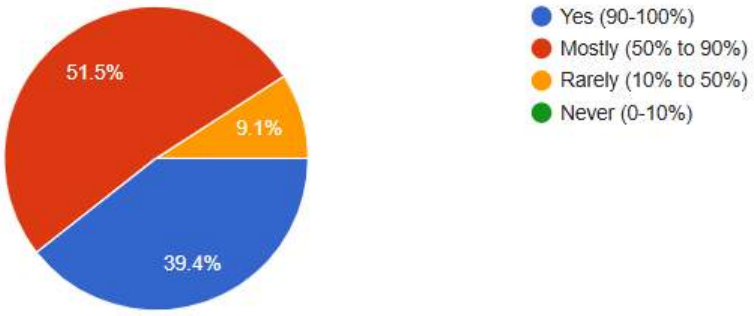
Question (SOQ-9) recorded participant's view on organization's supply chain risk. The details are appended below: -



4.3.5 Do you think these risks can be managed

Question (SOQ-10) recorded participant's view on organization's supply chain risk management. The details are appended below: -

10. Do you think these risks can be managed



4.4 Short Answer Questions (Question # 1 to Question # 9)

4.4.1. What is the biggest challenge you face in your supply chain management role? (describe in 2/3 sentences)

Summary of the responses

- Meeting uncertainties, frauds, demand & supply gambits, bureaucratic transactions while dealing with PSU supply partners, logistics unrests.
- Tier-II supplier RM coverage, Machine Breakdown at supplier end, Manpower crisis (contract role), Quality issues for critical special processes like Welding, Painting, Machining, Wiring, Soldering, Heat treatment etc.
- The biggest challenge in supply chain management is maintaining resilience and agility amidst unpredictable disruptions, such as geopolitical tensions, raw material shortages, or sudden demand fluctuations. Balancing cost efficiency with risk mitigation while ensuring sustainability and compliance adds complexity to decision-making.

- Biggest challenge is the risk mitigation of supplier who is declared as bankrupt.
- Managing the coordination of 14,000 SKUs across daily operations, ensuring planning parameters accuracy, timely monitoring of supply -demand, and minimizing inventory mismatches while handling unforeseen disruptions like supplier delays or demand fluctuations.
- Supply chains have become global and each region has its strength and demands, very challenging to tap best in everything, it becomes very cumbersome. Technology changes are also very fast and to cop up with that for supply base is at times challenging.
- Major challenges are production issues, defects, transportation delays and supplier inconsistency. Most frequent is transportation delays which disrupt the incoming raw materials and parts.
- Uncertainty in demand from wholesale customer. Pricing keeps on changing which also impacts supply.
- Uncertainty of customer order and lack of agility with suppliers.
- Fall in demand due to Market competition & Price War.
- Demand uncertainties and inventory carrying cost.
- Technical issues with printing machine.
- Inventory management, vendor management.
- Price fluctuation of crude oil.
- Supply challenges.
- Part shortage due to production schedule change.
- Holistic approach is missing during project scope definition stage. Effective Feedback system/communication to all the stake holders is missing.

- Geo-political situations and conflicts. Availability of in-house/local technology. Dependability on single source. High lead time for development of products.
- Fluctuating demand across variants/models/SKUs with sudden ramp up and ramp down. The supplier base is spread across geography so lead time prediction becomes very difficult.
- Volume fluctuations based on market demand.
- Government policy changes in case of import.
- Managing disruptions.
- Frequent fluctuation in demand from customer. Unforeseen risks from supply side, market volatility.
- Planning, BOP, Logistics, Understanding of critical situations.
- I face biggest challenge, especially when dealing with global and multiple suppliers. This lead to difficulties in accurately forecasting demand & managing inventory levels.
- Unavailable parts and lack of traction from SCM team.
- Industrial risk of supplier due to poor succession plan, union issues etc. Key components having single source. Long lead time of child parts with tier 2 suppliers.

4.4.2 How does your organization assess and prioritize potential supply chain risks? (Objective: To understand the risk identification and prioritization process)

- We do access SC Risk by performing Full Supply Chain Audit (muti projects) /Light Supply Chain Audit (mono project) for existing/new Suppliers.

- Measure Supplier performance in RYG (3 colour code category) and giving supplier rating based on previous 3 months performance.
- For prioritisation we perform Capacity Audit as well to identify bottleneck process at supplier end and seek for respective mitigation plan
- Our organization assesses and prioritizes potential supply chain risks in the automobile sector through a combination of data-driven analysis and risk mapping. Key factors such as supplier reliability, geopolitical stability, regulatory compliance, and technological disruptions are evaluated to identify vulnerabilities. These risks are ranked based on their potential impact on operations and probability, enabling proactive mitigation strategies to ensure supply chain resilience.
- By identifying the criticality of parts & number of sources we have for the same part.
- The organization evaluates risks through periodic reviews of planning accuracy, supplier reliability, operational data, and logistics performance. Key risks are prioritized based on their potential impact on business continuity and operational efficiency.
- Annual risk assessment/Risk register.
- Ad hoc, no structured approach.
- Risk registers are reviewed by leadership.
- Supply chain mapping, supplier segmentation according to class of materials (ABC analysis), weighted ranking, and value at risk (VaR) analysis are few of the tools used for assessing and prioritizing, to understand and quantify potential vulnerabilities.

- By submitting forecast with manufacturer which ensures timely availability of products.
- Regular assess risk and take actions for mitigation.
- We access risk by calculating the shortfall of books if printing machine is down for a specific time.
- Serious about SCM risks and take proactive steps to mitigate those.
- With the global phenomenon of OPEC.
- Supplier evaluation.
- Quarterly inventory management.
- Through risk priority Matrix.
- Review of single source products.
- There is a Risk Identification and assessment process wherein constraint data are captured monthly from each stakeholder. The data is then compiled in analytic tool called RCCP and being reviewed at the central level in Supply Planning meeting.
- Study the trends and making back up plan.
- Identify and document risks, Risk Assessment, Prioritization, Mitigation Strategies, Monitoring and Review, Strong Governance.
- Our organization focuses on SIOP process. We see major challenges in customer demand. Hence Proper planning is done to enter firm customer orders.
- It's a continuous cycle.
- Detailed working with all stake holders & calculated assumption input.
- Our organization assesses and prioritizes potential supply chain risks through a multi-faceted approach. We utilize a combination of quantitative and

qualitative methods, including risk assessments, supplier audits, and scenario analysis.

- In R&D function implementation of ERP for inventory management.
- Capacity risk assessment through OTD, quality risk assessment through NCR%, Financial risk assessment through credit score, Management risk assessment through periodic supplier connect and QBRs.

4.4.3 What strategies does your organization employ to mitigate supply chain disruptions? (Objective: To explore the organization's contingency plans and resilience strategies)

- To mitigate supply chain disruptions, our organization employs strategies such as diversifying suppliers to reduce dependency on a single source, implementing robust inventory management systems, and leveraging technology for real-time supply chain visibility.
- We establish strong supplier relationships, conduct regular risk assessments, and develop contingency plans, including alternative logistics routes and localized sourcing, to ensure business continuity (BCP).
- Development of alternate source, keeping meeting with suppliers on regular basis.
- Strategies include maintaining safety stock, collaborating with multiple suppliers, implementing robust inventory management systems, and having contingency plans for transportation and logistics delays.
- Product differentiation by maintaining good Quality Product.
- Supplier Relationship Management.
- Transparency in information flow.

- Ontime Payment to suppliers.
- Safety stocks, long term contracts and task force.
- Ad hoc, situational.
- Risk identifications and it's assessment.
- Supplier diversification.
- Inventory management.
- SOP for technology inclusion like real time delivery monitoring.
- Vendor development (locally and nearby plant).
- Collaborative Planning, Forecasting and Replenishment (CPFR)
- Conduct supplier Audit.
- By managing alternate source of printing machines, although getting free printing machine is difficult.
- Long term planning, build tech solutions.
- Putting the three months inventory.
- Periodic Supplier evaluation & Inventory building.
- Warehouse at local area.
- Mix product range planning. Having back-up for critical processes/resources.
- Reduced MTBF and MTTR.
- Indigenisation, Develop alternate source.
- There are multiple Strategies and Strategies depends on kind of risk. For example, If it's long-term risk involving financial health of the vendor then alternate sourcing strategy is adopted, if there is temporary disruption due to manpower then according actions. So like that there are various appropriate actions in line with the risks associated.
- Dual or multiple sourcing.

- Diversification of Suppliers, Digital Transformation, Improving Supplier Relationships,
- Strong SIOP Process. Strong Inventory build-up. Flexibility in Manufacturing Operations.
- Alternate sourcing, strategic inventory planning.
- Risk Register, Mitigation & Heat map.
- Plan Do check act (PDCA).
- Diversification: We maintain a diverse supplier base to reduce reliance on any single supplier and minimize the impact of potential disruptions.
- Inventory Optimization: We implement robust inventory management systems to ensure optimal stock levels, balancing the need for availability with cost-effectiveness.
- Real-time Visibility: We utilize advanced technologies to track shipments and monitor.
- Contingency Planning: We develop comprehensive contingency plans for various scenarios, such as natural disasters, supplier failures, or geopolitical events etc.
- Strong Supplier Relationships: We foster strong partnerships with our suppliers through open communication, collaboration, and joint problem-solving.
- Enterprise risk assessment and strategy, Localisation and dual sourcing initiatives.
- Addressing SCM challenges requires proactive planning, leveraging technology, and fostering strong supplier partnerships.

4.4.4 To what extent has your organization adopted digital technologies in its supply chain operations? (Objective: To gauge the level of digital maturity in the supply chain)

- Our organization has significantly embraced digital technologies to enhance supply chain operations, demonstrating a high level of digital maturity. Key implementations include advanced analytics for demand forecasting, IoT-enabled tracking for real-time visibility, and AI-driven systems for predictive maintenance and risk management.
- We use blockchain for transparent and secure data sharing and robotic process automation (RPA) to streamline repetitive tasks, ensuring an agile and efficient supply chain.
- We are almost fully digitalized.
- The organization is following advanced Excel calculation for inventory tracking, demand forecasting, and logistics management. There is a huge room for improvement in integrating advanced analytics and real-time monitoring.
- Low/Basic level
- MS Excel/Advanced Excel (18-20 responses).
- Usage of bar code identification, real time transportation monitoring/GPS for vehicle running status, online timely schedule monitoring of different materials are few digital technologies adopted by our organization.
- We use zoho as ERP which is cloud based. We have access to our inventory all via digital methods.
- Under development.

- We use several tools and models to simulate the unavailability of printing. This allows us to correctly know the extent of risk factor.
- Fully digitalized.
- Industrial 4.0.
- End to end material relieving system for warehouse and lines. EOL clearance by feedback and SCADA system.
- Almost 25-30% as of now.
- 100%
- Control Tower - Centralized hub that provides real-time, end-to-end visibility across the supply chain. It integrates data, processes, and technology to enhance decision-making and improve overall supply chain performance.
- ERP, Excel. Improvement required going forward to adopt more digitalization.
- In starting phase.
- SAP/Oracle/M3
- Digitised & online update.
- DELMIA, PLM, MES
- We have implemented a variety of solutions, including Enterprise Resource Planning (ERP) systems: To centralize data and streamline processes across various departments. Supply Chain Management (SCM) software: To gain real-time visibility into inventory levels, order status, and shipment tracking. Internet of Things (IoT) devices: To monitor and track assets in transit, ensuring timely and accurate delivery.
- Order booking, Order management and fulfilment are all recorded and tracked digitally.

- Inhouse developed systems (Reliance, Maximo, Power BI Apps).

4.4.5 Which specific digital technologies have had the most significant impact on your supply chain? (Objective: To identify key technologies driving supply chain improvements)

- ERP/SAP/Oracle (15-20 responses).
- Key digital technologies driving significant improvements in our supply chain include IoT for real-time tracking and monitoring, AI for predictive analytics and demand forecasting. These innovations have optimized efficiency, reduced risks, and improved decision-making across the supply chain.
- Online Tendering, E billing, electronic invoicing and Vehicle tracking system, etc.
- ARIBA, SAP FIORI tools are in place for better Supply Chain collaboration between supplier and Alstom.
- Robust ERP System, Inventory management software, warehouse management systems (WMS) and GPS-enabled tracking for logistics have significantly improved operational efficiency and accuracy.
- Shared portals have had key drive-in shortening lead times /TAT.
- Excel based analysis.
- To avoid mismatch of materials of same parts of different models of product, bar code identification on each component is most impressive tools helping our process.
- Zoho
- Pick to light system.

- Forecast and data science.
- SAP, real time tracking.
- Automation/Poka-Yoke.
- SCADA, ANDON, VKS/MES.
- ERP and Purchase through aggregators.
- Power BI Top spot report for various MIS including Inventory.
- AVEVA, ORACLE.
- Robust ERP to be implemented.
- SCC Tool & supplier score card.
- Several digital technologies have had a profound impact on our supply chain, but the most significant ones include Internet of Things (IoT): IoT devices have revolutionized supply chain visibility by enabling real-time tracking of assets and shipments. This has improved inventory accuracy, reduced transit times, and enhanced overall efficiency.
- Artificial Intelligence (AI) and Machine Learning: AI-powered analytics have enabled us to make data-driven decisions, optimize forecasting, and identify potential disruptions early.

4.4.6 How does your organization utilize data analytics to improve supply chain decision-making? (Objective: To understand the role of data-driven insights in supply chain optimization)

- Data analytics is important tool being utilised to periodically review and improve the process.
- On-Time In-Full (OTIF) measure for supplier performance.
- Consumer behaviour study, Market survey, Intelligence.

- Our organization leverages data analytics to enhance supply chain decision-making by analysing historical and real-time data to forecast demand, optimize inventory levels, and improve supplier performance.
- Advanced analytics tools provide actionable insights into potential risks, cost-saving opportunities, and operational inefficiencies, enabling informed, proactive decisions to drive overall supply chain efficiency.
- Data analytics is used for demand forecasting, identifying trends, and optimizing inventory levels to prevent overstocking or stockouts, ultimately improving operational planning and efficiency.
- For better forecasts / inventory optimisation etc.
- Excel and power BI based analytics
- The delivery time and duration each vehicle takes from supplier to our plant is mapped and online software on the basis of PERT is used to analyse the data for better output.
- Always. Data enables to take purchase decisions
- Use exhaustively/ Very often.
- We keep on improving our contacts and stockpile as per the data analysis reports.
- Data analysis, statistical studies are conducted.
- Material Scheduling strategy.
- MTO, MTP concepts.
- Annual procurement, Inventory in stock.
- It's at premature level. Currently it's at the level of Various MIS report and its review.
- Future volume projection based on previous trends.

- Demand Forecasting, Real-Time Monitoring.
- Customer Survey/Meetings. Market survey/Analysis, Investments in Railway sector.
- SAP/ORACLE.
- All metrics monitoring & assigning SPOC to every metrics & continual imprisonment.
- We utilize advanced analytics tools to analyze vast amounts of data from various sources, Including: Demand Forecasting, Inventory Optimization & Transportation and Logistics.
- Shortage with respect to demand/Inventory building.
- Supplier past performance gauged through various metrics and records of fulfilment and quality.

4.4.7 What do you perceive as the most significant challenges facing supply chain management in the next 5 years?

(Objective: To understand the industry's future challenges and opportunities)

- Market competition & Price War with New entrant.
- Cost disruptions. There is a need to optimise the cost of supply chain management to make business more profitable.
- JIT - Lead Time reduction / optimization.
- The most significant challenges to be faced by supply chain management in the next five years include managing geopolitical uncertainties, addressing sustainability and regulatory pressures, and adapting to rapidly evolving technologies.

- Mitigating risks from cyber threats, ensuring supply chain resilience amidst disruptions like pandemics or natural disasters and meeting increasing customer expectations for speed and price will be critical areas of focus.
- To find alternate sources/monopoly of good quality suppliers.
- Challenges include adapting to rapidly changing consumer demand, managing supply chain sustainability, mitigating risks from global disruptions and leveraging advanced technologies like AI and blockchain effectively.
- I think Geopolitical and political situations around the world, trade wars, technological disruptions etc could be the key challenges.
- Agility within supply chain and tariff war between countries.
- Contingency plan for disruptions is most significant challenges in coming years. The substitute supplier (more than two vendors) are real challenges.
- Raw material sourcing challenges in China, global issues.
- Supply constraint on fluctuating demand.
- Use of alternate energy over petroleum product.
- Just in time implementation for MTO.
- Product mix and seasonal demands.
- Non-availability of State-of-the-art technologies in India.
- There would be skill upgradation which is required and current way of operating might change completely. So to manage the skill gap and upgrade the human resource is a big challenge.
- Handling the uncertainty (VUCA world). Steep rise and steep down curve management without impacting cash flow.

- Supply Chain Resilience and Risk Management, Lack of talents and Skill Gaps, Cybersecurity threats.
- Geopolitical risks (~18-20 responses).
- Significant cost reduction with use of AI.
- AI tool & digitisations will take over current practices.
- The next 5 years will present several significant challenges for supply chain management like climate change, Natural disasters, Supply Chain Disruptions, Rising Costs and Inflation, Labor shortage and skills gaps.
- Digital transformation.
- Sustainability (Net 0).

4.4.8 Are there any specific supply chain issues or challenges that your organization is currently addressing? Mitigation Plan?

(Objective: To identify emerging trends and specific pain points & Mitigation Plan)

- Currently, our organization is addressing challenges such as supplier disruptions due to geopolitical tensions, rising costs of raw materials, and meeting sustainability requirements. To mitigate these, we are diversifying our supplier base, adopting cost optimization strategies, and investing in green supply chain initiatives, including energy-efficient logistics and eco-friendly materials. Additionally, we are enhancing real-time visibility through digital tools to proactively manage risks and ensure supply chain resilience.
- Currently, the organization is addressing supply issues and delays. The mitigation plan includes streamlining communication with suppliers,

providing better schedule, and creating a buffer stock at suppliers' warehouse.

- To secure long term supplies for semiconductors, to challenge the costs of Asian competitors and to find a balance between cost and situations around the world.
- Dual sourcing of key suppliers.
- SIOP challenges.
- Ramp up plan for which Suppliers are not fully ready.
- Specific pain point is quality of few specific sheet metal suppliers where the part quality is a major issue. During the transportation, there is high chance of defects being generated causing disruption in production. To mitigate the issue of sheet metal defects during transportation of parts, improvement in packaging/logistics is being done.
- Fright cost optimization is one area which is being addressed.
- Demand vs supply adherence.
- Supply issues due to Russia-Ukraine war.
- Make Vs Buy and SOB issues.
- Design & Process related issues.
- Single source situation.
- Supplier Performance and Reliability - Poor supplier performance can lead to delays and quality issues. Mitigation Plan is to use predictive analytics to monitor supplier health and maintain relationships with multiple suppliers to diversify risk.
- Competition by similar industries, War on cost reduction.

- Challenge - Market saturation, Mitigation Plan - Diversification, Product differentiation.
- Electronics parts management & warranty issues.
- Supply Chain Disruptions - Events like natural disasters, geopolitical tensions, and labour shortages can disrupt the flow of goods.
- Rising Costs - Increased costs of raw materials, transportation, and labour can erode profit margins.
- Supply Chain Visibility - Lack of real-time visibility into the supply chain can hinder decision-making and lead to unexpected delays.
- Demand Forecasting - Inaccurate demand forecasting can result in overstocking or understocking, both of which have negative financial implications. Mitigation Strategies: Diversification: Diversifying suppliers and distribution channels can reduce reliance on single sources and mitigate risks.
- Risk Management - Implementing robust risk management strategies, including contingency planning and business continuity plans, can help organizations respond to disruptions effectively.
- Digital Transformation - Leveraging digital technologies like IoT, AI, and blockchain can improve supply chain visibility, efficiency, and resilience. Strong Supplier Relationships - Building strong relationships with suppliers can foster collaboration, improve communication, and ensure timely delivery of goods.
- Localisation
- Supplier disruption due to industrial or management risks, unions and their leadership. Mitigation - alternate supplier development.

4.4.9 Any additional comments or suggestions regarding supply chain risks & mitigation

- Relying on a single source for critical supplies poses a significant risk, as it increases vulnerability to disruptions caused by supplier failures, geopolitical events, or natural disasters. To mitigate this risk, organizations should adopt a dual or multi-sourcing strategy, build strong relationships with secondary suppliers, and maintain safety stock levels. Additionally, leveraging digital tools for supplier performance monitoring can provide early warnings of potential disruptions.
- Building a resilient supply chain requires a proactive approach to risk assessment, investment in digital technologies, and stronger collaboration with suppliers. Regular training and scenario planning can further prepare the organization for unforeseen disruptions.
- Preparing to be Agile supply chain team would be the key to deal with future challenges in supply chain.
- Structured approach with strong ERP can go long way in mitigating supply chain issues.
- Supply chain risk once identified can be mitigated using tools like Value stream mapping.
- Collaboration/Timely communication/Flow of Information.
- Robust SIOP Process
- Firm scheduled planning is the key to mitigate the risk at organization level as well as supplier level.
- Regular analysis of risk and mitigation plan.

- Always ready with plan B.
- Invest in Technology - Leverage the latest technologies such as AI, blockchain, and IoT to enhance visibility and predictive capabilities. These technologies can provide real-time data and insights, helping to anticipate and mitigate risks more effectively.
- Cybersecurity - As supply chains become more digitized, cybersecurity becomes crucial. Implement robust cybersecurity measures, conduct regular audits, and ensure that all partners in the supply chain adhere to high security standards.
- Risk analysis to be done every quarter.
- To involve right set of people with identification of right talent & ensuring right process is followed.
- There are emerging challenges that organizations need to address: Climate Change and Sustainability: Climate change can impact supply chain through extreme weather events, supply shortages, and increased transportation costs.
- Supply Chain Labor Shortages - Labor shortages can disrupt operations, particularly in logistics and warehousing. Organizations may need to invest in automation, robotics, and artificial intelligence to address this challenge.
- Ethical Sourcing and Human Rights - Consumers and regulators are increasingly demanding ethical and sustainable sourcing practices.

CHAPTER V:

DISCUSSION

5.1 Introduction

This chapter discusses the results enumerated in the previous chapter IV. The chapter comprises **3** sections after the introduction. The first section comprises discussions on the demographic data of the respondents. The next section talks about the Organization Profile & Supply Chain Risks. Last section talks about the summary of the responses received from short answer questions.

The next two sections (5.2 & 5.3) discuss about the Research Questions 1- 10, i.e. responses received from multiple choice questions. The last section 5.4 discusses about the Research Questions 11- 19, i.e. responses received from short answer questions.

5.2 Discussion of Demographic data

In the study, the demographic data of the respondents were captured and the results were provided in section 4.2. The demographic data helped understand and categorize the respondents on multiple factors thereby assisting in the analysis of data. Important observations of the demographic data are appended below:-

5.2.1 Gender

The majority of the respondents (85.3%) were male & remaining 14.7% were female. It indicates that Indian manufacturing company is still dominated by male employees. Presence of male members in manufacturing company is almost 6 times than that of female.

5.2.2 Discussion of Educational Qualification

Majority of the respondents (61.8%) were post-graduates and next largest group (35.3%) were graduates. It indicates that white collars in Indian organisations are having more post graduates than graduates. People are aspired to get higher/senior positions in the organization - major reason for people to go for higher studies. Primary reason could be the growing Indian population.

5.2.3 Discussion of Work experience

Majority of the respondents (35.3%) were having 15-20 yrs of work experience. The second largest group (29.4%) were having more than 20 yrs of work experience. The third largest group (17.6%) were having 10-15 yrs of work experience. Each 8.8% of population were having less than 5 yrs & 5-10 yrs of work experience. It indicates that more than half of the population (~55%) in this survey are having more than 15 yrs of work experience, means having significant amount of experience handling supply chain in various organizations. They can be called as veterans of supply chain domain. Hence the survey results can be considered as realistic.

5.2.4 Discussion of Current role/designation in the organization

Majority of the respondents (52.9%) were either Manager or DGM. The second largest group (26.5%) were either team member or individual contributor. The third largest group (11.8%) were either general manager or Senior GM. Another group (8.8%) were either Director or VP or Senior VP. It indicates that approx. 73% (52.9% + 11.8% + 8.8%) of the population in this survey are either Manager or seniors. Hence, they have great experience of handling supply chain in various organizations. This result aligns with their work experience (5.2.3).

5.2.5 Discussion of Current role within the Supply Chain

Majority of the respondents (26.5%) were in Procurement/buyer role. The second largest group (23.5%) were in technical role like; Manufacturing/Process Engineering, NPI, Lean, etc. The third largest group (17.6%) were in direct manufacturing. 11.8% in sourcing, 8.8% in sales/after sales, 6% in warehouse/logistics/Inventory management & last 6% in SIOP/PPC domain. Entire survey group is very close to manufacturing & allied processes.

5.3 Organization Profile & Supply Chain Risks

This section of the chapter describes the Organization profile, how often Organization is conducting supply chain risks, % of risks in Supply Chain Management and can these risks be managed? Survey Online Questions SOQ 6 – SOQ 10 were dedicated around this topic.

5.3.1 Your organization operates in

Majority of the respondents (76.5%) were working in Manufacturing organization, 14.7% in non-manufacturing & remaining 8.8% were common in both manufacturing & non-manufacturing. Hence total 76.5+8.8 ~ 85% are related to manufacturing.

5.3.2 The size of your organization by employee strength is

50% of the respondents were working in large size organization where the employee strength was more than 10,000. 17.6% respondents were working with the organization with employee strength between 5,001 to 10,000. Next 11.8% respondents were working with the organization with employee strength between 3,001 to 5,000. Last 17.6% respondents were working with the organization with employee strength of less than 1000 employees.

5.3.3 How often do you/your organization conduct supply chain risk assessments?

Almost 73% of the organizations were doing supply chain risk assessment either quarterly or monthly. It infers that 73% of the organizations realize understand Supply chain risk & hence the need of frequent supply chain risk assessment. However, 15 % organizations does supply chain risk assessment annually.

5.3.4 What is the risk level/Uncertainty you experience in your Supply Chain role?

48.5 % of the respondents have witnessed 10 to 40% supply chain risk in their role. 21.2 % of the respondents have witnessed 40 to 70% supply chain risk in their role. 18.2 % of the respondents have witnessed less than 10% supply chain risk. 9.1 % of the respondents have witnessed 70 to 90% supply chain risk. Remaining 3% have witnessed 90 to 100% supply chain risk in their role.

5.3.5 Do you think these risks can be managed

51.5% respondents believe that Supply chain risks can be managed largely upto the extend between 50% to 90%. 39.4% respondents believe that Supply chain risks can be managed fairly between 90% to 100%. Remaining 9.1% respondents believe that Supply chain risks can be managed rarely between 10% to 50%.

5.4 Response on Short Answer Questions (Question # 1 to Question # 9)

5.4.1 What is the biggest challenge you face in your supply chain management role? (describe in 2/3 sentences)

Major challenges in supply chain belong to either supply side or demand side or information flow. Multiple reasons were mentioned by respondents on both the aspects.

Key challenges from Supply side were:

- Fall in demand due to Market competition & Price war.

- Meeting uncertainties, frauds, demand & supply gambits, bureaucratic transactions while dealing with PSU supply partners, logistics unrests.
- Tier-II supplier RM coverage, Machine Breakdown at supplier end, Manpower crisis (contract role), Quality issues for critical special processes like Welding, Painting, Machining, Wiring, Soldering, Heat treatment etc.
- Biggest challenge is the risk mitigation of supplier who is declared as bankrupt.
- Major challenges are production issues, defects, transportation delays and supplier inconsistency. Most frequent is transportation delays which disrupt the incoming raw materials and parts.
- Price fluctuation of crude oil.
- Part shortage due to production schedule change.
- Unavailable parts and lack of traction from SCM team.
- Industrial risk of supplier due to poor succession plan, union issues etc. Key components having single source. Long lead time of child parts with tier 2 suppliers.

Key challenges from Demand side were:

- Demand uncertainties and inventory carrying cost.
- Volume fluctuations based on market demand.

Key challenges related to Information flow were:

- Holistic approach is missing during project scope definition stage. Effective Feedback system/communication to all the stake holders is missing.
- Planning, BOP, Logistics, Understanding of critical situations.

- I face biggest challenge, especially when dealing with global and multiple suppliers. This leads to difficulties in accurately forecasting demand & managing inventory levels.

Key challenges related to both Supply as well as Demand were:

- The biggest challenge in supply chain management is maintaining resilience and agility amidst unpredictable disruptions, such as geopolitical tensions, raw material shortages, or sudden demand fluctuations. Balancing cost efficiency with risk mitigation while ensuring sustainability and compliance adds complexity to decision-making.
- Managing the coordination of 14,000 SKUs across daily operations, ensuring planning parameters accuracy, timely monitoring of supply -demand, and minimizing inventory mismatches while handling unforeseen disruptions like supplier delays or demand fluctuations.
- Supply chains have become global and each region has its strength and demands, very challenging to tap best in everything, it becomes very cumbersome. Technology changes are also very fast and to cop up with that for supply base is at times challenging.
- Uncertainty of customer order and lack of agility with suppliers.
- Uncertainty in demand from wholesale customer. Pricing keeps on changing which also impacts supply.
- Inventory management, vendor management.
- Geo-political situations and conflicts. Availability of in-house/local technology. Dependability on single source. High lead time for development of products.

- Fluctuating demand across variants/models/SKUs with sudden ramp up and ramp down. The supplier base is spread across geography so lead time prediction becomes very difficult.
- Government policy changes in case of import.
- Frequent fluctuation in demand from customer. Unforeseen risks from supply side, market volatility.

5.4.2 How does your organization assess and prioritize potential supply chain risks? (Objective: To understand the risk identification and prioritization process)

Different organizations are assessing their supply chain risks differently. Based on risk assessment, organizations are prioritizing the risks:

- Risk registers are reviewed by leadership.
- We do access SC Risk by performing Full Supply Chain Audit (muti projects) /Light Supply Chain Audit (mono project) for existing/new Suppliers.
- Measure Supplier performance in RYG (3 colour code category) and giving supplier rating based on previous 3 months performance.
- For prioritisation we perform Capacity Audit as well to identify bottleneck process at supplier end and seek for respective mitigation plan.
- Our organization assesses and prioritizes potential supply chain risks in the automobile sector through a combination of data-driven analysis and risk mapping. Key factors such as supplier reliability, geopolitical stability, regulatory compliance, and technological disruptions are evaluated to identify vulnerabilities. These risks are ranked based on their potential impact on operations and probability (heat map), enabling proactive mitigation strategies to ensure supply chain resilience.

- By identifying the criticality of parts & number of sources we have for the same part.
- The organization evaluates risks through periodic reviews of planning accuracy, supplier reliability, operational data, and logistics performance. Key risks are prioritized based on their potential impact on business continuity and operational efficiency.
- Annual risk assessment/Risk register.
- Ad hoc, no structured approach.
- Supply chain mapping, supplier segmentation according to class of materials (ABC analysis), weighted ranking, and value at risk (VaR) analysis are few of the tools used for assessing and prioritizing, to understand and quantify potential vulnerabilities.
- By submitting forecast with manufacturer which ensures timely availability of products.
- Regular assess risk and take actions for mitigation.
- Serious about SCM risks and take proactive steps to mitigate those.
- With the global phenomenon of OPEC.
- Supplier evaluation.
- Quarterly inventory management.
- Through risk priority Matrix.
- Review of single source products.
- There is a Risk Identification and assessment process wherein constraint data are captured monthly from each stakeholder. The data is then compiled in analytic tool called RCCP and being reviewed at the central level in Supply Planning meetings.
- Study the trends and making back up plan.

- Identify and document risks, Risk Assessment, Prioritization, Mitigation Strategies, Monitoring and Review, Strong Governance.
- Our organization focuses on SIOP (Sales Inventory & Operations Planning) process. We see major challenges in customer demand. Hence Proper planning is done to enter firm customer orders.
- It's a continuous cycle.
- Detailed working with all stake holders & calculated assumption input.
- Our organization assesses and prioritizes potential supply chain risks through a multi-faceted approach. We utilize a combination of quantitative and qualitative methods, including risk assessments, supplier audits, and scenario analysis.
- In R&D function implementation of ERP for inventory management.
- Capacity risk assessment through OTD, quality risk assessment through NCR%, Financial risk assessment through credit score, Management risk assessment through periodic supplier connect and QBRs.

5.4.3 What strategies does your organization employ to mitigate supply chain disruptions? (Objective: To explore the organization's contingency plans and resilience strategies)

Multiple responses have been received on the survey. Organizations are adopting different strategies to mitigate supply chain risks depending upon nature of risks. For example, If it's long-term risk involving financial health of the vendor then alternate sourcing strategy is adopted, if there is temporary disruption due to manpower/resources then according actions.

Some are using strategies to mitigate supply side risks; some are using strategies to mitigate demand side risks while some of them are using strategies to mitigate risks on the both the

sides. Survey results illustrate that still most of the organizations (~80-90 %) are focusing on supply side risks & not on demand or information flow.

Key strategies to mitigate Supply side risks:

- Supplier Relationship Management (SRM).
- Ontime Payment to suppliers.
- To mitigate supply chain disruptions, our organization employs strategies such as diversifying suppliers to reduce dependency on a single source, implementing robust inventory management systems, and leveraging technology for real-time supply chain visibility.
- We establish strong supplier relationships, conduct regular risk assessments, and develop contingency plans, including alternative logistics routes and localized sourcing, to ensure business continuity (BCP).
- Development of alternate source, keeping meeting with suppliers on regular basis.
- Strategies include maintaining safety stock, collaborating with multiple suppliers, implementing robust inventory management systems, and having contingency plans for transportation and logistics delays.
- Safety stocks, long term contracts and task force.
- Supplier diversification.
- Inventory management.
- Conduct supplier Audit/ Periodic Supplier evaluation.
- Long term planning, build tech solutions.
- Putting the three months inventory.
- Mix product range planning. Having back-up for critical processes/resources.
- Reduced MTBF (Mean Time between Failures) and MTTR (Mean Time to Repair).

- Indigenisation, Develop alternate source.
- Warehouse at local area.
- Diversification: We maintain a diverse supplier base to reduce reliance on any single supplier and minimize the impact of potential disruptions.
- Inventory Optimization: We implement robust inventory management systems to ensure optimal stock levels, balancing the need for availability with cost-effectiveness.
- Real-time Visibility: We utilize advanced technologies to track shipments and monitor.
- Contingency Planning: We develop comprehensive contingency plans for various scenarios, such as natural disasters, supplier failures, or geopolitical events etc.
- Strong Supplier Relationships: We foster strong partnerships with our suppliers through open communication, collaboration, and joint problem-solving.
- Enterprise risk assessment and strategy, Localisation and dual sourcing initiatives.
- Addressing SCM challenges requires proactive planning, leveraging technology, and fostering strong supplier partnerships.

Key strategies to mitigate Demand side risks:

- Product differentiation by maintaining good Quality Product.

Key strategies to mitigate both Supply as well as Demand side risks:

- Collaborative Planning, Forecasting and Replenishment (CPFR)
- Risk identifications and its assessment.
- SOP for technology inclusion like real time delivery monitoring.
- Ad hoc, situational.
- Different strategies depending upon types of risks associated.

- Diversification of Suppliers, Digital Transformation, Improving Customer-Supplier Relationship.
- Strong SIOP Process. Strong Inventory build-up. Flexibility in Manufacturing Operations.
- Risk Register preparation, Heat map & Mitigation actions.
- Plan Do check act (PDCA).

Key strategies to mitigate risks related to information flow:

- Transparency in information flow.

5.4.4 To what extent has your organization adopted digital technologies in its supply chain operations? (Objective: To gauge the level of digital maturity in the supply chain)

Survey result depicts that most organizations are still using conventional tools like MS Excel/advanced Excel & ERP (SAP, Oracle, local ERP). While some organizations are using advanced digital technologies like Industry 4.0, IoT & AI driven tools.

- MS Excel/Advanced Excel (18-20 responses).
- Our organization has significantly embraced digital technologies to enhance supply chain operations, demonstrating a high level of digital maturity. Key implementations include advanced analytics for demand forecasting, IoT-enabled tracking for real-time visibility, and AI-driven systems for predictive maintenance and risk management.
- The organization is following advanced Excel calculation for inventory tracking, demand forecasting, and logistics management. There is a huge room for improvement in integrating advanced analytics and real-time monitoring.

- Low/Basic level.
- Usage of bar code identification, real time transportation monitoring/GPS for vehicle running status, online timely schedule monitoring of different materials are few digital technologies adopted by our organization.
- We use zoho as ERP which is cloud based. We have access to our inventory all via digital methods.
- We are almost fully digitalized.
- We use blockchain for transparent and secure data sharing and robotic process automation (RPA) to streamline repetitive tasks, ensuring an agile and efficient supply chain.
- End to end material relieving system for warehouse and lines. EOL clearance by feedback and SCADA system.
- Almost 25-30% as of now.
- Control Tower - Centralized hub that provides real-time, end-to-end visibility across the supply chain. It integrates data, processes, and technology to enhance decision-making and improve overall supply chain performance.
- ERP, Excel. Improvement required going forward to adopt more digitalization.
- DELMIA, PLM (Product Lifecycle Management), MES (Manufacturing Execution System).
- We have implemented a variety of solutions, including: Enterprise Resource Planning (ERP) systems: To centralize data and streamline processes across various departments. Supply Chain Management (SCM) software: To gain real-time visibility into inventory levels, order status, and shipment tracking. Internet of Things (IoT) devices: To monitor and track assets in transit, ensuring timely and accurate delivery.

- Order booking, Order management and fulfilment are all recorded and tracked digitally.
- Inhouse developed systems like Reliance for Quality Management, Maximo for Asset Management, Power BI Apps for workflow approvals).

5.4.5 Which specific digital technologies have had the most significant impact on your supply chain? (Objective: To identify key technologies driving supply chain improvements)

- Key digital technologies driving significant improvements in our supply chain include IoT for real-time tracking and monitoring, AI for predictive analytics and demand forecasting. These innovations have optimized efficiency, reduced risks, and improved decision-making across the supply chain.
- Robust ERP System, Inventory management software, warehouse management systems (WMS) and GPS-enabled tracking for logistics have significantly improved operational efficiency and accuracy.
- ERP/SAP/Oracle (Maximum responses).
- Online Tendering, E billing, electronic invoicing and Vehicle tracking system, etc.
- ARIBA, SAP FIORI tools are in place for better Supply Chain collaboration between supplier and Alstom.
- Shared portals have had key drive-in shortening lead times /TAT.
- Excel based analysis.
- To avoid mismatch of materials of same parts of different models of product, bar code identification on each component is most impressive tools helping our process.
- Zoho

- Pick to light system.
- Forecast and data science.
- SAP, real time tracking.
- Automation/Poka-Yoke.
- SCADA, ANDON, VKS/MES.
- ERP and Purchase through aggregators.
- Power BI Top spot report for various MIS including Inventory.
- AVEVA, ORACLE.
- SCC Tool & supplier score card.
- Several digital technologies have had a profound impact on our supply chain, but the most significant ones include Internet of Things (IoT): IoT devices have revolutionized supply chain visibility by enabling real-time tracking of assets and shipments. This has improved inventory accuracy, reduced transit times, and enhanced overall efficiency.
- Artificial Intelligence (AI) and Machine Learning: AI-powered analytics have enabled us to make data-driven decisions, optimize forecasting, and identify potential disruptions early.

5.4.6 How does your organization utilize data analytics to improve supply chain decision-making? (Objective: To understand the role of data-driven insights in supply chain optimization)

Multiple responses have been received on the survey. Different organizations are utilizing data analytics differently to improve supply chain decision-making.

- Our organization leverages data analytics to enhance supply chain decision-making by analysing historical and real-time data to forecast demand, optimize inventory levels, and improve supplier performance.
- Consumer behaviour study, Market survey, Intelligence.
- Data analytics is important tool being utilised to periodically review and improve the process.
- On-Time In-Full (OTIF) measure for supplier performance.
- Advanced analytics tools provide actionable insights into potential risks, cost-saving opportunities, and operational inefficiencies, enabling informed, proactive decisions to drive overall supply chain efficiency.
- Data analytics is used for demand forecasting, identifying trends, and optimizing inventory levels to prevent overstocking or stockouts, ultimately improving operational planning and efficiency.
- For better forecasts / inventory optimisation etc.
- Excel and power BI based analytics.
- The delivery time and duration each vehicle takes from supplier to our plant is mapped and online software on the basis of PERT is used to analyse the data for better output.
- Use exhaustively/ Very often.
- We keep on improving our contacts and stockpile as per the data analysis reports.
- Data analysis, statistical studies are conducted.
- Material Scheduling strategy.
- MTO, MTP concepts.
- Annual procurement, Inventory in stock.

- It's at premature level. Currently it's at the level of Various MIS report and its review.
- Future volume projection based on previous trends.
- Demand Forecasting, Real-Time Monitoring.
- Customer Survey/Meetings. Market survey/Analysis, Investments in Railway sector.
- All metrics monitoring & assigning SPOC to every metrics & continual imprisonment.
- We utilize advanced analytics tools to analyze vast amounts of data from various sources, Including: Demand Forecasting, Inventory Optimization & Transportation and Logistics.
- Shortage with respect to demand/Inventory building.
- Supplier past performance gauged through various metrics and records of fulfilment and quality.

5.4.7 What do you perceive as the most significant challenges facing supply chain management in the next 5 years? (Objective: To understand the industry's future challenges and opportunities)

As per survey feedback, Supply chain is expected to have multiple challenges in next 5 years. The risks can be classified into 6 major categories:

4 **Supplier Risks**:

5 **Geopolitical Risks**:

6 **Natural Risks**:

7 **Economic Risks**:

8 **Technological Risks**:

9 **Regulatory Risks**:

Details of potential risks (as per survey feedback):

- The most significant challenges to be faced by supply chain management in the next five years include managing geopolitical uncertainties, addressing sustainability and regulatory pressures, and adapting to rapidly evolving technologies.
- Market competition & Price War with New entrant.
- Cost disruptions - Cost optimisation – Making business more profitable.
- JIT - Lead Time reduction / optimization.
- Mitigating risks from cyber threats, ensuring supply chain resilience amidst disruptions like pandemics or natural disasters and meeting increasing customer expectations for speed and price will be critical areas of focus.
- To find alternate sources/monopoly of good quality suppliers.
- Challenges include adapting to rapidly changing consumer demand, managing supply chain sustainability, mitigating risks from global disruptions and leveraging advanced technologies like AI and blockchain effectively.
- Geopolitical and political situations around the world (~18-20 responses), trade wars, technological disruptions etc could be the key challenges.
- Agility within supply chain and tariff war between countries.
- Contingency plan for disruptions is most significant challenges in coming years. The substitute supplier (more than two vendors) are real challenges.
- Raw material sourcing challenges in China, global issues.
- Supply constraint on fluctuating demand.
- Use of alternate energy over petroleum product.

- Just in time implementation for MTO.
- Product mix and seasonal demands.
- Non-availability of State-of-the-art technologies in India.
- There would be skill upgradation, which is required, and current way of operating might change completely. So to manage the skill gap and upgrade the human resource is a big challenge.
- Handling the uncertainty (VUCA world). Steep rise and steep down curve management without impacting cash flow.
- Supply Chain Resilience and Risk Management, Lack of talents and Skill Gaps, Cybersecurity threats.
- Significant cost reduction with use of AI.
- AI tool & digitisations will take over current practices.
- The next 5 years will present several significant challenges for supply chain management like climate change, Natural disasters, Supply Chain Disruptions, Rising Costs and Inflation, Labor shortage and skills gaps.
- Digital transformation.
- Sustainability (Net 0).

5.4.8 Are there any specific supply chain issues or challenges that your organization is currently addressing? Mitigation Plan? (Objective: To identify emerging trends and specific pain points & Mitigation Plan)

As per survey feedback, there are specific supply chain issues or challenges that almost all the organizations are facing & trying to solve in different ways. Largely, the challenges belong to supply side. Summary of the survey feedback:

- Currently, our organization is addressing challenges such as supplier disruptions due to geopolitical tensions, rising costs of raw materials, and meeting sustainability requirements. To mitigate these, we are diversifying our supplier base, adopting cost optimization strategies, and investing in green supply chain initiatives, including energy-efficient logistics and eco-friendly materials. Additionally, we are enhancing real-time visibility through digital tools to proactively manage risks and ensure supply chain resilience.
- Currently, the organization is addressing supply issues and delays. The mitigation plan includes streamlining communication with suppliers, providing better schedule, and creating a buffer stock at suppliers' warehouse.
- To secure long term supplies for semiconductors, to challenge the costs of Asian competitors and to find a balance between cost and situations around the world.
- Specific pain point is quality of few specific sheet metal suppliers where the part quality is a major issue. During the transportation, there is high chance of defects being generated causing disruption in production. To mitigate the issue of sheet metal defects during transportation of parts, improvement in packaging/logistics is being done.
- Supplier Performance and Reliability - Poor supplier performance leads to delays and quality issues. Mitigation Plan is to use predictive analytics to monitor supplier health and maintain relationships with multiple suppliers to diversify risk.
- Demand Forecasting - Inaccurate demand forecasting can result in overstocking or understocking, both of which have negative financial implications. Mitigation Strategies: Diversification: Diversifying suppliers and distribution channels can reduce reliance on single sources and mitigate risks.

- Risk Management - Implementing robust risk management strategies, including contingency planning and business continuity plans, can help organizations respond to disruptions effectively.
- Digital Transformation - Leveraging digital technologies like IoT, AI, and blockchain can improve supply chain visibility, efficiency, and resilience. Strong Supplier Relationships - Building strong relationships with suppliers can foster collaboration, improve communication, and ensure timely delivery of goods.
- Supplier disruption due to industrial or management risks, unions and their leadership. Mitigation - alternate supplier development.
- Supply Chain Disruptions - Events like natural disasters, geopolitical tensions, and labour shortages can disrupt the flow of goods.
- Rising Costs - Increased costs of raw materials, transportation, and labour can erode profit margins.
- Competition by similar industries, War on cost reduction.
- Challenge - Market saturation, Mitigation Plan - Diversification, Product differentiation.
- Electronics parts management & warranty issues.
- Supply Chain Visibility – Lack of real-time visibility into the supply chain hinders decision-making and lead to unexpected delays.
- Ramp up plan for which Suppliers are not fully ready.
- Dual sourcing of key suppliers.
- Localisation
- SIOP challenges.
- Fright cost optimization is one area which is being addressed.
- Demand vs supply adherence.

- Make Vs Buy and SOB issues.
- Design & Process related issues.

5.4.9 Any additional comments or suggestions regarding supply chain risks & mitigation?

Idea for having this question in the survey was to know any topic which might not have been covered in the survey questionnaire & still respondents want to share & let others know. Good response/suggestions have been received against this question by multiple respondents. Summary is as below:

- Relying on a single source for critical supplies poses a significant risk, as it increases vulnerability to disruptions caused by supplier failures, geopolitical events, or natural disasters. To mitigate this risk, organizations should adopt a dual or multi-sourcing strategy, build strong relationships with secondary suppliers, and maintain safety stock levels.
- Leveraging digital tools for supplier performance monitoring can provide early warnings of potential disruptions.
- Building a resilient supply chain requires a proactive approach to risk assessment, investment in digital technologies, and stronger collaboration with suppliers. Regular training and scenario planning can further prepare the organization for unforeseen disruptions.
- Preparing to be Agile supply chain team would be the key to deal with future challenges in supply chain.
- Structured approach with strong ERP can go long way in mitigating supply chain issues.

- Supply chain risk once identified can be mitigated using tools like Value stream mapping.
- Firm scheduled planning is the key to mitigate the risk at organization level as well as supplier level.
- Invest in Technology - Leverage the latest technologies such as AI, blockchain, and IoT to enhance visibility and predictive capabilities. These technologies can provide real-time data and insights, helping to anticipate and mitigate risks more effectively.
- Cybersecurity - As supply chains become more digitized, cybersecurity becomes crucial. Implement robust cybersecurity measures, conduct regular audits, and ensure that all partners in the supply chain adhere to high security standards.
- There are emerging challenges that organizations need to address: Climate Change and Sustainability: Climate change can impact supply chain through extreme weather events, supply shortages, and increased transportation costs.
- Supply Chain Labor Shortages - Labor shortages can disrupt operations, particularly in logistics and warehousing. Organizations may need to invest in automation, robotics, and artificial intelligence to address this challenge.
- Ethical Sourcing and Human Rights - Consumers and regulators are increasingly demanding ethical and sustainable sourcing practices.
- To involve right set of people with identification of right talent & ensuring right process is followed.
- Risk analysis to be done every quarter.
- Collaboration/Timely Communication/flow of Information.
- Regular analysis of risk and mitigation plan.
- Always ready with plan B.

- Robust SIOP Process

5.5 Common Specific Problems in Manufacturing Supply chain

As supply chains continue to bear the brunt of global changes, supply chain disruptions and inventory control have emerged as significant problems facing the manufacturing industry. The upswing in the manufacturing sector is an encouraging sign of the industry's growth. However, several internal challenges in the manufacturing industry impede its growth. Based on survey conducted & interviews with some of the veterans of the Manufacturing industry, following are the most common manufacturing industry problems:

- Unreliable suppliers lead times
- Production line delays due to material shortages
- Poor demand forecasting accuracy
- Disconnected systems (ERP not talking to MES or SCM)
- Slow response to customer orders or changes
- Inefficient warehouse operations
- Frequent stockouts or excess inventory
- High logistics or transportation costs
- Compliance issues (e.g., safety, environmental)

5.5.1 Unreliable suppliers lead times

Unreliable suppliers lead times are a major pain point in manufacturing. They can cause production delays, missed customer orders, and higher holding costs from safety stock. Following are the symptoms and the potential improvement strategies-

Symptoms:

- Late deliveries or wide variance in lead time
- Frequent production rescheduling
- Excess safety stock to buffer against unpredictability
- Poor customer delivery performance (OTIF decline)

Solution Strategy: Fixing Supplier Lead Time Variability

1. Diagnose the Root Cause

- Audit historical data: Look at actual vs. promised lead times.
- Categorize suppliers: Which ones are consistently late? Are delays due to their own suppliers, shipping, customs, etc.?
- Understand causes: Is it forecasting, capacity issues, logistics, documentation delays?

Tools: Excel analysis / Power BI dashboards / ERP data exports

Outcome: Clarity on *who* is unreliable and *why*

2. Implement Supplier Scorecards

- Track KPIs like:
    - % On-Time Delivery
    - Average Lead Time Variance

- Quality Defects
- Responsiveness

Tools: Custom dashboards, ERP vendor module, or tools like Ariba, Gatekeeper, or Jaggaer

Outcome: Transparent, objective performance tracking and accountability.

3 . Improve Forecast Collaboration

- Share your production forecast regularly with key suppliers.
- Introduce rolling forecasts (e.g. 3-month view).
- Use Vendor Managed Inventory (VMI) wherever possible.

Tools: Collaborative portals, EDI, or simple shared dashboards

Outcome: Suppliers can plan capacity better, reducing surprises.

10 Diversify & Tier Suppliers

- Avoid overreliance on one vendor.
- Set up tier 2 suppliers or local backup sources.
- Implement dual sourcing for critical materials.

Outcome: Less risk from any one supplier's delays.

11 Contractual SLAs + Incentives

- Include lead time expectations in contracts.
- Offer incentives for consistent on-time delivery.
- Penalize recurring underperformance.

Outcome: Align performance with business impact.

12 Buffer Strategically (Not Excessively)

- Calculate optimal safety stock using lead time variability + demand data.
- Use dynamic buffers that adjust automatically based on trends.

Tools: Demand-Driven MRP (DDMRP), SAP IBP, Kinaxis, NetSuite

Outcome: Protection without bloated inventory.

13 Increase Visibility into Shipments

- Use tracking tools (IoT, GPS, EDI updates) for real-time updates.
- Integrate these updates into your ERP/MES to alert production teams.

Tools: FourKites, Project44, CargoSmart, Flexport

Outcome: Faster reaction to delays.

TABLE 4: 5.5.1 ACTION PLAN

Action	Owner	Timeline
Pull 6 months of supplier lead time data	Procurement / Supply Chain Analyst	Week 1
Set up supplier scorecard dashboard	Ops / IT	Week 2–3
Schedule QBRs with top 5 critical suppliers	Procurement Lead	Week 4
Identify backup suppliers for top risk categories	Sourcing Manager	Month 2
Implement buffer optimization (DDMRP or Excel-based)	Planning Team	Month 2–3

5.5.2 Production line delays due to material shortages

Production line delays due to material shortages are especially painful because they cause cascading issues: idle machines, missed deadlines, overtime costs, and unhappy customers.

Root Causes:

- Inaccurate material planning or poor forecasting

- Long or inconsistent supplier lead times
- Lack of real-time visibility into inventory
- Poor coordination between procurement and production teams
- Overreliance on manual tracking or disconnected systems

SOLUTION STRATEGY: FIXING MATERIAL SHORTAGE DELAYS

1. Improve Material Requirements Planning (MRP)

- Review and tune your Bill of Materials (BOM) to reflect true usage.
- Use real-time inventory and demand data to drive procurement.
- Upgrade or configure your ERP/MRP system to give accurate reorder points.

TOOLS: SAP, ORACLE, NETSUITE, KATANA, or custom Excel MRP

OUTCOME: Ordering as per actual need.

2. Forecast More Accurately

- Integrate sales forecasts, historical usage, and seasonality into planning.
- Use machine learning models for improved demand planning if variability is high.

Tools: Power BI, Anaplan, Excel + regression, SAP IBP

Outcome: Less overordering/underordering of key materials.

3. Increase Material Visibility Across Departments

- Set up live dashboards to show real-time inventory levels, expected deliveries, and production needs.
- Ensure production, procurement, and planning teams share a single source of truth.

Tools: ERP dashboards / custom Power BI / MES integration

Outcome: Teams react faster to material shortages before they cause a stoppage.

4. Tighten Supplier Coordination

- Share production schedules with suppliers to align deliveries with demand.
- Move to Just-in-Time (JIT) with reliable partners or Vendor Managed Inventory (VMI).
- Introduce order status alerts from suppliers (EDI or manual).

OUTCOME: Materials arrive on time, in sync with the production cycles.

5. Add Safety Buffers Where Necessary

- Identify high-risk materials (long lead times, single source).
- Calculate minimum safety stock using lead time + usage variability.
- Track and adjust buffer levels monthly.

TOOLS: DDMRP, Inventory planning tools, or dynamic Excel models

OUTCOME: Avoid line stoppages without overstocking.

6. Track & Act on Shortage Risks

- Create a Material Shortage Watchlist: flag items below reorder point or with late POs.
- Review daily/weekly and escalate critical shortages fast.

Tools: Simple spreadsheet, ERP alerts, or email digests

Outcome: Proactive mitigation of production risks.

TABLE 5: 5.5.2 ACTION PLAN

Action	Owner	Timeline
Audit top 20 materials causing delays	Planner / Analyst	Week 1
Configure ERP to send reorder alerts	IT / SCM	Week 2
Implement material dashboard (Excel or BI)	Ops / Planning	Week 2–3
Meet with top suppliers to sync schedules	Procurement	Month 1
Recalculate safety stock for key items	Planning / SCM	Month 1–2

TABLE 6: 5.5.2 SAMPLE KPI TRACKING

Metric	Goal	Tools
% of production delays due to material shortage	<5%	MES, ERP
Material availability rate	>98%	MRP / BI
Inventory turnover	>10	ERP / Excel
Supplier On-Time Delivery	>95%	Scorecard

5.5.3 Poor demand forecasting accuracy

Poor demand forecasting accuracy is a root cause for so many downstream issues: excess stock, material shortages, production delays, and even lost sales.

COMMON SYMPTOMS:

- Frequent mismatch between inventory and actual demand
- High forecast error (MAPE > 20%)
- Firefighting: rush orders, production reschedules, overtime
- Overstock of slow-movers, stockouts of fast-movers

SOLUTION STRATEGY: IMPROVE FORECASTING ACCURACY

1. CLEAN AND SEGMENT THE DATA

- Separate make-to-stock vs. make-to-order items
- Segment demand by product families, customers, or regions

- Clean out outliers, promotions, or COVID-era anomalies

Tools: Excel, Python, Power BI

Outcome: Clear, actionable demand history you can trust.

2. Use Statistical and ML-Based Forecasting Models

- Move beyond basic averages or gut-feel
- Use models like:
    - Moving average / exponential smoothing (for stable products)
    - ARIMA or Prophet (for seasonal trends)
    - Random forest / XGBoost (for complex, multi-variable forecasts)

Tools:

- Excel (for basic models)
- Python (statsmodels, Prophet)
- Forecasting platforms: Forecast Pro, NetSuite Demand Planning, SAP IBP, o9, Anaplan

Outcome: Forecasts that learn from trends, cycles, and events.

3. Include External and Leading Indicators

- Pull in data like:
    - Customer orders or RFQs
    - Marketing and promotions calendar
    - Distributor stock levels
    - Macroeconomic data (if relevant)

OUTCOME: Forecasts based on what's about to happen, not just history.

4. **Implement Collaborative Forecasting (S&OP / IBP)**

- Combine inputs from sales, marketing, finance, and ops
- Create a monthly Consensus Forecast as part of your Sales & Operations Planning (S&OP) process

Tools: Excel-based templates, or platforms like SAP IBP / Oracle Demantra / Board

Outcome: Alignment across departments, fewer surprises.

5. **Track Forecast Accuracy + Bias**

- Set up a dashboard to track:
    - MAPE (Mean Absolute Percentage Error)
    - Forecast Bias (consistent over- or under-forecasting)
- Review monthly and feed back into the planning process

OUTCOME: Continuous improvement of your forecasting model.

TABLE 7: 5.5.3 ACTION PLAN

Action	**Owner**	**Timeline**
Segment and clean demand history by SKU-family	Planning Team	Week 1
Build or select a forecasting model for top 50 SKUs	Analyst	Week 2
Align cross-functional team for consensus forecast	Ops / SIOP/PPC	Month 1
Set up a rolling 3–6 month forecast review cycle	SCM Lead	Ongoing
Begin tracking MAPE and Bias monthly	SCM or BI Team	Month 2

TABLE 8: 5.5.3 SAMPLE KPI TRACKING

Metric	**Target**	**Tools**
MAPE	<10–15%	BI Tools / Excel
Forecast Bias	±5%	Excel / Tableau
Service Level (OTIF)	>98%	ERP / WMS
Inventory Turns	>10	ERP / BI

5.5.4 Disconnected systems

Disconnected systems are a silent killer in manufacturing supply chains. When ERP doesn't sync with MES or SCM, results into:

- Manual data entry (aka mistakes waiting to happen)
- Delayed decisions (we are always reacting instead of planning)
- No end-to-end visibility (leading to stockouts, rush orders, overproduction)
- Poor alignment between planning and execution

Let's break down how to bridge those system gaps and create a truly integrated digital supply chain.

Common Issues:

- Production orders in ERP not auto-sent to MES
- MES updates (e.g. completed jobs) not flowing back to ERP
- Inventory levels inaccurate due to delayed updates
- SCM systems unaware of actual production status or raw material availability
- Separate logins, files, and spreadsheets for each department

SOLUTION STRATEGY: SYSTEM INTEGRATION FOR A SMART SUPPLY CHAIN

1. Map Current System Flows (or Lack Thereof)

- Identify what data should be flowing between:
  - **ERP** (e.g. SAP, Oracle, NetSuite)
  - **MES** (e.g. Siemens, Rockwell, GE Proficy)
  - **SCM** (e.g. Blue Yonder, Kinaxis, o9)
- Track what is manual vs. automated

- Highlight delays, duplicates, and errors

TOOL: Create a data flow diagram

OUTCOME: Clear view of gaps and integration needs

2. Define the Data Touchpoints

Start with critical sync points:

- **ERP → MES**: Production plans, BOMs, routing
- **MES → ERP**: Production status, consumption, output
- **ERP → SCM**: Forecasts, purchase orders, inventory
- **MES → SCM**: Real-time shop floor status (for dynamic planning)

OUTCOME: Structured data exchange — no more "Excel bridges".

3. Choose the Right Integration Approach

Option A: Middleware Integration (Best for Medium-Large Ops)

- Use platforms like MuleSoft, Dell Boomi, Zapier, Informatica, or custom APIs
- Pull/push data between systems in near real-time

Option B: Direct API Connections

- If systems are modern, connect via REST/SOAP APIs
- Custom connectors between ERP-MES-SCM

Option C: MES-ERP Integration via OPC or MQTT

- Common for real-time factory floor → ERP data flow
- Industrial protocols that work with PLCs and IoT devices

OUTCOME: Automated data sharing, real-time updates, fewer errors

4. Use a Central Data Lake or BI Layer

- Aggregate data from all systems into one reporting layer
- Power real-time dashboards and predictive analytics
- Platforms: Power BI, Snowflake, Tableau, Azure Synapse

OUTCOME: Unified view of inventory, production, and supply chain KPIs

6. Align Teams & Train

- Create standard operating procedures (SOPs) for new integrated workflows
- Cross-train teams on how systems interact
- Appoint integration champions in each department

OUTCOME: Process drives tech — not the other way around

TABLE 9: 5.5.4 INTEGRATION ROADMAP

Action	Owner	Timeline
Map current data flows and system gaps	IT / Ops	Week 1
Prioritize key data exchanges (ERP ↔ MES ↔ SCM)	SCM Lead	Week 2
Select integration tool or partner	CIO / IT	Month 1
Pilot connection between ERP and MES	IT / Vendor	Month 2
Roll out and monitor full syncs + dashboards	SCM / Ops	Month 3–4

TABLE 10: 5.5.4 KEY BENEFITS OF SYSTEM INTEGRATION

Before	After Integration
Manual production updates	Real-time MES-to-ERP sync
Forecasts don't match floor status	SCM sees live factory data
Inventory inaccuracies	Live inventory from MES to ERP
Reactive firefighting	Proactive planning with accurate data
Siloed reports	Unified KPI dashboards across teams

5.5.5 Slow response to customer orders or changes

Slow response to customer orders or changes can directly hit customer satisfaction, brand trust, and Organization’s bottom line. In today's market, flexibility and responsiveness are just as important as cost and quality.

Common Symptoms:

- Sales sends a last-minute order change → production can’t adapt
- Customer order status is unclear or delayed
- Custom orders take too long to quote or confirm
- Rush orders disrupt normal production flow
- Lack of visibility into inventory, capacity or supply chain impact

Solution Strategy: Faster, Smarter Customer Response

1. **Build Real-Time Order Visibility**

- Give sales & customer service access to live order status:
    - Inventory availability
    - Production progress
    - Delivery tracking

- Sync ERP, MES and WMS to avoid waiting on emails or calls

Tools: ERP dashboards, Customer Portals, Power BI, Salesforce
Outcome: Instant answers to "Where’s my order?"

2. **Create a Cross-Functional Order Change Workflow**

- Design a change approval workflow that includes:
    - Sales → Planning → Production → Logistics

- Use a ticketing or alert system (Jira, ServiceNow, Odoo, Trello)
- Tag orders as high-impact, low-impact or non-disruptive

OUTCOME: Order changes get reviewed quickly with minimal disruption.

3. **Use Available-to-Promise (ATP) and Capable-to-Promise (CTP)**

- ATP: Checks if inventory exists
- CTP: Checks if capacity & materials are available
- Respond to customers with confidence (and no double-booking)

Tools: SAP, Oracle, NetSuite ATP, Kinaxis Rapid Response

Outcome: Realistic, fast confirmations on new or changed orders.

4. **Add Smart Buffering & Flexible Scheduling**

- Use dynamic buffers for high-variability customers/products
- Implement finite scheduling that allows for inserts or rushes
- Use AI-assisted planning to simulate change impacts

Tools: Asprova, PlanetTogether, Preactor, DELMIA

Outcome: Adapt without chaos.

5. **Preconfigure Responses to Common Scenarios**

- "Rush order request": Add surcharge + priority lane
- "Spec change mid-production": Approve if within tolerance
- "Order cancelation": Adjust raw material POs automatically

Outcome: Reps handle common cases without waiting for ops.

6. **Empower the Frontline with Info & Tools**

- Train customer service & sales on:

- Where to find real-time order/material info
- How to estimate lead time dynamically
- What the rules are for order changes

Outcome: Frontline can answer fast — no bottlenecks.

TABLE 11: 5.5.5 FAST RESPONSE IMPROVEMENT PLAN

Step	Owner	Timeline
Map current order-to-delivery process	Ops / Sales / IT	Week 1
Identify top 5 slow-down points (approval, visibility, etc.)	CX Team	Week 2
Enable real-time order tracking dashboard	IT / BI	Month 1
Implement ATP/CTP logic for key products	SCM / ERP	Month 2
Train frontline on dynamic quoting & order rules	Sales Ops	Ongoing

5.5.6 Inefficient warehouse operations

Inefficient warehouse operations can quietly bleed time, money, and morale. And in manufacturing, it's even more critical, since warehouse is the bridge between supply, production, and shipping.

Let's break down the problem and build a practical improvement roadmap that boosts speed, accuracy, and throughput.

Common Symptoms:

- Long pick/pack/ship times
- Frequent stockouts or misplaced inventory
- High labor costs with low output
- Overstock in some areas, shortages in others
- Manual paper-based processes or outdated systems

- Space is full but productivity is low

Solution Strategy: Streamline Warehouse for Speed + Accuracy

1. **Layout Optimization**

- Reorganize for flow efficiency: receiving → storage → picking → shipping
- Place fast movers closer to packing/shipping zones
- Use vertical space with racking systems where possible
- Eliminate cross-traffic and dead zones

Outcome: Less walking, faster picks, safer paths.

2. **Implement Warehouse Management System (WMS)**

- Digitize inventory management, picking, put-away, cycle counts
- Enable barcode or RFID scanning to reduce errors
- Track real-time inventory and location down to bin level

Tools: NetSuite WMS, SAP EWM, Zoho Inventory, Fishbowl, Odoo, or custom Excel + scanner setup

Outcome: Full control and visibility, no more paper logs.

3. **Slotting and Inventory Accuracy**

- Assign products to optimal locations based on:
  - Picking frequency
  - Size/weight
  - Seasonality
- Schedule daily cycle counts instead of year-end inventory chaos

Outcome: Inventory is where it should be — and it's accurate.

4. **Streamline Picking Methods**

- Use the best method for your operation:
    - Zone picking (for larger warehouses)
    - Wave or batch picking (for high-volume small orders)
    - Pick-to-light / voice-picking (for speed)
- Add pick route optimization with handheld scanners

Outcome: Faster, error-free order fulfillment.

5. **Automate Where It Makes Sense**

- Start small with:
    - Conveyor belts
    - Label printers
    - Automated packaging
- Explore AS/RS (Automated Storage & Retrieval Systems) or AMRs (Autonomous Mobile Robots) wherever required

Outcome: Higher throughput without needing more labor.

6. **Train and Cross-Skill warehouse Team**

- Standardize processes with SOPs and visual work instructions
- Cross-train on inbound, picking, packing, cycle counting
- Use KPIs and gamification to motivate teams

Outcome: More flexible labor, fewer errors, better morale.

PICTURE: 5 Autonomous Mobile Robots (AMRs)

AMR: An autonomous mobile robot is a robot that is able to navigate within, and respond to, its environment without humans directly controlling it. Equipped with sensors they can steer clear of obstacles and connect with other robots and networks.

PICTURE: 6 Automated Storage & Retrieval Systems (ASRS)

ASRS: An automated storage and retrieval system consists of a variety of computer-controlled systems for automatically placing and retrieving loads from defined storage locations. Automated storage and retrieval systems (AS/RS) are typically used in applications where:

- There is a very high volume of loads being moved into and out of storage.
- Storage density is important because of space constraints.
- No value is added in this process (no processing, only storage and transport)
- Accuracy is critical because of potential expensive damages to the load

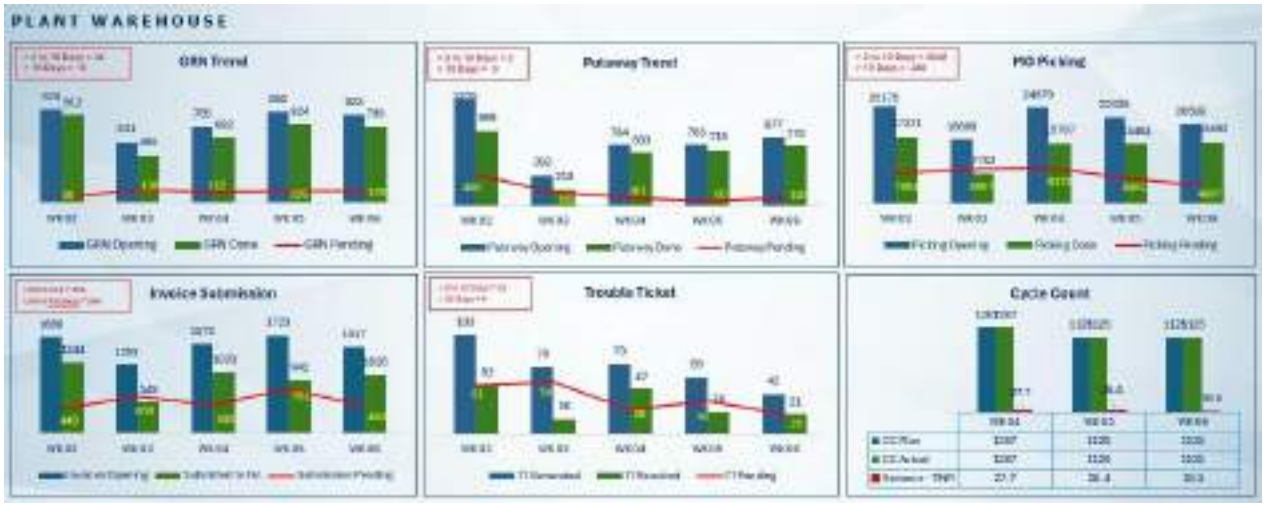
TABLE 12: 5.5.6 WAREHOUSE EFFICIENCY IMPROVEMENT PLAN

Action	Owner	Timeline
Map current warehouse layout & flow	Ops / WH Manager	Week 1
Analyze pick times, travel distances, and error rates	Analyst	Week 2
Implement barcode scanning & digital inventory	IT / Ops	Month 1
Re-slot inventory based on velocity (ABC analysis)	SCM / WH	Month 2
Set up live WMS dashboard (or Excel tracker)	BI / Ops	Month 2–3

TABLE 13: 5.5.6 KEY KPIS TO TRACK

Metric	Target
Inventory accuracy	>98%
Order pick accuracy	>99.5%
Pick rate per labor hour	+20% baseline
Cycle count completion rate	100% monthly
Orders shipped on time	>98%

PICTURE 7: 5.5.6 WAREHOUSE DASHBORAD SAMPLE



5.5.7 Frequent stockouts or excess inventory

It usually points to misalignment between demand, supply, and execution. The goal is to find the sweet spot between just-in-time and just-in-case — where we have enough stock to meet demand, but not so much that cash is tied up or storage is wasted.

Common Symptoms:

- Running out of high-demand items, halting production
- Overstock of slow-moving SKUs taking up shelf space
- High carrying costs (storage, depreciation, write-offs)
- Emergency orders and expediting costs
- Inaccurate demand forecasts or poor supplier coordination

Solution Strategy: Smarter Inventory Planning & Control

1. **Improve Demand Forecast Accuracy**

- Use historical sales + seasonality + trends + promotions
- Apply AI/ML or statistical models (ARIMA, exponential smoothing, etc.)
- Align forecasts across sales, ops, and supply chain
- Update forecasts monthly or weekly, not annually

Tools: NetSuite, o9, SAP IBP, Anaplan, Excel + Python models
Outcome: Predict demand more precisely → less guesswork.

2. **Classify Inventory: ABC + XYZ Analysis**

- **ABC**: Based on sales revenue or volume
    - A = top 20% (high focus)
    - B = next 30%

    - C = bottom 50%
- **XYZ**: Based on demand predictability (X = steady, Z = erratic)

Outcome: Focus effort & safety stock rules where it matters most.

3. **Set Dynamic Safety Stock Levels**

- Use formulas that consider:
    - Demand variability
    - Lead time variability
    - Service level target (e.g. 95%)
- Don’t apply a one-size-fits-all rule

Tools: Excel models, ERP-native inventory control modules

Outcome: Enough buffer, without overstocking.

4. **Improve Supply Planning**

- Collaborate with suppliers on lead times and delivery accuracy
- Use Supplier Performance Tracking (OTIF rates, avg delays)
- Implement reorder point and lead time-based triggers
- Use MRP (Material Requirements Planning) with live inputs

Outcome: Inventory comes in when actually needed not when it’s too late or early.

5. **Enable Real-Time Inventory Visibility**

- Use WMS or ERP to track:
    - Inventory by location, status, and age
    - Open POs and expected receipts
    - Inventory in transit

Tools: NetSuite, Oracle, Zoho Inventory, Power BI dashboards

Outcome: You can trust your numbers when making decisions.

6. **Clean Up the SKU Catalog**

- Regularly review for:
    - Duplicate SKUs
    - Obsolete or low-turnover items
    - Products with erratic demand and high holding cost
- Rationalize and consolidate where possible

Outcome: Simpler planning, lower carrying costs.

TABLE 14: 5.5.7 INVENTORY OPTIMIZATION ACTION PLAN

Action	Owner	Timeline
Run ABC/XYZ classification	Inventory Analyst	Week 1
Analyze past stockouts/excess patterns	Ops Team	Week 2
Build or configure forecast model	SCM / IT	Month 1
Adjust safety stock rules by item class	Inventory Control	Month 2
Roll out reorder point automation in ERP/WMS	IT / Ops	Month 2–3
Set up KPI dashboard: Stockouts, Inventory Turns, DOH	BI Team	Month 3

TABLE 15: 5.5.7 INVENTORY HEALTH KPIS TO TRACK

Metric	Target
Inventory Turnover Ratio	>8x per year (depends on industry)
Stockout Rate	<2%
Days of Inventory on Hand (DOH)	30–45 days (adjust by segment)
Forecast Accuracy (MAPE)	<15%
Dead Stock %	<5% of total inventory

5.5.8 High logistics or transportation costs

This is a common issue, especially in manufacturing, where raw materials, components, and finished goods are constantly on the move. When logistics isn't optimized, it eats organizations' margins fast.

Let's look at why it happens, how to bring those costs down, and a smart action plan to tackle it.

Common Symptoms:

- High spend on expedited/rush shipping
- Underutilized truckloads or half-full containers
- Paying premium rates due to poor route planning
- No visibility into freight costs until invoices arrive
- Carrier performance issues (late, damaged, inconsistent)

Solution Strategy: Optimize Logistics for Cost & Reliability

1. **Analyze Freight Spend by Mode, Region, Carrier**

- Break down costs: inbound vs outbound, LTL vs FTL, domestic vs international
- Identify top cost drivers: fuel surcharges, expedited orders, low load utilization
- Benchmark rates by lane and volume

Outcome: Visibility into where the money is going and why.

2. **Optimize Shipment Consolidation & Load Planning**

- Combine small shipments (especially LTL) into full truckloads
- Use milk runs or multi-stop routes where possible
- Align production and shipping schedules to reduce partial loads
- Use a Transportation Management System (TMS) to automate load building

Tools: SAP TM, Oracle TMS, Freightview, Descartes, Open dock

Outcome: Fewer trips, fuller trucks → lower cost per unit.

3. **Route & Mode Optimization**

- Use software to evaluate:
    - Cheapest route based on delivery window
    - Most efficient mix of air, sea, road, rail
- Consider shifting high-cost lanes to multi-modal
- For repeat lanes: contracted carriers vs spot rates

Outcome: Smart trade-off between cost and delivery performance

4. **Negotiate Better Carrier Rates**

- Consolidate volume with fewer, more strategic carriers
- Share your forecast volumes to get bulk discounts
- Compare actual vs quoted rates — flag frequent discrepancies
- Use reverse auctions for bidding if shipping is large-scale

Outcome: Lower per-mile and per-unit costs, stronger partnerships.

5. **Improve Delivery Scheduling**

- Avoid late pickups/deliveries that incur fees
- Implement **dock appointment systems** for better flow
- Improve communication between warehouse, shipping, and carriers

Outcome: Fewer detention/demurrage charges.

6. **Improve Packaging & Cube Utilization**

- Redesign packaging to reduce volume or dead space
- Use dimensional weight optimization for air freight
- Standardize pallet configs to improve stacking and trailer use

Outcome: More product per load, fewer shipments.

TABLE 16: 5.5.8 LOGISTICS COST REDUCTION ACTION PLAN

Action	Owner	Timeline
Analyze 6-month freight spend by lane, carrier, mode	Logistics Analyst	Week 1
Identify low-utilization lanes and partial loads	TMS / Ops	Week 2
Roll out load consolidation rules in TMS	IT / SCM	Month 1
Negotiate preferred rates with top 3 carriers	Logistics Lead	Month 2
Redesign high-volume packaging for space savings	Packaging Eng.	Month 2–3
Set up freight cost dashboard (per kg, per unit, % of COGS)	BI / Finance	Month 3

TABLE 17: 5.5.8 KEY LOGISTICS KPIS TO TRACK

Metric	Target
Freight cost per unit	↓ 10–20% vs baseline
Load utilization (TL % full)	>90%
% of expedited shipments	<5%
On-time delivery rate	>98%
Freight cost as % of COGS	Benchmark vs industry (usually 4–10%)

5.5.9 Compliance issues

It’s a big deal, especially in manufacturing where safety regulations, environmental laws, and quality standards can vary by region, product, and industry.

Let’s breakdown that why compliance gets messy, how to clean it up, and a step-by-step improvement roadmap.

Common Symptoms:

- Fines or penalties from audits
- Delays in shipments due to missing documentation
- Inconsistent safety training or reporting
- Improper handling of hazardous materials
- Failure to meet ISO, OSHA, EPA, or local regulatory standards
- Reactive rather than proactive compliance management

Solution Strategy: Build a Proactive Compliance System

1. **Conduct a Compliance Risk Assessment**

- Map current regulations that apply (OSHA, ISO 9001/14001, REACH, RoHS, etc.)
- Identify gaps in:
    - Documentation
    - Processes
    - Employee training
- Categorize risks (legal, financial, reputational)

Outcome: Clear visibility on what's at stake and where to focus first.

2. **Standardize Processes with SOPs & Visual Work Instructions**

- Create or update Standard Operating Procedures for:
    - Safety checks
    - Environmental handling
    - Quality control
- Make procedures visual (signage, diagrams) and accessible on the floor

Outcome: Everyone knows what to do — no guessing, no shortcuts.

3. **Digitize Compliance Tracking**

- Use systems to track:
    - Safety inspections
    - Incident reporting
    - Permit expirations
    - Emissions/waste logs
- Automate alerts for upcoming deadlines

Tools: ETQ Reliance, Enablon, Intelex, or even SharePoint/Excel trackers

Outcome: Nothing falls through the cracks.

4. **Strengthen Safety & Environmental Training**

- Provide role-specific training (e.g. forklift ops, chemical handling)
- Make it part of onboarding + ongoing refreshers
- Track completion, test comprehension
- Create culture-based reinforcement, not just checkboxes

Outcome: Safer workforce = fewer incidents = better compliance.

5. **Conduct Internal Audits & Drills**

- Set monthly/quarterly audits for:
    - Safety protocols
    - Hazardous materials handling
    - Waste disposal records
- Run mock inspections or emergency drills
- Fix root causes, not just symptoms

Outcome: We catch issues before the regulators/auditors do

6. Assign a Compliance Champion or Team

- Someone owns it — ideally with authority
- Responsible for updates, audits, training, reporting
- Acts as the liaison between production and legal/HR/safety

Outcome: Accountability = execution.

TABLE 18: 5.5.9 COMPLIANCE PROGRAM IMPROVEMENT PLAN

Action	Owner	Timeline
Complete full compliance audit (safety/enviro/quality)	Compliance Officer	Week 1
Document all SOPs + post visual guides	Ops / EHS	Month 1
Implement digital tracking tool or checklist	IT / EHS	Month 1–2
Roll out role-based compliance training plan	HR / Training	Month 2
Schedule internal audit and improvement loop	Compliance Team	Monthly
Build compliance dashboard (KPIs + alerts)	BI / EHS	Month 3

TABLE 19: 5.5.9 COMPLIANCE KPIS TO MONITOR

Metric	Target
Safety incidents (TRIR)	0 or below industry avg
Environmental violations	0
% of employees trained	100% (active)
Audit pass rate	>95%
Permits/licenses expired	0

PICTURE 8: EHS DASHBOARD SAMPLE

CHAPTER VI:

SUMMARY, RECOMMENDATIONS FOR FUTURE RESEARCH AND CONCLUSION

6.1 Summary

Risk management in supply chain involves identifying, assessing, and mitigating potential risks that can disrupt the smooth flow of goods and services. In a supply chain, these risks can arise from various factors, including natural disasters, geopolitical issues, economic fluctuations, supplier disruptions, technological failures, and market volatility. Effective risk management is crucial for minimizing the impact of these risks and ensuring that the supply chain operates efficiently and resiliently.

6.2 Key elements of risk management in the supply chain:

6.2.1 Risk Identification

- **Supplier Risks**: Reliability and financial stability of suppliers.
- **Geopolitical Risks**: Political instability or trade disruptions.
- **Natural Risks**: Natural disasters like floods, earthquakes, and hurricanes that disrupt transportation or production.
- **Economic Risks**: Currency fluctuations, interest rates, inflation, or economic recessions affecting cost and demand.
- **Technological Risks**: Cybersecurity threats, system failures, or software issues.

- **Regulatory Risks**: Changes in laws, tariffs, or trade regulations that can affect sourcing or transportation.

6.2.2 Risk Assessment

- **Impact Analysis**: Evaluating the severity of different risks on the supply chain's operations and bottom line.
- **Probability Assessment**: Estimating how likely each risk is to occur.
- **Vulnerability Assessment**: Understanding how vulnerable the supply chain is to each identified risk.
- **Risk Matrix**: Plotting the risks on a matrix to prioritize those that need immediate attention based on their potential impact and likelihood.

6.2.3 Risk Mitigation Strategies

- **Diversification**: Sourcing from multiple suppliers or regions to avoid dependency on a single source.
- **Inventory Management**: Holding buffer stock or creating strategic reserves to handle disruptions in supply.
- **Supplier Collaboration**: Building strong relationships with suppliers and partners to ensure reliable communication and flexibility in times of crisis.

- **Technology Implementation**: Using digital tools like supply chain visibility software, blockchain, and AI to track, analyze, and predict risks in real time.
- **Contingency Planning**: Developing backup plans, such as alternative transport routes or secondary suppliers, to quickly respond to disruptions.
- **Risk Transfer**: Using insurance or outsourcing certain risks (e.g., logistics or production) to third parties to mitigate financial exposure.

6.2.4 Monitoring and Review

- **Continuous Monitoring**: Regularly tracking risks and monitoring the performance of risk management strategies to ensure they remain effective.
- **Scenario Planning**: Running simulations or stress tests to assess how the supply chain would respond to different risk events.
- **Feedback Loops**: Learning from past disruptions and continuously improving the risk management processes.

6.3 Supply Chain Improvement Roadmap for Manufacturing

Phase 1: Assess & Analyze

Goal: Understand current performance, pain points, and opportunities.

Actions:

- Conduct **end-to-end supply chain audit** (procurement to distribution).
- Map existing **supplier, production, and logistics flows**.

- Identify **key KPIs**: lead time, order accuracy, inventory turnover, OTIF (On-Time In-Full).
- Assess tech stack: ERP, MES, WMS, SCM tools in use.

✅ **Deliverables:**

- Supply Chain Maturity Scorecard
- Bottleneck & Risk Heatmap
- Baseline Performance Metrics

Phase 2: Stabilize Core Operations

Goal: Fix fundamental issues (inventory, production inefficiencies, poor visibility).

Actions:

- Implement **Inventory Management System** or improve the current one.
- Adopt **MES** to monitor and control production.
- Improve supplier reliability through **vendor scorecards**.
- Set up **real-time dashboards** for operational KPIs.

✅ **Deliverables:**

- Digital inventory control
- Reduced downtime
- Supplier performance tracking

Phase 3: Optimize & Automate

Goal: Streamline processes and remove manual dependencies.

Actions:

- Introduce **AI/ML-based demand forecasting**.
- Use **route optimization** for logistics efficiency.
- Implement **predictive maintenance** with IoT for critical machinery.
- Begin **process automation** in procurement and reporting.

✅ **Deliverables:**

- Forecast accuracy improvement
- Reduced transport cost per unit
- Fewer emergency maintenance incidents

Phase 4: Integrate & Digitize

Goal: Unify systems, enhance data sharing, and digitize decision-making.

Actions:

- Integrate ERP, MES, SCM, and CRM systems.
- Apply **Digital Twin** models to simulate supply chain scenarios.
- Roll out **supplier portals** for digital collaboration.
- Implement **blockchain or audit trails** for compliance-heavy industries.

✅ **Deliverables:**

- End-to-end supply chain visibility
- Simulation capabilities for demand/supply planning
- Faster supplier collaboration

Phase 5: Resilience & Sustainability

Goal: Future-proof the supply chain against disruptions and improve ESG impact.

Actions:

- Diversify sourcing and logistics partners (risk mitigation).
- Set up sustainability KPIs and emission tracking.
- Integrate circular economy practices (e.g., remanufacturing, recycling).
- Create disruption playbooks (pandemic, port delays, geopolitical risks).

✅ **Deliverables:**

- Supply chain risk dashboard
- Sustainability reporting (Scope 1–3 emissions)
- Business continuity plans

Table 20: Sample KPI Dashboard:

KPI	Target	Current	Tools
Inventory Turnover	>10	-	ERP/Inventory Mgmt
On-time in-full (OTIF)	98%	-	SCM Platform
Downtime Hours/Month	<10	-	MES, IoT
Supplier Lead Time Variance	<5%	-	Vendor Mgmt System
CO2 per Shipment	↓ 10% YoY	-	Sustainability Tools

6.4 Recommendations for Future Research

Based on the findings and analysis of this study, there are several recommendations for future research that could be undertaken to further understand the Risk Management in Supply Chain or Managing Uncertainty in Supply Chain.

6.3.1 Extension to Service industries - The scope of the research was restricted to Manufacturing industries only. This can be further extended to non-manufacturing industries like IT, health care, banking etc.

6.3.2 Extension beyond Manufacturing companies based out of India - The scope of the research was restricted to the Manufacturing companies which are operating from India. These companies are Indian multinational or global companies. The research can be further extended to the manufacturing companies which are not operating from India.

6.3.3 Impact of Artificial Intelligence & Machine Learning in Supply Chain – Recently AI & ML has already started impacting every domain of the business. It would be good to further research the impact of AI & ML in Supply Chain, in specific manufacturing Operations.

6.5 Conclusion

Risk management in supply chain is a critical process for ensuring that a supply chain is both efficient and resilient. This includes understanding risks that may impact the various components of the supply chain, from suppliers and transportation to storage and final delivery. As globalization and technological advancements increase, supply chains are becoming more complex and vulnerable to a wider array of risks.

Effective risk management in the supply chain is an ongoing and dynamic process. Given the complexity and interconnected nature of global supply chains, companies must adopt a proactive approach to identifying and mitigating risks. By combining strategies like diversification, technology adoption, supplier collaboration, and contingency planning, businesses can enhance the resilience of their supply chains and ensure continuity even in the face of disruptions. The goal is to minimize the negative impacts of these uncertainties while maximizing the efficiency and flexibility of the supply chain.

Managing uncertainty in the supply chain requires a proactive, flexible, and collaborative approach. By leveraging technology, improving forecasting, diversifying suppliers, and adopting agile supply chain practices, businesses can mitigate risks and adapt quickly to unexpected changes. Continuous monitoring, scenario planning, and a focus on communication with partners and customers are key to maintaining supply chain resilience in uncertain environments.

APPENDIX-A

SURVEY COVER LETTER AND INFORMED CONSENT

RISK MANAGEMENT IN SUPPLY CHAIN

(MANAGING UNCERTAINTY IN SUPPLY CHAIN)

I am Santosh Kumar, pursuing my Doctor in Business Administration from Swiss School of Business and Management, Geneva. I am doing a Research on the topic mentioned above and invite you to participate in my Research Study. This will not take more than 15 mins of your time, and I thank you in advance for your participation. The Survey comprises of 2 sections. The first section is MCQ and second section is having short questions. Please answer the questions as honestly as possible. Your answers will be completely confidential, there is no requirement to mention the organization you work for, and participation is strictly voluntary.

By answering the survey, you are providing the consent and agreeing to participate in this study. I thank you for taking the time to support me in my education pursuit. If you have any questions regarding the survey, pls contact me at sks323167@gmail.com/ Santosh4@ssbm.ch

APPENDIX-B

SURVEY QUESTIONNAIRE

SECTION-I (MULTIPLE CHOICE QUESTIONS):

1. YOUR GENDER

- FEMALE
- MALE

2. EDUCATIONAL QUALIFICATION

- GRADUATE
- POSTGRADUATE
- DOCTORATE
- POST DOCTORATE

3. YOUR WORK EXPERIENCE

- < 5 YEARS
- 5-10 YEARS
- 10-15 YEARS
- 15-20 YEARS
- >20 YEARS

4. YOUR CURRENT ROLE

- TEAM MEMBER/INDIVIDUAL CONTRIBUTOR
- MANAGER/DGM
- GENERAL MANAGER/SR GM
- DIRECTOR/VP/SR VP
- CEO/MD

5. WHICH OF THE FOLLOWING BEST DESCRIBES YOUR ROLE IN THE SUPPLY CHAIN?

- SOURCING
- PROCUREMENT/BUYER
- WAREHOUSE/LOGISTICS/INVENTORY MANAGEMENT
- SIOP (SALES, INVENTORY & OPERATIONS PLANNING)/PPC
- MANUFACTURING
- QUALITY/SUPPLIER QUALITY
- TECHNICAL (ME, PROCESS, NPI, LEAN, TOT ETC.)
- SALES/AFTER SALES

6. YOUR ORGANIZATION OPERATES IN

- MANUFACTURING
- NON-MANUFACTURING
- BOTH

7. THE SIZE OF YOUR ORGANIZATION BY EMPLOYEE STRENGTH IS

- <1000 EMPLOYEES
- 1001 -3000 EMPLOYEES
- 3001- 5000 EMPLOYEES
- 5001- 10000 EMPLOYEES
- >10,001 EMPLOYEES

8. HOW OFTEN DO YOU/YOUR ORGANIZATION CONDUCT SUPPLY CHAIN RISK ASSESSMENTS?

- ANNUALLY
- QUARTERLY
- MONTHLY
- AD-HOC
- NEVER

9. WHAT IS THE RISK LEVEL/UNCERTAINTY YOU EXPERIENCE IN YOUR SUPPLY CHAIN ROLE?

- LOWEST (0-10%)
- 10% TO 40 %
- 40% TO 70%
- 70% TO 90%

- HIGHEST (90 – 100%)

10. DO YOU THINK THESE RISKS CAN BE MANAGED

- YES (90-100%)
- MOSTLY (50% TO 90%)
- RARELY (10% TO 50%)
- NEVER (0-10%)

SECTION-II (SHORT ANSWER QUESTIONS):

1. What is the biggest challenge you face in your supply chain management role? (describe in 2/3 sentences)

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2. How does your organization assess and prioritize potential supply chain risks? (Objective: To understand the risk identification and prioritization process)

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3. What strategies does your organization employ to mitigate supply chain disruptions? (Objective: To explore the organization's contingency plans and resilience strategies)

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4. To what extent has your organization adopted digital technologies in its supply chain operations?(Objective: To gauge the level of digital maturity in the supply chain)

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5. Which specific digital technologies have had the most significant impact on your supply chain? (Objective: To identify key technologies driving supply chain improvements)

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6. How does your organization utilize data analytics to improve supply chain decision-making? (Objective: To understand the role of data-driven insights in supply chain optimization)

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7. What do you perceive as the most significant challenges facing supply chain management in the next 5 years? (Objective: To understand the industry's future challenges and opportunities)

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8. Are there any specific supply chain issues or challenges that your organization is currently addressing? Mitigation Plan? (Objective: To identify emerging trends and specific pain points & Mitigation Plan)

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9. Any additional comments or suggestions regarding supply chain risks & mitigation

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