MODELLING OF CRITICAL FACTORS IN THE TEXTILE SUPPLY CHAIN: DIGITAL TRANSFORMATION

A DISSERTATION

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I, Vaibhav (2K21/PRD/15) student of M.Tech Final Year, Department of Mechanical Engineering, hereby declare that the Project Dissertation titled "MODELLING OF CRITICAL FACTORS IN THE TEXTILE SUPPLY CHAIN: DIGITAL TRANSFORMATION"**,** which is submitted by me to the Department of Mechanical Engineering, Delhi Technological University, Delhi, in partial fulfilment of the requirement for the award of the degree of Master of Technology, is original and not copied from any source without citation. This work has not previously formed the basis for the award of any degree, Diploma Associateship, Fellowship or other similar title or recognition.

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I hereby certify that the Project Dissertation titled "MODELLING OF CRITICAL FACTORS IN THE TEXTILE SUPPLY CHAIN: DIGITAL TRANSFORMATION" which is submitted by Vaibhav(2K21/PRD/15), Department of Mechanical Engineering, Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the student under my supervision. To best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place: Delhi **Dr. MOHD SHUAIB**

Date: **SUPERVISOR**

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ABSTRACT

The textile industry is a very dynamic and complex sector that can greatly benefit from the integration of digital technologies in order to improve operational performance or efficiency, enhance collaboration, and achieve sustainable practices. The study begins by providing an overview of the textile industry, highlighting its significance in the global economy and the challenges it faces. It then focuses on the application of digital technologies in various stages of the textile supply chain, including sourcing, manufacturing, logistics, and customer engagement. Examples of digital technology applications, such as data analytics, artificial intelligence, Internet of Things (IoT), and are discussed to illustrate their potential impact. This study aims to identify the Critical Success Factors (CSFs) in the adoption of digital technologies for supply chain management in textile industry. To build the interrelationships between the factors, the Interpretive Structural Modeling (ISM) technique is employed. This technique enables the development of a hierarchical structure that reflects the interdependencies and relationships among the identified factors. Based on the ISM analysis, a model is formulated to prioritize the CSFs and understand their influence on each other. Further, this model is modernized with TISM Approach. The new TISM model provides insights into the key factors that drive the successful adoption of digital technologies in the textile sector's supply chain. The findings will assist textile industry practitioners in making informed decisions regarding technology investments, process improvements, and organizational strategies. The proposed research contributes to the existing literature by providing a comprehensive understanding of the CSFs in digital technology adoption in the textile industry. The results derived from this study is that TISM model is developed with factors in different levels and relations are determined between the factors. The critical success factor found out to be Adaptive Agility which is at level 5. Customer Intimacy is at level 1 which is influenced by all factors. MICMAC analysis shows three factors in dependent quadrant and no factor is in the autonomous quadrant. It bridges the gap between theoretical concepts and practical implementation, offering valuable insights for textile companies, researchers, and policymakers.

Keywords: Critical Success Factors, digital technologies, supply chain management, textile industry, TISM, Interpretive Structural Modeling (ISM)

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LIST OF SYMBOLS & ABBREVIATIONS

Abbreviations

AI	Artificial Intelligence
AR	Augmented Reality
CAGR	Compound Annual Growth Rate
CSF	Critical Success Factor
DSCM	Digital Supply Chain Management
FRM	Final Reachability Matrix
GPS	Global Positioning System
IoT	Internet of Things
IT	Information Technology
IRM	Initial Reachability Matrix
ISM	Interpretive Structural Modeling
LP	Level Partitioning
RPA	Robot Processs Automation
SCM	Supply Chain Management
SSIM	Self-Structural Interaction Matrix
TSCM	Traditional Supply Chain Management
TISM	Total Interpretive Structural Modeling
USD	United States Dollar
VR	Virtual Reality
WTO	World Trade Organization

Symbols

i	represents row element of SSIM matrix
j	represents column element of SSIM matrix

V	represents factor *i* will help to achieve factor *j*
A	represents factor *i* will help to achieve factor *j*
X	represent factors *i* and *j* will help to achieve each other
O	represent factors *i* and *j* are unrelated or not related
X-Y	coordinate axis

CHAPTER 1

INTRODUCTION

1.1 SUPPLY CHAIN MANAGEMENT-AN OVERVIEW

Supply chain management, often known as SCM, is the control of how products are moved from the site of production to the point of consumption. This includes the movement and storage of raw materials, inventory for work-in-progress, and finished goods. In 2006, Li et al. Along with managing information flow and financial transactions along the supply chain, it entails the coordination and integration of tasks related to the creation, acquisition, storage, distribution, delivery, and transportation of finished goods and services. To optimise processes and increase profitability, firms must implement effective SCM (Christopher, 2016). A properly managed supply chain can help save costs, boost quality, boost productivity, raise customer happiness, and give an organisation a competitive edge in the domestic or international market. In today's global economy, where businesses operate in a highly interconnected and dynamic environment, supply chain management has become increasingly complex and challenging. The general supply chain of an organization is shown in **Figure 1** (Kozma et al., 2019). Here the solid lines represent the logistics service that is the transportation of goods and services, dotted lines give the information flow.

The distinction between conventional supply chain management (TSCM) and digital supply chain management (DSCM) should be understood before discussing supply chains in the textile sector.

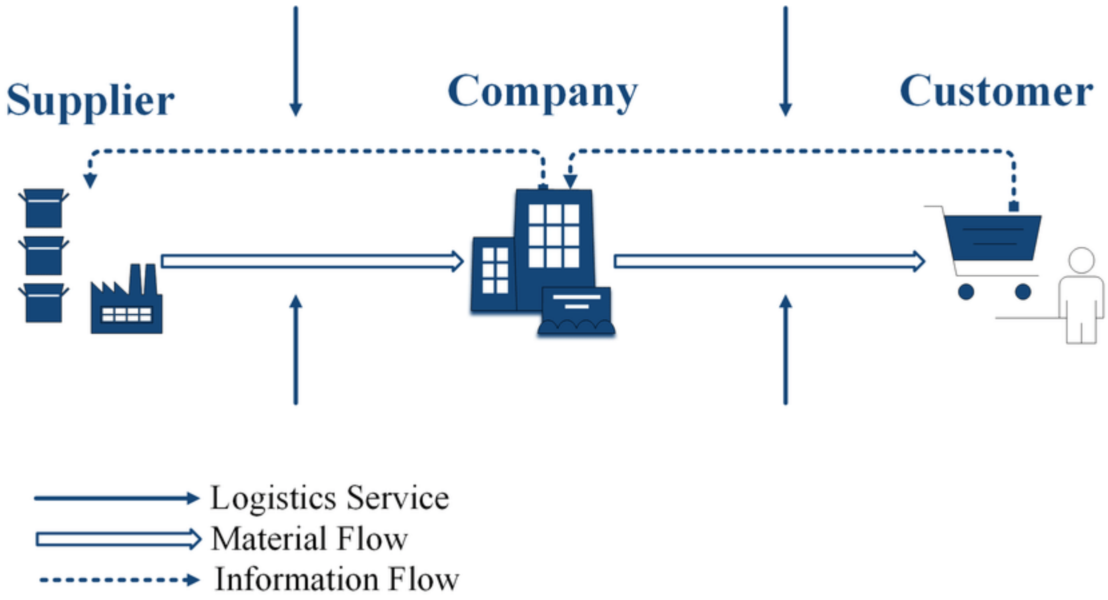

Figure 1 Supply Chain Management (Kozma et al., 2019)

1.2 DIFFERENCE BETWEEN TRADITIONAL SCM AND DIGITAL SCM

Traditional supply chain management (TSCM) is a conventional approach to managing supply chain activities, including planning, sourcing, production, and distribution. It involves managing these activities through sequential, linear processes and primarily relies on paper-based documents, phone calls, and fax to communicate and coordinate with suppliers and partners (Gunasekaran, 2020). However, this approach has several limitations, including lack of real-time information, poor visibility, and inefficient communication channels, resulting in increased lead times, higher costs, and reduced responsiveness to market demand.

By utilising digital technologies like cloud computing, the Internet of Things (IoT), artificial intelligence (AI), and big data analytics, digital supply chain management (DSCM) has emerged as a remedy to these limitations, enabling real-time visibility, information sharing, and integrated collaboration among supply chain partners (Wamba et al., 2020). By using DSCM, organizations can achieve enhanced efficiency, flexibility, and responsiveness to customer needs, leading to better supply chain performance and customer satisfaction. The difference between the two SCM practices can be shown as in **Table 1**. Several studies have shown the benefits of DSCM implementation in various industries, including textile and apparel. For example, Zhang et al. (2020) demonstrated that digitalization of the textile and apparel supply chain using IoT, and big data analytics can improve inventory accuracy, reduce lead times, and enhance order fulfilment rates. Similarly, Wang et al. (2020) in his findings, state that the adoption of DSCM can enhance supply chain agility and responsiveness to customer needs, leading to improved competitiveness.

Therefore, it is essential for organizations in the textile industry to understand the differences between TSCM and DSCM and the potential benefits of implementing DSCM to remain competitive in the market.

Table 1 Traditional SCM vs DSCM.

S.No	Features	Traditional SCM	Digital SCM
1.	**Data Collection**	Data is collected manually or through basic tools and systems. (Smith et al., 2019)	Advanced devices and systems, such as cloud computing, IoT sensors, Radio Frequency Identification (RFID), and, are used to collect data.
2.	**Data Processing**	Data is processed manually or using basic software, such as spreadsheets.	Machine learning and AI algorithms are used in advanced analytics to process data.
3.	**Communication and Collaboration**	Communication and collaboration are often limited to phone and email, with little integration between supply chain partners.	Communication and collaboration are seamless and integrated across the supply chain, with the use of collaboration platforms, real-time data sharing, and transparency. (Anderson et al., 2019)
4.	**Inventory Management**	Inventory is managed using basic systems, such as Excel spreadsheets.	Inventory is managed using advanced systems, such as automated inventory management systems that use RFID technology to

			track and locate inventory in real-time.
5.	**Supply Chain Visibility**	Limited visibility into the supply chain, with little or no real-time data. (Johnson et al., 2021)	High levels of both visibility and transparency into the supply chain, with real-time data on inventory levels, shipping times, and production schedules.
6.	**Supply Chain Integration**	Limited integration between supply chain partners, with little or no data sharing.	High levels of integration between supply chain partners, with real-time data sharing and collaboration. (Smith et al., 2022)
7.	**Supply Chain Flexibility**	Limited ability to adapt to shifts in demand or supply chain disruptions. (Svensson et al., 2021)	High levels of flexibility in responding to changes in disruptions or demand in the supply chain, with the use of advanced analytics and real-time data.
8.	**Supply Chain Resilience**	Lack of or inadequate planning for contingencies results in limited supply chain resilience.	High levels of resilience to disturbance or interference in the supply chain, with the use of advanced analytics and contingency planning.
9.	**Customer Experience**	Inability or limited ability to satisfy client needs seamlessly and deliver an excellent customer experience.	A high level of proficiency in meeting customer needs and delivering a seamless customer experience. (Prajogo et al., 2020)

1.3 APPLICATIONS OF DSCM

Applications for DSCM are numerous and cross numerous industries. One of DSCM's most important advantages is its capacity to offer real-time visibility and understanding of the whole supply chain process. This allows for better decision-making, more efficient operations, and improved customer satisfaction. One of the industries that can greatly benefit from DSCM is the textile industry. With the increasing demand for sustainability and transparency, DSCM can help textile manufacturers and retailers track and monitor the production process, from raw materials to finished products. This allows for better management of the supply chain, reduced waste, and improved efficiency. Another industry that can benefit from DSCM is the food industry. DSCM may aid in ensuring that the food supply chain is visible and traceable, which is important given that food safety and quality are major concerns. DSCM can track and monitor the transportation of goods from farm to table, guaranteeing that food products are high-quality, safe, and fresh. The healthcare sector can gain a lot from DSCM as well. The necessity for effective supply chain management and the daily rise in demand for personalised medicine make it possible for DSCM to ensure that medications, medical equipment, and supplies are delivered on schedule and in the appropriate amount. By providing them with extra attention, this can improve patient outcomes, lower costs, and increase operational effectiveness.

Table 2 Applications of DSCM

Area	Industry	Company	Benefits
Manufacturing	Automotive	General Motors, BMW	Optimize supply chain, improve communication with suppliers (Jha & Singh, 2019)
Healthcare	Pharmaceuticals	Pfizer, Glaxo Smith Kline	Improve supply chain visibility, reduce risk (Venkatesh & Sharma, 2018)

Manufacturing	Aerospace	Airbus, Boeing	Improve communication with suppliers, better manage inventory (Bharadwaj & Barua, 2019)
Retail	Fashion	H&M, Zara	Improve supply chain visibility, increase efficiency (Chauhan et al., 2020)
Food	Food and Beverages	Nestle, Walmart	Improve traceability, enhance transparency in the supply chain (Rathore & Kapoor, 2019)
Manufacturing	Electronics	Samsung, Apple	Improve collaboration with suppliers, optimize the supply chain (Verma & Singh, 2017)
Manufacturing	Chemical	BASF, DuPont	Optimize supply chain, improve efficiency (Agrawal & Khanduja, 2019)

The applications of DSCM are shown in **Table 2**. In general, DSCM has a wide range of applications in multiple domains and industries. Artificial intelligence, machine learning, and blockchain are just a few examples of the digital technologies that may be used to optimise supply chains, cut costs, boost efficiency, and ultimately raise customer happiness.

1.3.1 Digital Technologies

Digital technologies cover a broad range of devices, programmes, and systems that use digital information and communication to carry out various operations. These technologies have transformed numerous aspects of our personal and professional lives. Here are explanations of some commonly used digital technologies:

- **Internet of Things (IoT)**: The network of networked gadgets with connectivity, software, and sensors is referred to as the "Internet of Things." They make it possible for one another to gather and exchange data. IoT technology has transformed numerous industries by enabling smart homes, industrial automation, wearable technology, and efficient SCM. (Kumar et al., 2019).
- **Artificial Intelligence (AI):** Development of computer systems capable of carrying out operations that traditionally require human intelligence is known as artificial intelligence. Robotics, computer vision, natural language processing, and machine learning are all examples of AI technologies. Virtual assistants, recommendation engines, driverless vehicles, and medical diagnostics are just a few examples of the applications of AI. (Kirtan Jha et al., 2019).
- **Big Data Analytics:** The processing and analysis of enormous and complicated data sets is known as "big data analytics," and it aims to uncover significant patterns and insights. Data mining, predictive analytics, and data visualisation are just a few examples of the approaches it includes. Businesses employ big data analytics to enhance decision-making, streamline operations, and gain a competitive edge (Hariri et al., 2019).
- **Cloud Computing:** Cloud computing makes it possible to access, store, and process data and applications over the internet, negating the need for on-premises equipment. It is well-liked for hosting websites, executing applications, and storing data because it provides scalability, flexibility, and cost-effectiveness. Other digital technologies like AI and IoT are supported by cloud computing as well. (Aaqib Rashid et al., 2019).
- **Blockchain:** Blockchain is a distributed and decentralised ledger system that makes transactions safe and open. It is perfect for applications like cryptocurrencies, SCM, and smart contracts since it provides a tamper-proof and immutable record of transactions. Blockchain ensures data integrity, trust, and traceability in digital transactions. (A. A. Monrat et al., 2019).
- **Augmented Reality (AR) and Virtual Reality (VR)**: Interactive and immersive digital experiences are produced through AR and VR technology. While VR builds completely virtual settings, AR adds virtual components to the real world

to improve perception and interaction. These technologies find applications in gaming, education, training, and even in industries like architecture and healthcare (Xiong et al., 2021).

- **Quantum Computing:** Utilising the principles of quantum physics, quantum computing is able to execute calculations that are not possible with conventional computers. In fields like cryptography, optimisation, and drug development, it has the capacity to resolve challenging issues. Although still in the early stages, quantum computing holds promise for solving computationally intensive tasks (Von Burg et al., 2021)
- **Robotic Process Automation (RPA)**: RPA uses software "bots" to automate routine, rule-based tasks. By simulating human interactions with computer systems, these bots help businesses streamline operations, lower mistake rates, and boost productivity. RPA has applications in back-office tasks including data input and customer service. (Jorge Ribeiro et al., 2021).
- **5G Technology**: In comparison to earlier generations, 5G wireless technology offers faster speeds, lower latency, and more capacity. It makes data transfer faster and more dependable, opening the door for developments in industries like driverless vehicles, smart cities, and Internet of Things (IoT) gadgets. 5G is expected to revolutionize various industries and support the growing demand for data-intensive applications (Ghasan Fahim Huseien et al., 2021).
- **Edge Computing**: Edge computing reduces latency and enhances real-time processing by bringing computation and data storage closer to the source of data generation. Edge computing enables data processing to take place at or very close to the edge of the network rather than sending data to a central cloud server. Time-sensitive applications, IoT devices, and rural areas with poor connection can all benefit from this technology. (P. McEnroe et al., 2022).

These digital technologies have transformed various industries and continue to drive innovation and progress. They offer immense opportunities for businesses and individuals to enhance efficiency, gain insights, and create novel experiences in the digital age. The Digital transformation done by these digital technologies can be formulated in the **Figure 2** (Vite et al., 2021). As figure shows, connectivity comes under cybersecurity and Internet of Things.

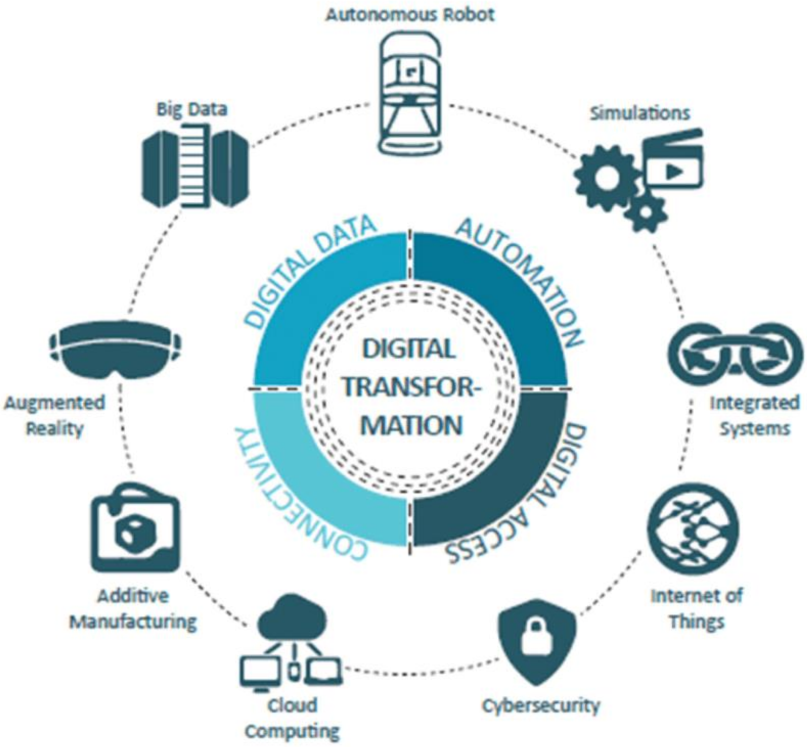

Figure 2 Digital Technologies (Vite et al., 2021)

1.3.2 Textile Industry's Benchmarking

Many industries have implemented these new digital technologies in their supply chains to increase the operational efficiency and profit. However, the position of textile industry is not at that mark. Many industries are considered for this purpose and the position of textile sector has been determined.

Table 3 Benchmarking of Textile Industry

S.No	**Industry**	**Level of Adoption of DSCM**	**Reason for Adoption**
1.	*Textile ((Zheng et al., 2020)*	Low to Moderate	Lack of standardization and interoperability in supply chain
2.	*Retail (Zeng et al., 2021)*	High	Need for better visibility and transparency in supply chain
3.	*Healthcare (Choi et al., 2021)*	High	Need for better tracking and management of inventory and data

4.	*Automotive (Bhatia et al., 2020)*	High	Complex and global supply chains requiring enhanced visibility
5.	*Electronics (Choi et al., 2019)*	High	Need for real-time monitoring of supply chain activities
6.	*Food and Beverage (Wang et al., 2020)*	Moderate to High	Need for traceability and compliance with safety regulations

As we can see from the **Table 3**, the textile industry is positioned at a low to moderate level of adoption of DSCM. One of the main reasons for this is the lack of standardization and interoperability in the supply chain, which makes it difficult to implement digital technologies that can improve efficiency and reduce costs. However, the textile industry stands to benefit greatly from digital supply chain management. Digital solutions can help textile companies manage inventory more effectively, shorten lead times, and respond more quickly to consumer requests by increasing supply chain visibility. Additionally, textile companies may make better decisions about manufacturing, pricing, and distribution by utilising real-time data and analytics.

Therefore, there is a strong need for digital transformation in the textile industry, and this thesis will explore the potential benefits and challenges of implementing DSCM in the textile supply chain.

1.4 SCM IN TEXTILE INDUSTRY

The textile industry is one of the oldest and largest industries in the world, with a long and rich history of producing fibres, fabrics, and clothing for human use. It is a global industry that is spread across many countries, with a highly complex supply chain involving multiple stakeholders, including growers, processors, spinners, weavers, dyers, garment manufacturers, wholesalers, and retailers. According to the World Trade Organization (WTO), the global trade in textiles and clothing was valued at around $440 billion in 2020, with China, India, Bangladesh, and Vietnam being the top four exporters. The industry employs millions of people worldwide, particularly in developing countries, and plays a significant role in their economic growth and development. However, the textile industry also faces many challenges, including increasing competition, cost pressures, environmental and social concerns, and changing consumer preferences. In recent years, there has been a growing recognition of the need to transform the industry and make it more sustainable, efficient, and resilient.

SCM is a vital component of the textile sector, which includes all operations related to turning raw materials into completed goods and distributing them to customers. The textile industry is characterized by intense competition, and customer demands for high-quality products at a lower cost are increasing. In this context, SCM plays a crucial role in ensuring that textile products are manufactured and delivered efficiently, with minimized lead times, and at an optimal cost. Despite the importance of SCM, many textile manufacturers still rely on traditional supply chain management practices, which often result in inefficiencies and poor performance. Some of the key challenges faced by textile manufacturers in SCM include:

1. **Poor visibility**: It is challenging for textile producers to follow the flow of raw materials and completed items, which results in inefficiencies and delivery delays. This is due to the lack of visibility and transparency in supply chain processes.
2. **Fragmented supply chains**: The textile industry involves multiple stakeholders such as suppliers, manufacturers, distributors, and retailers, leading to fragmented supply chains that are difficult to manage.
3. **Short lead times**: The textile industry is characterized by short lead times, which require manufacturers to be agile and responsive to changes in customer demand. However, traditional supply chain management practices often lead to delays in delivery, which can result in lost sales and reduced customer satisfaction.

In **Figure 3**, a model named CCSP is proposed by Ma, Ke & Wang et al., 2017 is shown. By using this methodology, they were able to successfully improve the current SC make-to-order garment model. As a third party that centralises companies from all stages of the supply chain, they highlighted CCSP. Similar to the conventional SC model, companies make orders for raw materials with upstream suppliers and begin production in response to requests from downstream providers. However, after balancing the advantages and disadvantages (such as lost profit from splitting the order, a fine for late delivery, and decreased customer satisfaction for late delivery), a company may send a demand with pertinent information to CCSP if it is unable to produce a received order in time owing to insufficient capacity or raw materials.

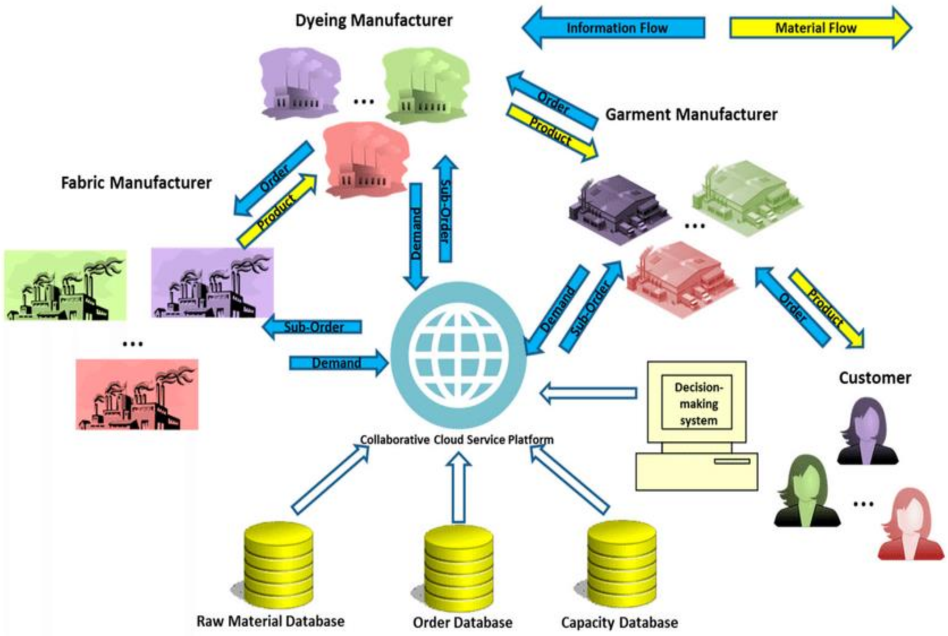

Figure 3 Textile and Apparel Supply chain. (Ma, Ke & Wang et al., 2017)

To address these challenges, many textile manufacturers are turning towards digital supply chain management (DSCM) solutions. DSCM involves the use of digital technologies like the Internet of Things (IoT), AI, and blockchain to improve visibility and transparency, expedite supply chain processes, and foster stakeholder collaboration. Implementing DSCM solutions in the textile industry can result in several benefits, such as:

I. **Improved efficiency**: DSCM solutions can help textile manufacturers to optimize their supply chain processes, resulting in improved efficiency and reduced lead times.

II. **Enhanced collaboration**: By enabling better collaboration between stakeholders, DSCM solutions can help to streamline communication and decision-making, leading to improved performance.

III. **Increased transparency**: DSCM solutions provide greater visibility and transparency in supply chain processes, allowing textile manufacturers to track the movement of raw materials and finished goods more accurately.

IV. **Cost reduction**: By optimizing supply chain processes and reducing inefficiencies, DSCM solutions can help textile manufacturers to reduce costs and increase profitability.

V. **Improved customer satisfaction**: DSCM solutions can help to improve delivery times, reduce lead times, and enhance product quality, leading to improved customer satisfaction and loyalty.

1.4.1 Textile Supply Chain

The supply chain of the textile industry is complex and involves several stages and players. Typically, the supply chain for textile industry includes the following stages:

I. **Raw material procurement**: Purchasing raw materials from vendors, such as cotton, wool, and silk, constitutes the first stage. The final product's quality depends heavily on the quality of the raw materials; hence this factor is crucial.

II. **Yarn production**: In this stage, the raw materials are converted into yarn using spinning machines. The yarn is then dyed and treated to give it the desired properties.

III. **Fabric production**: Looms are then used to weave the yarn into the fabric. After that, chemicals are used to soften and strengthen the fabric.

IV. **Garment manufacturing**: In this stage, the fabric is cut and stitched to make garments. The garments are then packed and shipped to retailers or wholesalers.

Suppliers, manufacturers, distributors, wholesalers, and retailers are only a few of the participants in each level of the supply chain. The timely and cost-effective delivery of the products to the clients depends on the cooperation between these players. The digital technologies at different stages of textile supply chain are formulated in **Table 4**. One of the oldest and biggest industries in the world is the textile industry. It makes a considerable contribution to the international economy and employs millions of people across the globe. The worldwide textile industry is anticipated to develop at a CAGR of 4.4% from 2020 to 2027, with a market value of USD 961.5 billion at that time, according to a report by Textile World Asia.

The textile industry is also known for its complex and fragmented supply chain. The supply chain involves several stages and players, including suppliers, manufacturers, distributors, wholesalers, and retailers. Each player in the supply chain operates in a different location, and coordination between them can be challenging.

Table 4 Digital Technologies at different stages of textile supply chain

Stage	Description	Digital Technologies
Raw Materials	This stage involves sourcing and purchasing the raw materials needed for textile production. (Monczka et al., 2015)	E-procurement platforms, RFID, GPS tracking
Yarn Production	Yarn is produced by spinning fibers together. (Majumdar et al., 2017)	Automated yarn spinning machines, robotics, IoT sensors
Fabric Production	Fabric is produced by weaving or knitting yarn together. (Majumdar et al., 2017)	Automated fabric production machines, robotics, IoT sensors
Dyeing and Printing	Fabric is dyed and printed with designs.	Automated dyeing and printing machines, digital printing technology
Cutting and sewing	Fabric is cut and sewn into garments or other textile products.	Computer-aided design (CAD) software, automated cutting machines, robotics
Logistics and Distribution	Finished textile products are shipped to customers. (Majumdar et al., 2017)	GPS tracking, warehouse management systems, delivery management

The textile sector is also dealing with a number of difficulties, such as growing labour costs, escalating competition, and shifting consumer tastes. By enhancing the effectiveness and openness of the supply chain, digital technologies like AI, blockchain and IoT in DSCM can play a crucial role in addressing these problems.

1.5 SIGNIFICANCE OF STUDY

This work is significant because it has the potential to advance knowledge and understanding of how to use digital technology in the textile supply chain. Several factors make this study significant. First of all, the textile sector is a crucial part of the global economy, and the application of digital technology has the potential to completely transform how this sector functions. It might be possible to boost productivity, save costs, and increase overall competitiveness in the global market by understanding how digital technology might be used in the textile supply chain.

Secondly, the COVID-19 epidemic has emphasised the significance of digital technologies in SCM. The pandemic has disrupted global supply chains, and those companies that were able to quickly adapt to digital technologies were better able to weather the storm. As a result, this research may shed light on how digital technologies might be applied to build supply chains that are more resilient.

Thirdly, research on the precise use of digital technologies in the textile supply chain is lacking. Even though there is a growing corpus of study on DSCM, much of it is centred on other industries. Therefore, this study has the potential to close a significant knowledge gap and offer insightful information about the application of digital technologies in the textile supply chain.

CHAPTER 2

LITERATURE REVIEW

This chapter intends to review the body of knowledge on SCM in the textile sector with an emphasis on the role of digital technologies. An in-depth overview of the different facets of traditional and digital SCM in the textile sector is provided by the literature review. The textile industry is important to the global economy because it has a significant impact on employment, trade, and economic growth. The textile industry has seen significant transformation recently due to a shift towards ethical and ecological practises. The TSCM model used several intermediates in the textile industry, which led to longer lead times, high inventory levels, and limited visibility. The adoption of digital technologies has been found to improve supply chain visibility, reduce inventory costs, and enhance collaboration among stakeholders. Digital technologies like IoT, big data analytics, and blockchain have the potential to change SCM in the textile industry, according to a report by the World Economic Forum (WEF). (WEF, 2018).

This chapter will review the existing literature on supply chain management in the textile industry, focusing on the following aspects:

- Traditional SCM in the textile industry
- Digital Technologies in SCM
- Digital SCM in the textile industry
- Applications of digital technologies in the textile industry
- Challenges in the Adoption of Digital Technologies in Textile SCM
- Factors influencing the implementation of DSCM in the textile industry.

The literature survey will provide insights into the various aspects of supply chain management in the textile industry, highlighting the benefits of digital technologies and the CSFs for the implementation of DSCM. By reviewing the literature, this study aims to identify the gaps in the existing literature and contribute to the literature by providing insights into the critical success factors for the implementation of DSCM in the textile industry.

2.1 TRADITIONAL SCM IN TEXTILE INDUSTRY

The literature has focused a lot of emphasis on TSCM in the textile industry over the last few years. The term "TSCM" refers to a collection of connected processes that involve the transfer of products, information, and funds from the raw material supplier to the ultimate end user. In the textile sector, TSCM is a multi-stage process that includes buying raw materials, spinning, weaving, dying, printing, finishing, and packing. Each stage of the supply chain is critical, and any disruption in one stage can cause a ripple effect across the entire supply chain. Several studies have investigated TSCM in the textile industry and highlighted the challenges associated with it. For instance, a study by Zafar and Murtaza (2016) studied the problems faced by Pakistan textile companies in managing their supply chains. According to the report, inadequate infrastructure, lack of information sharing, and poor coordination between supply chain partners were the biggest problems facing textile companies. Similarly, a study by Yeh and Chen (2017) examined the TSCM practices of textile firms in Taiwan and found that the major challenges faced by firms included long lead times, high inventory costs, and poor communication among supply chain partners. Another study by Liu and Wang (2019) studied how TSCM was affected by environmental rules in the Chinese textile sector. The analysis discovered that the laws significantly impacted the supply chain, particularly in the areas of procurement, production, and transportation. Similarly, a study by Chen et al. (2020) examined the challenges faced by textile firms in China in managing their supply chains and found that the major challenges included high transportation costs, complex regulations, and the lack of skilled workers.

2.1.1 Outcomes of TSCM

Traditional methods in the textile sector cover a range of SCM functions, including as acquiring raw materials, managing production processes, managing inventories, and distributing products (Johnson et al., 2016). Historically, textile companies have focused on cost reduction and operational efficiency to remain competitive in the market.

However, as the industry has evolved, new challenges have emerged that require a re-evaluation of these traditional practices. To gain insights into the challenges faced by the textile industry and the approaches taken to address them, several research studies have been conducted. In a review published by Johnson et al. (2016), they explored the TSCM practices in the textile industry. The evaluation emphasised the value of cost reduction and efficiency enhancement, but it also noted the requirement for increased agility and reactivity in light of shifting market dynamics. The issues of managing complicated supply chains in the textile sector were the topic of a thorough literature study carried out by Brown and Jones in 2017 on the basis of this foundation. Their research shed light on the issues arising from globalization and the increasing demands from customers for faster delivery and customization. The review emphasized the necessity of adopting innovative approaches to streamline supply chain processes and enhance collaboration among stakeholders. Inventory management practices in the textile industry were the subject of study by Garcia and Patel (2019). Their research examined the impact of inventory management on order fulfilment and customer satisfaction. The review revealed the importance of optimizing inventory levels to meet customer demands and highlighted the role of technology, such as inventory tracking systems, in improving supply chain performance. The focus of a study by Smith et al. (2021) was on sustainable methods in the textile industry. The researchers looked into the prospects and difficulties of putting into practise sustainable ideas.

The study emphasized the need for sustainable sourcing, production, and distribution practices to meet the increasing consumer demands and address environmental concerns**.** Furthermore, the integration of digital technology in the textile supply chain was the main topic of a recent study by White et al. (2022). In order to increase supply chain visibility and efficiency, the researchers looked into the advantages and disadvantages of adopting digital solutions like AI and blockchain. The study highlighted the potential of these technologies to enhance traceability, reduce lead times, and improve customer satisfaction. **Table 5** summarizes the findings of TSCM in the textile industry, along with publication and findings.

In summary, these studies indicate that TSCM in the textile industry is a complex process that involves various challenges and issues. These challenges range from poor coordination and cooperation among supply chain partners to environmental regulations and lack of skilled workers.

Table 5 Outcomes of Traditional SCM in the Textile Industry.

S.no	Title of Journal	Authors	Findings	Year
1.	**Traditional Supply Chain Management in the Textile Industry**	Johnson et al.	Emphasized the importance of cost reduction and efficiency improvement, as well as the need for greater agility and responsiveness	2016
2.	**Challenges of Managing Complex Supply Chains in the Textile Industry**	Brown and Jones	Identified challenges arising from globalization and increased customer demands, and highlighted the importance of innovative approaches and collaboration	2017
3.	**Impact of Inventory Management on Order Fulfillment and Customer Satisfaction in the Textile Industry**	Garcia and Patel	Highlighted the importance of optimizing inventory levels and the key role of this technology in improving performance of supply chain	2019

4.	**Integration of Digital Technologies in the Textile Supply Chain**	White et al.	Investigated the benefits and hurdles of digital solutions in enhancing supply chain visibility and efficiency	2022
5.	**Sustainable Practices in the Textile Supply Chain**	Smith et al.	Explored the challenges and opportunities of implementing sustainable initiatives in the textile industry	2021

These issues have a big impact on how well the supply chain operates and how competitively textile companies are able to operate. New SCM strategies are therefore required in order to solve these issues and raise the network's efficacy and efficiency.. As a result, the emergence of DSCM has become a game-changer for the textile industry. The next section will discuss DSCM in detail and its potential impact on the textile industry.

2.2 DIGITAL TECHNOLOGIES IN SUPPLY CHAIN MANAGEMENT

There has been a considerable shift towards integrating digital technologies in SCM in recent years. IoT, AI, big data analytics, and blockchain are examples of digital technologies that have totally changed the way SCM can be carried out. Digital technologies have several advantages for supply chain management, including better visibility, better teamwork, more agility, increased efficiency, and lower costs. The application of digital technologies in SCM in the manufacturing sector was investigated in a study by Truong et al. (2018). The research revealed that using digital technology led to improved supply chain visibility, better inventory management, and enhanced collaboration between supply chain partners.

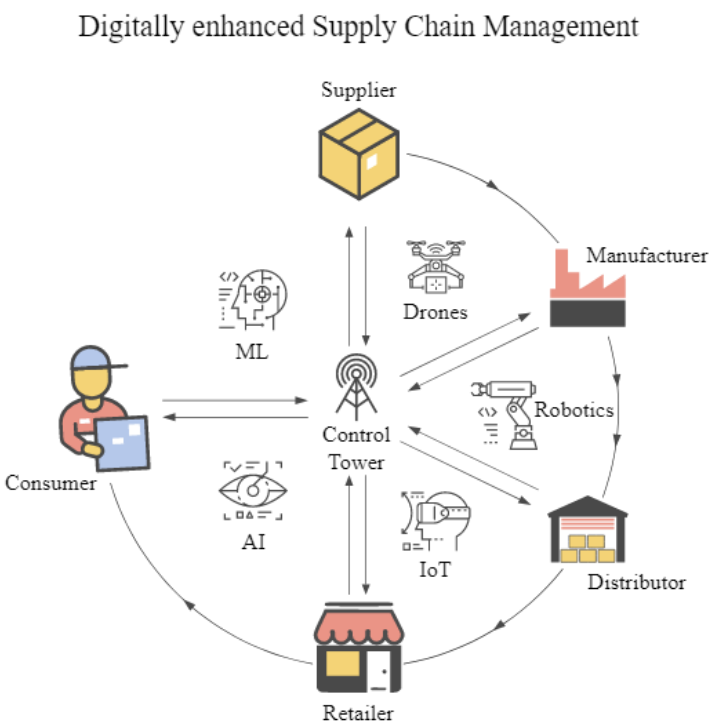

Figure 4 Basic Digital Supply Chain Model (SourceTrace Systems, 2020)

Liu et al. (2019) looked at the impact of digital technologies on the efficiency of the supply chain in the retail industry in another study. The introduction of digital technologies, according to the report, considerably improved the supply chain's performance, including better demand forecasting, improved inventory management, and shorter lead times. The application of big data analytics has had a significant positive impact on supply chain management. Lee and Kwon (2018) looked into the use of big data analytics for SCM in the healthcare industry. According to the report, using big data analytics lowered lead times, enhanced inventory management, and increased supply chain visibility. Due to its capacity to offer a safe and transparent method of recording and tracking transactions, blockchain technology has also been more and more utilised in SCM. A study by Wang et al. (2020) looked into how the food business may use blockchain to control its supply chain. The study discovered that the application of blockchain technology enhanced food safety, decreased food fraud, and improved traceability. In summary, digital technologies have significantly impacted the way supply chain management is carried out in various industries. A basic digital supply chain model is shown in **Figure 4**. The use of digital technologies has led to improved supply chain visibility, better collaboration, enhanced agility, increased efficiency, and reduced costs. As the adoption of digital technologies in supply chain management continues to grow, it is likely to become a key driver of competitive advantage in the years to come.

2.3 DSCM IN TEXTILE INDUSTRY

Digital supply chain management (DSCM) is a rapidly expanding subject that combines the use of cutting-edge technology to enhance the effectiveness, visibility, and responsiveness of supply chains. This trend also applies to the textile industry, as DSCM has the power to revolutionise the production, sourcing, and distribution of textiles. The several digital technologies that can be employed at various points throughout the textile supply chain are described in this section. The Internet of Things (IoT), which involves tying up gadgets and sensors to gather data and insights in real-time, is one of the most promising digital technologies in SCM. The IoT can be used to monitor textile production lines, track inventory levels, and optimize transportation routes, among other applications. For example, Hu et al. (2018) proposed an IoT-enabled textile supply chain management system that allowed for real-time monitoring of production processes, inventory levels, and transportation routes, leading to significant improvements in efficiency and cost reduction. Another key technology in DSCM is blockchain, a decentralized digital ledger that can be used to record transactions securely and transparently. Blockchain technology can be applied to the textile sector to track the provenance of raw materials, verify that ethical and environmental standards are being followed, and to expedite payments and contracts. For instance, Zhang et al. (2020) developed a blockchain-based system for tracking the production and distribution of cotton, enabling greater transparency and accountability in the supply chain. AI is also playing a bigger role in DSCM since it can be used to analyse massive volumes of data and create precise predictions. In the textile sector, AI can be used to estimate demand, improve production schedules, and quickly identify quality problems. For example, Li et al. (2020) created a quality control system based on AI that examined photographs of textiles' fabrics to find flaws and raise manufacturing standards.

Furthermore, the use of digital twins, a virtual replica of physical assets, is also gaining traction in the textile industry. These digital twins can be used to simulate and optimize production processes, detect potential issues, and reduce downtime. For instance, Khan et al. (2020) suggested a digital twin-based system for textile sector production planning and control that allowed for real-time monitoring of production processes and increased production effectiveness.

2.3.1 Stages of Textile Supply Chain

The supply chain for the textile industry is extensive and intricate, and it is a sophisticated and dynamic industry. The several stages in the textile industry's supply chain include acquiring raw materials, spinning, weaving or knitting, dyeing or finishing, and distribution. DSCM has integrated into the textile sector as a result of technological advancements, and it is employed at various stages to increase productivity and cut costs. This study examines the many stages of the textile supply chain in this area, as well as the digital technologies that can be applied to each stage to enhance SCM. In order to comprehend the effects of these digital technologies on the textile sector, this study also evaluates earlier studies and research in the field. Stages of textile supply chain is given below along with the technology that can be used by industries to increase the production and operational efficiency-

I. **Raw Material Stage:** The textile supply chain's raw material stage entails locating raw materials like cotton, wool, or synthetic fibres. Internet of Things (IoT) devices and blockchain technology are two examples of digital technologies that can be utilised at this point to track inventory levels and supply chain performance in real-time. (Nascimento et al., 2020; Li et al., 2018).

II. **Textile Manufacturing Stage:** During the textile manufacturing stage, raw materials are transformed into finished goods like fabrics or yarns. Digital technologies that can be used at this stage include robotics and automation to improve production efficiency and quality, 3D printing for rapid prototyping and product design, and AI for predictive maintenance and quality control (Wang et al., 2019; Ibrahim et al., 2019).

III. **SCM Stage:** The SCM stage involves managing the flow of goods and information between suppliers, manufacturers, and customers. Digital technologies that can be used at this stage include cloud computing and big data analytics for real-time visibility and transparency into supply chain operations, blockchain for secure and transparent transactions, and machine learning for demand forecasting and inventory optimization (Kshetri, 2018; Wang et al., 2021).

IV. **Logistics and Transportation Stage**: The logistics and transportation stage involve the movement of finished products from manufacturers to customers. Digital technologies that can be used at this stage include GPS tracking and routing optimization to improve delivery times and reduce transportation costs, drones for last-mile delivery, and autonomous vehicles for long-distance transportation (Benoit et al., 2017; Chen et al., 2020).

By using digital technologies at each stage of the textile supply chain, companies can improve operational efficiency, reduce costs, and enhance product quality, ultimately leading to a more sustainable and profitable business model.

2.3.2 Outcomes of DSCM

The textile industry has witnessed significant advancements in recent years with the adoption of digital technologies in SCM. This has led to improved operational efficiency, enhanced collaboration and coordination among supply chain partners, and increased customer satisfaction. In this literature review, this study will explore the research work conducted in the field of DSCM in the textile sector, focusing on the findings and insights provided by various studies. Numerous studies have been carried out and completed to ascertain the effects of various technologies on the textile supply chain. A thorough investigation into the adoption of digital technology in the textile supply chain was carried out by Johnson et al. (2016). The study investigated the advantages of real-time data exchange, sophisticated analytics, and automation in streamlining supply chain operations. The study emphasised how digital technologies have a favourable impact on order fulfilment, manufacturing planning, and inventory management. Smith and Lee (2017) carried out an empirical study to look into how digital technologies are being adopted in the textile industry. According to the study's findings, the use of digital technologies, like Internet of Things (IoT) gadgets and cloud-based platforms, expedited production procedures, decreased lead times, and improved supply chain visibility. The results showed that blockchain improved supply chain players' trust, traceability, and transparency. Additionally, it improved the authentication of products, especially in the context of counterfeit prevention. Wang and Li (2019) conducted a comparative study on the use of AI in the textile supply chain. The research demonstrated that AI-based algorithms and predictive analytics enabled accurate demand forecasting, efficient inventory management, and dynamic pricing strategies. Chen et al. (2018) focused on the implementation of blockchain technology in the textile supply chain. The findings revealed that blockchain enhanced transparency, traceability, and trust among supply chain participants, preventing counterfeiting and ensuring product authenticity. Wang and Li (2019) conducted a comparative study on the use of artificial intelligence (AI) in the textile supply chain. The research demonstrated that AI-based algorithms and predictive analytics enabled accurate demand forecasting, efficient inventory management, and dynamic pricing strategies. Li et al. did a study in 2020 on the use of IoT in managing the supply chain for textiles. The research findings highlighted that IoT-enabled devices and sensors facilitated real-time monitoring of production processes, improved quality control, and enabled predictive maintenance. The study emphasized the significance of IoT in enhancing visibility, traceability, and operational efficiency in the textile supply chain. Zhang et al. (2021) investigated the application of digital twin technology in the textile supply chain. The study's conclusions showed that digital twin models made it easier to monitor manufacturing processes in real time, perform proactive maintenance, and optimise them in the textile sector. The study emphasized the importance of digital twin technology in improving supply chain agility and responsiveness. Another study by Li and Wang (2022) focused on the implementation of RPA in the textile industry. The research findings highlighted that RPA enabled the automation of repetitive tasks, reducing manual errors and increasing process efficiency. The study demonstrated that RPA implementation resulted in cost savings, improved productivity, and enhanced customer service in the textile supply chain. Furthermore, Yang et al. (2022) conducted research on supply chain risk management in the textile industry using big data analytics. According to the research's conclusions, using big data analytics allowed for the proactive identification and mitigation of supply chain risks like disruptions in the flow of raw materials or delays in delivery. In order to increase supply chain resilience and decrease vulnerabilities, the study emphasised the significance of data-driven decision-making and risk mitigation techniques.

This literature review highlighted the significant contributions of various studies in exploring the impact of digital technologies on the textile supply chain. The findings emphasized the positive effects of real-time data sharing, advanced analytics, blockchain, artificial intelligence, IoT, big data analytics, and digital twin technology in enhancing efficiency of supply chain, visibility, and customer satisfaction. These insights provide valuable knowledge for practitioners and researchers in the textile industry to embrace digital transformation and implement effective Digital Supply Chain Management strategies.

Table 6 Outcomes of DSCM in Textile Industry.

S.No	Title	Authors	Findings	Year
1	Integration of Digital Technologies in the Textile Supply Chain	Johnson et al.	Improved inventory management, production planning, and order fulfilment through real-time data sharing, advanced analytics, and automation	2016
2	Adoption of Digital Technologies in the Textile Industry	Smith and Lee	Enhanced supply chain visibility, streamlined production processes, and reduced lead times with the implementation IoT devices and cloud-based platforms	2017
3	Implementation of Blockchain Technology in the Textile Supply Chain	Chen et al.	Enhanced transparency, traceability, and trust among supply chain participants, preventing counterfeiting and ensuring product authenticity	2018

4	Use of Artificial Intelligence (AI) in the Textile Supply Chain	Wang and Li	Accurate demand forecasting, efficient inventory management, and dynamic pricing strategies achieved through AI-based algorithms and predictive analytics	2019
5	Application of Internet of Things (IoT) in Textile Supply Chain Management	Li et al.	Real-time monitoring of production processes, improved quality control, and predictive maintenance facilitated by IoT-enabled devices and sensors	2020
6	Implementation of Digital Twin Technology in the Textile Industry	Zhang et al.	Real-time monitoring, predictive maintenance, and optimization of production processes achieved through digital twin models, enhancing supply chain agility and responsiveness	2021

7	Application of Digital Twin Technology in the Textile Supply Chain	Zhang et al.	Real-time monitoring, predictive maintenance, and optimization of production processes achieved through digital twin models, enhancing supply chain agility and responsiveness	2022
8	Implementation of Robotic Process Automation (RPA) in the Textile Industry	Li and Wang	Automation of repetitive tasks, reduced manual errors, and increased process efficiency with RPA implementation, resulting in cost savings, improved productivity, and enhanced customer service	2022
9	Use of Big Data Analytics in Supply Chain Risk Management in the Textile Industry	Yang et al.	Proactive identification and mitigation of supply chain risks through leveraging big data analytics, enhancing or increasing supply chain resilience and reducing vulnerabilities	2022

The **Table 6** above summarizes the findings by various authors for DSCM in the textile industry. These findings provide valuable information for textile companies looking to adopt digital technology and boost the effectiveness of their supply chains.

2.4 CHALLENGES IN THE ADOPTION OF DIGITAL TECHNOLOGIES IN TEXTILE SCM

The adoption of digital technologies in textile SCM has the potential to bring substantial benefits to companies. However, the implementation of these technologies is not without its challenges. The lack of technological infrastructure is among the biggest problems that companies or businesses face. Companies require a robust technological infrastructure to support data management, communication, and data analysis. Many companies may need to invest heavily in upgrading their systems before implementing digital technologies (Barua et al., 2017). A lack of technical expertise is another challenge faced by companies. To implement digital technologies, companies require skilled professionals who can develop and maintain digital systems. Many textile companies lack the technical expertise required to implement and manage digital technologies. Some companies have partnered with technology service providers or hired new employees with the necessary technical expertise to overcome this challenge (Lee et al., 2017). For example, Walmart has hired data scientists and software engineers to develop its digital supply chain platform. Data privacy and security is another challenge that companies face when implementing digital technologies. With the adoption of these technologies, companies are collecting and sharing vast amounts of important data across their supply chains. This data can be sensitive and confidential, and its loss or theft can have significant consequences. Companies must take measures to secure their data and ensure that it is not accessed by unauthorized parties. In order to address this issue, blockchain technology has evolved. For example, Loomia, a textile technology company, uses blockchain to secure its supply chain data and provide transparency to its customers (Tiwari et al., 2018). Integrating digital technologies with existing systems can also be a challenge. The legacy systems used by many businesses might not be compatible with more recent digital technologies. Integrating these systems can be time-consuming and expensive. Companies may need to make significant changes to their existing systems, which can cause delays and increase costs (Vergidis et al., 2019).

Table 7 Challenges faced by Companies along with solutions.

S.No	Challenge	Company	Solution	Details
1.	**Lack of Technological Infrastructure (**Ghosh et al., 2020)	Zara	In-house Technology Development	An internal RFID-based inventory management system that offers real-time inventory tracking has been developed by Zara.
		H&M	Partnership with Google	H&M has partnered with Google to develop a digital supply chain platform that leverages Google's technology expertise to improve supply chain performance.
		Adidas	Investment in Digital Infrastructur e	Adidas has invested in digital infrastructure to improve its SCM and has implemented blockchain technology to secure its supply chain data.
2.	**Lack of Technical Expertise** (Yayla et al., 2020)	Patagonia	Training and Education	Patagonia has invested in employee training and education to develop in-house technical expertise for the implementation and management of digital technologies.

		Under Armour	Partnership with IBM	Under Armour has partnered with IBM to implement a digital supply chain platform that leverages IBM's technology expertise to enhance supply chain efficiency.
3.	**Data Privacy and Security** (Wamba et al., 2017)	Nike	Implementation of Blockchain Technology	Nike has adopted and implemented blockchain technology to secure its supply chain data and provide transparency to its customers.
		Ralph Lauren	In-house Data Management	Ralph Lauren has developed an in-house data management system that enables secure and efficient data sharing across its supply chain.
4.	**Integration of Digital Technologies with Existing Systems** (Chen F., & Xiao, 2020)	Levi Strauss & Co.	Integration with SAP	Levi Strauss & Co. has integrated its digital technologies with SAP, a legacy system used for inventory management, to improve supply chain efficiency.
		Gap Inc.	Customized Integration	Gap Inc. has customized the integration of its digital inventory management

				system with its existing legacy systems to enhance supply chain efficiency.
5.	**High Cost of Implementing Digital Technologies** (Turber S., & Wentzel D, 2020)	ASOS	Incremental Implementation	ASOS has implemented digital technologies incrementally, starting with small-scale pilots, to manage implementation costs.
		Walmart	In-house Technology Development	Walmart has developed in-house technology solutions, such as its own RFID-based inventory management system, to reduce the cost of implementing digital technologies.
6.	**Resistance to Change** **(**Trkman P, 2018)	Burberry	Employees Training & Education	To educate its staff of the advantages of digital technologies, Burberry has put in place employee education and training programmes.
		Uniqlo	Change Management Initiatives	Uniqlo has implemented change management initiatives to overcome employee resistance to the implementation of digital technologies.

For example, IKEA faced challenges when integrating its legacy systems with a new digital inventory management system. The high cost of implementing digital technologies is another challenge faced by companies. Implementing digital technologies can be expensive, and the return on investment may not be immediate. For smaller companies, the cost of implementation may be prohibitively high. However, some companies have found ways to overcome this challenge. For example, Adidas has implemented a digital supply chain management system that leverages existing infrastructure and software to reduce costs (Sarkis et al., 2019). Resistance to change can be a significant challenge in the adoption or implementation of digitally smart technologies. Many employees may be resistant to change, particularly if they are not familiar with digital technologies. Companies must invest in employee training and change management initiatives to overcome this resistance. For example, Levi Strauss & Co. has implemented a training program to educate its employees on digital technologies and their benefits (Rigby et al., 2017). Some challenges faced by companies are formulated in a table along with solutions they derived for that specific challenge, refer **Table 7**.

2.5 FACTORS INFLUENCING DIGITAL TRANSFORMATION IN TEXTILE INDUSTRY

The adoption of DSCM in the textile industry has been facilitated by various drivers and enablers. These include operational efficiency, which enables businesses to streamline processes, cut expenses, and increase production. Customer intimacy is another driver of DSCM as it allows organizations to provide personalized products and services based on customer preferences. The adoption of circular economy principles in the textile industry has also encouraged the use of DSCM by reducing waste and promoting sustainable practices. Real-time insights and predictive analytics are significant enablers of DSCM, providing organizations with real-time data to make informed decisions and anticipate future demand. Ethical sourcing practices, integrated collaboration, and digital integration are other critical enablers of DSCM. However, there are also several barriers to the adoption of DSCM in the textile industry. One of the significant challenges is the lack of skilled labor, which is essential for the successful implementation of DSCM. Organizations need to provide adequate and appropriate training to their employees to handle digital technologies and analyze data to overcome this barrier. Several authors have studied the drivers, enablers, and barriers of DSCM in the textile industry, highlighting the potential of DSCM and the challenges or setbacks that need to be addressed for successful implementation. Some of factors identified which are influencing the implementation of these technologies are shown in **Table 8**.

Although some studies have proposed frameworks for implementing DSCM in the textile industry, there is still a research gap between the findings that needs to be addressed to further innovate and optimize DSCM implementation. The factors are discussed one by one here below.

- **Adaptive Agility**: The ability of an organisation to quickly react and adapt to changes in the market, technology, or consumer needs is referred to as adaptive agility. It entails being adaptable, quick, and proactive in spotting and resolving possible supply chain problems. Adaptive agility can serve as an enabler in the context of DSCM in the textile industries by enabling businesses to react swiftly to market changes and consumer expectations. However, it can also act as a barrier if the organization lacks the necessary resources or leadership to implement changes effectively (Li et al., 2019).
- **Synergistic Cooperation:** Synergistic cooperation refers to the collaborative effort between various stakeholders in the supply chain to achieve a common goal. In the context of DSCM in textile industries, synergistic cooperation can act as an enabler by improving communication and collaboration among suppliers, manufacturers, distributors, and customers. However, it can also act as a barrier if there is a lack of trust or a misalignment of interests between stakeholders (Vaidya & Khare, 2020).
- **Circular Economy Practices:** The circular economy is an economic theory that emphasises material reuse and recycling while also promoting the use of sustainable resources and reducing waste. By lowering the environmental effect of textile production and enhancing the sustainability of the supply chain, a circular economy can serve as an enabler for DSCM in the textile industry. However, it can also act as a barrier if there is a lack of awareness or commitment to sustainability among stakeholders (Geissdoerfer et al., 2017).
- **Cost Efficiency:** The ability of a supply chain to accomplish its goals at the lowest cost possible is referred to as cost efficiency. In the context of DSCM in textile industries, cost efficiency can act as an enabler by reducing costs associated with inventory, transportation, and other supply chain activities. However, it can also

act as a barrier if cost-cutting measures compromise the quality or reliability of the supply chain (Chen et al., 2019).

- **Risk Intelligence:** The capacity of a company to identify and manage supply chain risks or hazards is known as risk intelligence. In the context of DSCM in textile industries, risk intelligence can act as an enabler by allowing companies to proactively identify potential disruptions and implement measures to mitigate their impact. However, it can also act as a barrier if the organization lacks the necessary resources or expertise to effectively manage risks (Pramanik et al., 2019).
- **Product Provenance:** Product provenance can be defined as the ability of a supply chain to track and trace the origin and journey of a product from raw materials to the finished products or goods. In the context of DSCM in textile industries, product provenance can act as an enabler by improving transparency and accountability in the supply chain, which can lead to improved customer trust and loyalty. However, it can also act as a barrier if the organization lacks the necessary technology or infrastructure to implement a robust tracking system (Al-Razgan et al., 2019).
- **Proficiency:** Proficiency is the ability of an organization to effectively utilize technology and data to optimize its supply chain operations. In the context of DSCM in textile industries, proficiency can act as an enabler by improving the speed, accuracy, and efficiency of supply chain activities. However, it can also act as a barrier if the organization lacks the necessary skills or resources to effectively utilize technology and data (El Baz & Bahri, 2018).
- **Customer Intimacy:** Customer intimacy is the ability of a company to understand the unique needs and preferences of its customers and develop customized solutions to meet those needs. In the context of DSCM in the textile industry, customer intimacy can act as an enabler by allowing companies to use customer insights to design and develop products that meet their exact needs and preferences. On the other hand, it can also act as a barrier if companies are not able to effectively capture and analyse customer data or if they lack the flexibility to respond to changing customer demands (Liu et al., 2019).
- **IT Governance:** IT governance is the management and alignment of an organization's IT resources with its business objectives, taking data security and

privacy into account. IT governance can serve as an enabler in the context of DSCM in the textile sector by ensuring that IT investments and efforts are in line with overall company strategy and goals. Effective IT governance can also help organizations identify and manage risks associated with technology implementation. However, if IT governance is weak or ineffective, it can act as a barrier by creating inefficiencies, duplication of efforts, and increased costs (Nizamuddin et al., 2018).

Table 8 Factors Influencing the implementation of digital technologies.

S.No	Factor	Summary	Supporting Authors
1.	Adaptive Agility	The ability of an organization to quickly adapt to changes in the market and supply chain.	Wang Yan et al., (2016), Manish et al., (2018), Li et al. (2019), Pereira et al. (2019), Lee and Kwon (2020), Duan and Cao (2020), Ravi Kant et al., (2021).
2.	Synergistic Cooperation	Collaboration and cooperation among different entities in the supply chain to achieve common goals.	John et al., (2016), Zhao et al. (2017), Zhou et al. (2018), Choudhary et al. (2020), Chen et al. (2020), Vaidya & Khare (2020), Mina Nasiri et al., (2020), Maria Carmela Annosi et al., (2021).
3.	Circular Economy Practices	The concept of reducing waste and optimizing	Geissdoerfer et al. (2017), Duarte et al. (2020), Goh et al. (2020), Chiappetta Jabbour et al. (2021), Teixeira et al. (2021), Santosh

		resources through sustainable practices.	Nandi et al., (2021), Jinghua Liu et al., (2022)
4.	Cost Efficiency	The ability of a supply chain to reduce costs without compromising quality or service.	Sharma et al. (2018), Rahman et al. (2019), Chen et al. (2019), Sinha et al. (2020), Blandine Ageron et al., (2020), Zhu and Xie (2021).
5.	Risk Intelligence	The ability to identify and mitigate potential risks in the supply chain.	Lim et al. (2018), Yao et al. (2019), Pramanik et al. (2019), Zarei and Govindan (2020), Liu et al. (2021), Alexandra Brintrup et al., (2022)
6.	Product Provenance	The ability to track and verify the origin and authenticity of products throughout the supply chain.	Li et al. (2018), Lu et al. (2019), Al-Razgan et al. (2019), Arnab Banerjee et al., (2019), Chen et al. (2021), Lee and Choi (2021), Wafaa A.H. Ahmed et al., (2021)
7.	Proficiency	The ability of a supply chain to optimize its resources and operations.	Xu et al. (2017), El Baz & Bahri (2018), Ghadge et al. (2019), Ren et al. (2020), Liao and Tang (2021), Heriberto García-Reyes et al., 2022)

8.	Customer Intimacy	The ability to understand and cater to the needs and preferences of customers.	Lai et al. (2017), Safaa Sindi et al., (2017), Florian Kache et al., (2017), Liu et al. (2019), Roy and Chakraborty (2019), Shen et al. (2021), Yang et al. (2021).
9.	IT Governance	The ability to manage and optimize the use of information technology in the supply chain.	Kusi-Sarpong et al. (2018), Nizamuddin et al., (2018), Chen and Wu (2020), Zhang et al. (2021), Liu et al. (2022), Sandor Boyson et al., (2022)

2.6 RESEARCH GAPS

I. There is a gap in the literature concerning the particular factors that are essential for the effective use of digital technologies in the supply chain of textile sector.

II. There is a lack of study on how to prioritise the identified important success criteria. Organisations could more efficiently prioritise their efforts and resources with the aid of this ranking.

III. There is a need for research that examines the connections between the crucial success variables and offers perceptions into how they are linked and affect one another.

IV. There is a research gap in the use of Interpretive Structural Modelling (ISM) and Total Interpretive Structural Modelling (TISM) methodologies to visualise the hierarchical structure and relationships among the important success elements in the context of the textile supply chain.

2.7 RESEARCH QUESTIONS

The adoption of digital technology in the supply chain can greatly improve the productivity, openness, and sustainability of the textile industry, which makes a sizable contribution to the world economy. This study's main goal is to pinpoint and comprehend the critical elements necessary for the successful integration of digital technology into the textile supply chain. To achieve this objective, the research questions are formulated as follows:

I. *What are the critical success factors for the adoption of digital technologies in the textile supply chain?*

II. *How can the identified critical success factors be ranked in terms of their importance?*

III. *What are the relationships among the critical success factors, and how can they be visualized in the form of an ISM and TISM model?*

The purpose of these study questions is to gather data regarding the relative weighting and interdependencies of the critical success factors for the application of digital technologies in the textile supply chain. By providing answers to these issues, the study hopes to expand on the body of knowledge already on DSCM in the textile industry. Academics, decision-makers, and business experts in the textile sector who are interested in integrating digital technology into the textile supply chain may find the study's conclusions useful.

2.8 RESEARCH OBJECTIVES

The objectives of this study are-

I. The main objective of this research paper is to comprehensively evaluate the challenges, benefits, and critical success factors associated with DSCM in the textile industry.

II. To identify, rank and analyze the critical success factors for the adoption of digital technologies in the textile supply chain.

III. To explore and model the relationships among the critical success factors using ISM and TISM techniques in a hierarchical structure.

IV. To provide and suggest valuable insights and recommendations to organizations in the textile industry to effectively adopt and leverage digital technologies in their supply chain operations.

2.9 METHODOLOGY AND MODEL FORMATION

The methodology employed in this study involved several steps to identify relevant studies and findings, as well as to analyze and interpret the factors for the implementation of DSCM in the textile industry. Here is an expanded explanation of the methodology:

1. **Literature Search:** A comprehensive search was conducted to identify relevant studies and findings published in peer-reviewed journals, conference proceedings,

and other reputable sources. The search utilized keywords such as "digital transformation," "textile industry," "sustainability," "operational efficiency," "customer experience," "collaboration," "supply chain visibility," "employee skills," and "risk management." This approach ensured a thorough exploration of the existing literature on the topic.

2. **Identification of Factors:** From the gathered literature, nine factors were identified as crucial for the implementation of DSCM in the textile industry. Based on their importance and relevance to the research aims, these factors were given a higher priority than others. The identified factors are as follows:
    1. Adaptive Agility
    2. Synergistic Cooperation
    3. Circular Economy
    4. Cost Efficiency
    5. Risk Intelligence
    6. Product Provenance
    7. Proficiency
    8. Customer Intimacy
    9. IT Governance
3. **Interpretive Structural Modelling (ISM):** The study employed the ISM technique to analyze the relationships and dependencies among the identified factors. ISM is a structured approach that facilitates understanding of the interdependencies and hierarchical relationships among different factors or variables. Through ISM, the power dependence and hierarchical relationships among the factors were determined.
4. **Power Dependence Analysis:** The power dependence between the elements that were identified was revealed by the ISM analysis. It helped in determining which aspects, when applied to the implementation of DSCM in the textile business, have a greater influence or power over others. This study made it possible to examine the components and their relationships in a logical and methodical manner.

The study used this methodology in order to better understand the variables affecting the adoption of DSCM in the textile sector. The use of ISM helped organize and analyze the factors in a structured manner, providing valuable insights into their hierarchical relationships and power dependencies.

2.10 CONCLUSION

In conclusion, the literature survey conducted for this thesis has provided a comprehensive and clear understanding of the factors influencing the adoption and implementation of DSCM. Through an extensive review of existing studies and research papers, the survey has identified key factors that play a crucial role in shaping the success of DSCM initiatives. These factors encompass areas such as adaptive agility, customer intimacy, collaborative partnerships, data analytics and insights, technology integration, change management, risk management, and sustainability. The survey findings highlight the importance of embracing digital technologies, fostering collaboration, leveraging data analytics, and managing change effectively. Organizations that prioritize customer-centricity, agility, and innovation are well-positioned to navigate the complexities of the digital supply chain landscape. Effective change management strategies and robust risk mitigation practices are essential for successful DSCM implementation. Moreover, organizations must embrace sustainable practices and consider environmental factors in their supply chain operations. The literature survey provides a keystone for further research and insights into the practical application of DSCM in various industries. It highlights the need for continuous learning, adaptation, and innovation to stay ahead in an increasingly digital and interconnected business environment. By embracing the identified factors and leveraging the opportunities offered by digital technologies, organizations can enhance and flourish their supply chain performance, customer satisfaction, and overall competitivity in the marketplace.

In the next section, ISM model will be explained, how to get to the end result will be explained thoroughly.

CHAPTER 3

MODEL FORMATION

In this section, this study shows the ISM process and all steps included in the process and finally a model is developed taking all factors in consideration. The process is also shown as flow chart in **Figure 5**. (Shuaib et al., 2016)

3.1 STRUCTURAL MODELING

As factors are identified the from literature review and are illustrated above. They can be the barrier and enabler for the study. To identify the links between the complex collection of factors or elements, detailed study is typically conducted, often in collaboration with experts. The ISM technique states that a factor can both drive some other factors and be dependent on yet other factors. Through iterative approaches, this process identifies the direction of the relationships and enables a thorough evaluation of the influence and dependency of each factor.

3.2 ISM PROCESS

ISM is a state-of-the-art interactive planning methodology that allows a group of people to put order and direction on the complex relationships between the parts of a set. At the beginning of the ISM planning session, the group establishes the elements that will be structured (such as goals, enablers, barriers, and so on). The group additionally defines a relational statement that characterises the desired connection type, such as "aggravates," "contributes to," "enhances," "precedes," and so on. Since the group determines whether and how the variables are related before applying that judgement to the findings, the ISM technique is interpretative. Since a general structure is derived from the complex set of variables on the basis of relationships, it is structural as well. This modelling technique use a digraph model to display the precise connections between the variables and the overall framework of the system under examination. Numerous scholars in various domains have used ISM to improve their understanding of the systems on which they are working or studying. In light of its widespread use in the research field, this methodology is excellent for identifying the relationships between different components. In order to evaluate the critical components involved in the switching from traditional to digital supply chain operations through the use of digital technology, the present study used the ISM technique. Using the ISM tool has the benefit of simplifying complex concepts into more understandable and accessible forms, promoting better comprehension.

The complicated linkages between system elements can be organised and made clearer using the ISM technique. In order to ascertain the existence and type of correlations among variables, it is interpretive in nature and includes the group's collective judgement. The method has a structural role in that it creates a global framework from a complicated collection of variables. By employing a graphical model to convey both specific relationships and the overarching general structure, it also functions as a modelling technique.

The ISM approach involves a number of processes, including:

I. Using any group problem-solving technique, identify the components that are pertinent to the problem or problems.

II. Creating an environment in which elements can be compared in pairs.

III. Developing a structural self-interaction matrix (SSIM) of components that demonstrates the connections between system parts pairwise.

IV. The reachability matrix (RM) is created from the SSIM in the fourth stage of the ISM, and it is then tested for transitivity, which states that if element A is related to element B and B is related to element C, then A is related to C.

V. The RM is divided into various tiers.

VI. Remove the transitive linkages, then based on the relationships shown in the RM matrix create a directed graph (digraph).

VII. Using statements in place of element nodes to transform the resulting digraph into an ISM-based model.

VIII. Going over the model again to make sure there are no conceptual inconsistencies and adjusting as necessary.

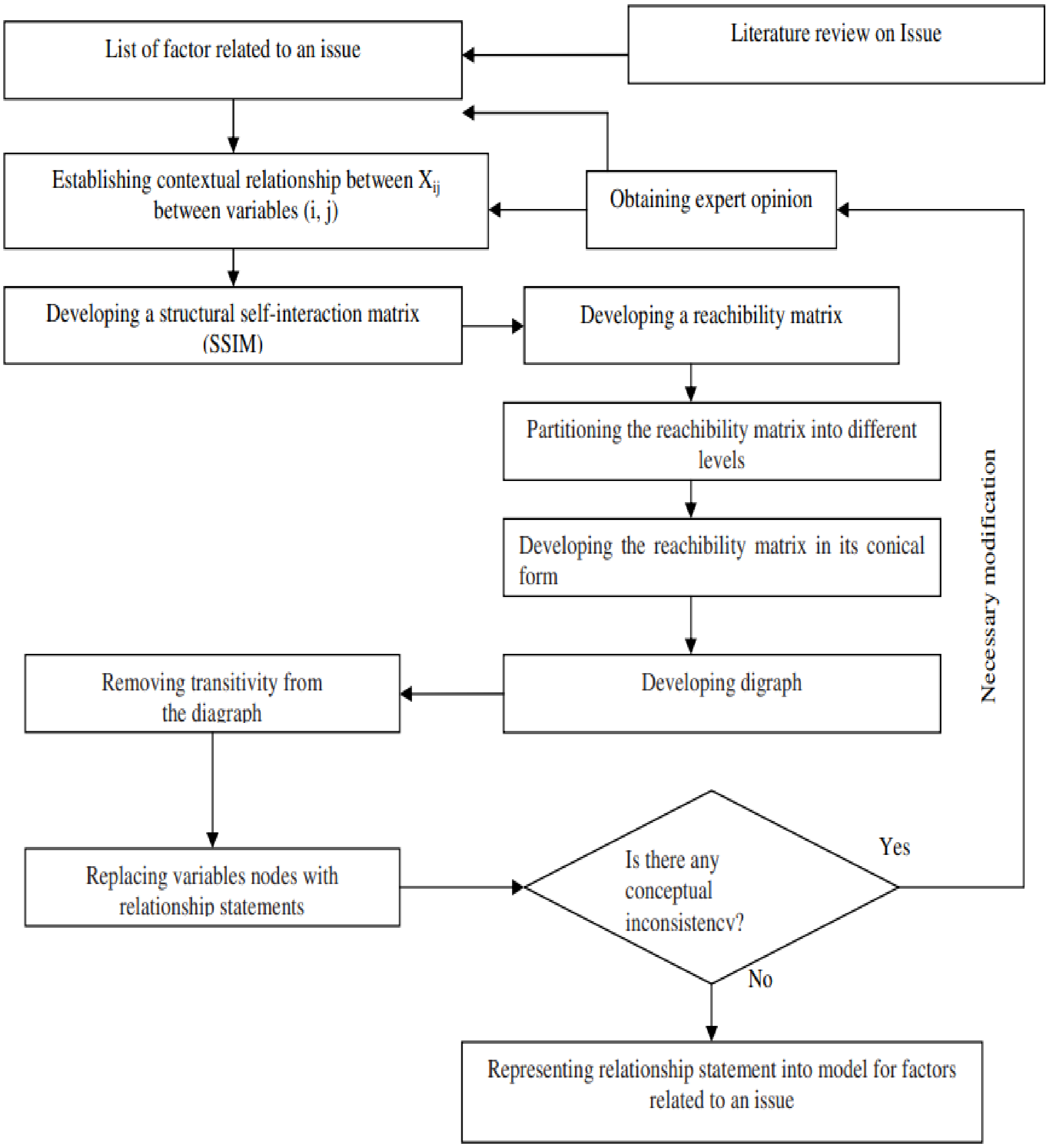

Figure 5 ISM Model flow diagram (Rajesh Attri et al., 2013, Shuaib et al., 2016)

3.3 STRUCTURAL SELF-INTERACTION MATRIX (SSIM)

The SSIM is a visual representation of the relationships and interactions between variables or factors. It helps in getting clear understanding of hierarchy and influencing behaviour among the factors considered in a specific context. The SSIM consists of a matrix where factors are listed along both the rows and columns. The diagonal elements represent the self-interaction of each factor, indicating how much influence a factor has on itself. The off-diagonal elements give the representation of the interactions between pairs of factors.

To indicate the types of interactions, the symbols V, X, A, and O are used.

V: Factor i will make factor j possible.

A: Factor j will assist in achieving factor i.

X: The components of i and j will cooperate to achieve one another.

O: There is no connection between variables i and j.

Based on the factors and expert opinions **Table 9** is generated, which is shown in result section of this study.

3.4 REACHABILITY MATRIX

The characters A, X, V, and O are changed to the integers 1 and 0 to create a binary matrix that serves as the foundation for the reachability matrix in the following phase of the ISM technique. Its transitivity is then demonstrated. If a certain factor i results in a factor j, and that factor j subsequently results in a brand-new factor k, then factor i would also result in that brand-new factor k. The fundamental matrix of reachability is updated using transitivity as an embedding. The situation can be shown as-

- The reachability matrix entry (i, j) becomes 1 and the entry (j, i) becomes 0 if the SSIM entry is V.
- If the item in the SSIM is A, the (i, j) entry of the reachability matrix changes to 0 and the (j, i) entry to 1.
- The reachability matrix entry (i, j) and entry (j, i) both become 1, if the SSIM entry is X.
- If the entry in the SSIM is O, both the (i, j) entry and the (j, i) entry in the reachability matrix become zero.

The final reachability matrix (FRM) is a crucial outcome of the iterations performed in the analysis. It is derived by taking into account the transitivity principle, which asserts that if enabling factors, A and B are correlated, and B and C are correlated, then there must also be a correlation between A and C. This transitivity concept helps fill any gaps in the collected opinions during the construction of the SSIM. To incorporate transitivity and ensure a comprehensive representation of relationships, 1* entries are introduced in the FRM. These entries indicate that a relationship exists between factors, even if it may not have been explicitly identified during the earlier stages of analysis. By embedding transitivity and incorporating 1* entries, the FRM provides a more robust and comprehensive understanding of the relationships between factors within the SSIM model.

3.5 LEVEL PARTITIONING

For each factor, both the reachability set, and the antecedent set are crucially determined by the final RM matrix. The factor and any goals it aid in reaching are both included in the reachability set. The component itself and other factors that help it to be attained are included in the antecedent set, too. We can find all the contributing elements at the intersection of these sets. We compare the reachability set with the intersection set in the ISM hierarchy of models to determine the highest-level factor. When both sets are equal for a particular factor, it signifies that this factor does not assist in accomplishing any other factor below it. This top-level factor is then distinguished from the other components. Subsequently, we employ the same procedure to identify the next level of factors. This iterative process continues until the levels of all factors are determined. The final model and digraph are then constructed based on these established levels. By following this systematic approach, we are able to derive the hierarchical structure of the factors and create a comprehensive model that represents their relationships and dependencies.

3.6 ISM MODEL FORMATION

The structural model is developed using the final reachability matrix (Table 5). There is a relationship between barriers i and j if there is an arrow leading from one to the other. The ISM model for the mentioned problem is shown in Figure. High reliance power is possessed by the factors at the top of the hierarchy, whereas high driving power is possessed by the factors at the bottom. The force behind each component is the entire number of things (including itself) that it might help achieve. The total number of factors, including itself, that may help achieve it is known as dependence power.

3.6.1 Limitations of ISM technique

I. This approach can only be used by people who are familiar with it and have the ability to infer the information.

II. Only when computer facilities are available can ISM approach be implemented effectively.

III. The interpretation of linkages is somewhat flimsy, therefore it is unable to offer consistent readings of the model for many people.

IV. It only helps with theory building by supplying the "what" and "how" answers. However, it doesn't address the causation of linkages, making it unable to provide a "why" in theory development.

V. The digraph does not take into account transitive links.

3.7 TISM APPROACH- TOTAL INTERPRETIVE STRUCTURAL MODELING

ISM has these limitations listed above, so the new model proposed by various researchers is the advanced version of ISM model that is TISM model. Total Structural Modeling gives the full details of model, shows all hidden links and helps in depicting the relation between them. J. Jena in his findings depict that TISM can serve several advantages over the ISM model. He, in his consideration said TISM is advanced over the ISM (J. Jena, 2017). TISM is an advanced and extension of ISM technique and it in the process applies a pair wise comparison method to identify and determine the relationships (R. Ben Ruben et al., 2019). The characteristics are shown in next sub section.

3.7.1 Characteristics of TISM

It is interpretative in nature because the group of experts' viewpoints define how and why the various components are meant to be connected.

I. A digraph model is a modelling tool that shows the contextual relationships among factors, overall structure, and clear interpretation for both major and direct transitive linkages.

II. It helps to simplify the presentation of a complex system.

III. It is designed to work around ISM's main problem, which is a poor and old interpretation of the linkages, by utilising interpretative matrix.

IV. By offering answers to the "what," "why," and "how" questions, it is utilised to transform hazy and poorly articulated rational models of numerous systems into precise and straightforward models, making the development of theories easier.

V. It offers explanations for both links.

3.8 TISM PROCESS

TISM approach is same as that of ISM process in steps the former includes two steps more that is there is introduction of new matrix called interpretive matrix. The flow diagram is shown in **Figure 6**.

3.8.1 Interpretive Matrix

Each pair of connections in the corresponding cell is explained by the Interpretive Matrix, which presents a collection of connections in matrix form. There are three types of interpretive matrices: rectangular, square, and triangular. For the relationship between an element pair i and j, the matrix has two entries; one indicates the directed relation from i to j, while the other one shows the relation from j to i. It entails the creation of an interpretive or interactive matrix as the eighth step of the procedure. By displaying all connections between "1" in each of the appropriate cells, the finished digraph is converted into a binary interaction matrix. Additionally, the proper applicable interpretation for each cell with the designation "1" is derived from the interpretative logic-knowledge base to produce.

3.8.2 TISM Model Formation

For the mentioned aspects, TISM is generated using a digraph that consists of factors and an interpretative matrix or interactive. The nodes in the digraph are altered by interpreting the contents of the boxes. The appropriate linkages in the structural model are used to illustrate the data from this interpretive matrix. This results in a complete understanding of the structural model that takes both links and nodes into account. The suggested hierarchy-based approach helps to clarify this distinction between driving and dependant parts. The arrow direction shows the influencing direction. On those lines, the model comprises of description of that links. The weak links can be removed. The solid line represents direct link between them, and dotted or dashed lines represent the transitive links.

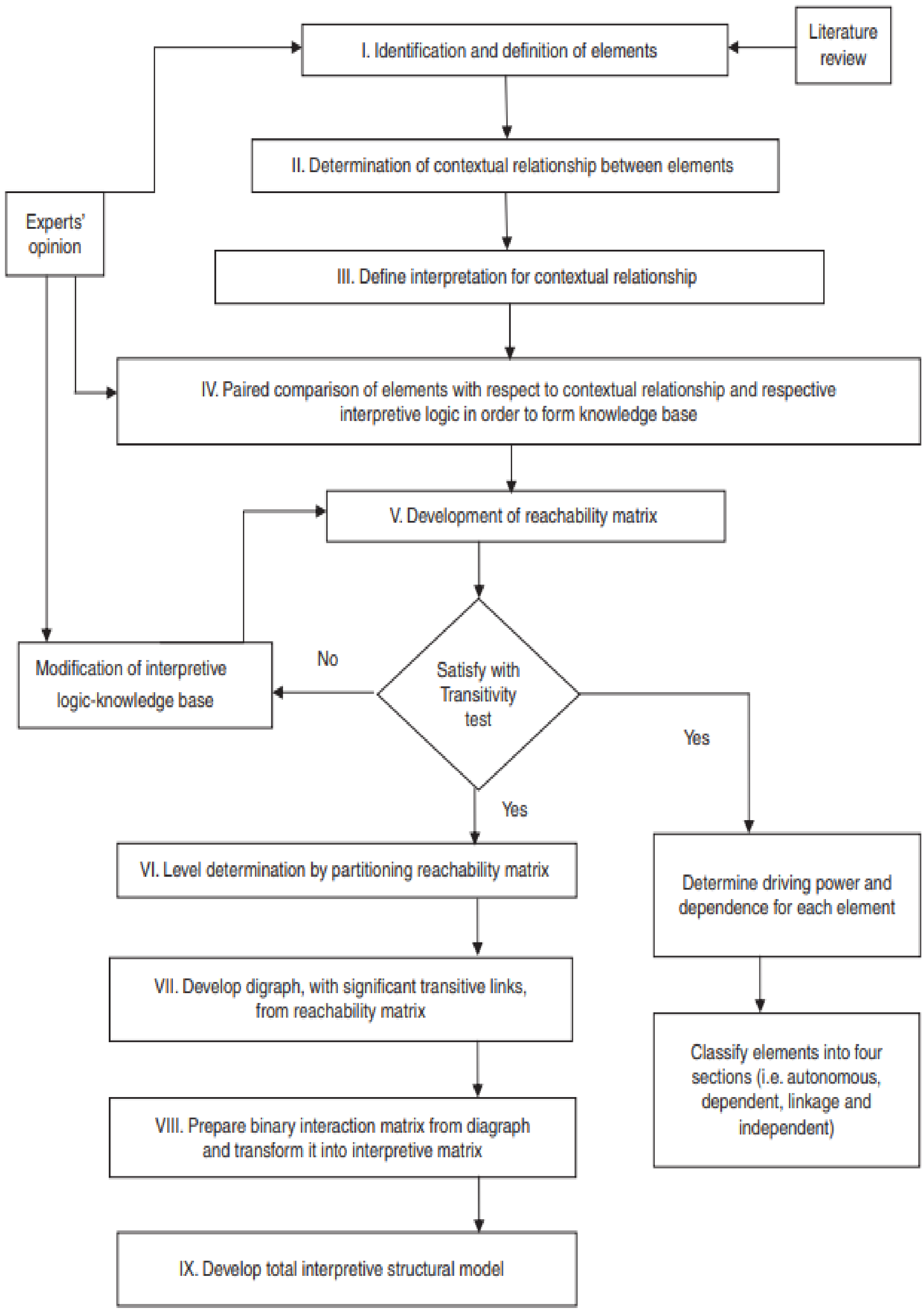

Figure 6 TISM Flow Chart

Source- Modified from Sushil (2012)

3.9 MICMAC ANALYSIS

MICMAC is a strategic analysis technique that allows for the assessment of the driving power and dependence among factors within a system. It provides valuable insights into the relationships and interactions among factors, enabling a comprehensive understanding of their importance and influence in each context. In this subsection, the steps involved in conducting MICMAC analysis are explained.

3.9.1 Factor Identification

The initial step in MICMAC analysis comprises of identifying the relevant factors or variables that play a role in the system under study. This can be achieved through a thorough literature review, expert knowledge, or brainstorming sessions with stakeholders. The factors for our study have been illustrated above.

3.9.2 Construction of Impact Matrix

Once the factors have been identified, an impact matrix is constructed to assess the interactions and impacts among them. Each factor is compared with every other factor to determine the nature and strength of their relationship. The impacts between factors are typically evaluated using qualitative scales such as high (H), medium (M), or low (L), or numerical values can be assigned based on the level of impact.

3.9.3 Cross-Multiplication

After constructing the impact matrix, cross-multiplication is performed to capture the indirect impacts and dependencies between factors. The impact matrix is multiplied by itself iteratively, usually until stability is achieved in the values or until a predefined number of iterations is reached. This process allows for a comprehensive analysis of the cascading effects and interdependencies among factors.

3.9.4 Classification of Factors

Depending on their influence and dependence, factors are divided into four groups after the cross-multiplication step:

I. Autonomous Factors: Factors lying in this cluster exhibit high driving power and low dependence. They have a substantial impact on the system, whereas other elements have a negligible impact on them. Autonomous factors are crucial in understanding the primary drivers within the system.

II. Linkage Factors: Linkage factors high driving power along with high dependence. They play a pivotal role in the system and are influenced by other factors. Changes in linkage factors can have a substantial impact on the overall behavior of the system, making them important focal points for analysis and decision-making.

III. Dependent Factors: Dependent factors demonstrate low driving power but high dependence. They are influenced by other factors but have minimal influence on the system themselves. Understanding dependent factors helps identify elements that are more reactive to changes in other factors.

IV. Independent Factors: Independent factors exhibit low driving power and has low dependence. They have minimal influence on the system and are not significantly influenced by other factors. While their impact may be negligible, considering independent factors can provide a holistic perspective on the system.

3.9.5 Interpretation and Analysis

The results of the MICMAC analysis are then interpreted and analysed as the final phase. Insights into the dynamics of the system can be gained through the classification of variables into four clusters, namely autonomous, linkage, dependent, and independent categories. Decision-makers can prioritize their efforts and allocate resources effectively by focusing on factors with high driving power. Additionally, managing the dependencies among factors becomes crucial for mitigating risks and maximizing system performance. MICMAC analysis offers a structured and systematic approach to understand the relationships and influences among factors in complex systems. It facilitates the identification of critical drivers and dependencies, aiding in strategic decision-making, resource allocation, and policy formulation. By employing MICMAC analysis, researchers and practitioners gain a comprehensive understanding of the underlying dynamics and interactions within a system, enabling informed decision-making for various domains.

3.10 ADVANTAGES OF MICMAC

MICMAC analysis provides numerous advantages when applied in research and decision-making processes:

I. Identification of influential factors: MICMAC analysis enables the identification of the most significant factors within a system or set of variables. This helps researchers and all decision-makers working in their fields to focus their attention on the factors that have the greatest impact on the desired outcomes.

II. Understanding interdependencies: Through MICMAC analysis, researchers gain insights into the complex web of relationships and interdependencies among factors. This comprehensive understanding enhances their grasp of the system being studied.

III. Categorization of factors: The categories for factors in MICMAC analysis include autonomous, dependent, linkage, and independent. By identifying those factors that operate as drivers or enablers and those that are more dependent on other factors, this categorization helps to provide a clear understanding of the driving strength and dependence of each element.

IV. Prioritization of actions and resources: By identifying influential factors and comprehending their interdependencies, MICMAC analysis helps decision-makers prioritize actions and allocate resources effectively. This ensures that efforts are concentrated on factors with the greatest impact and those crucial for achieving desired outcomes.

V. Enhanced decision-making: MICMAC analysis provides a structured and systematic approach to understanding complex systems, leading to informed decision-making. By analyzing the relationships and dependencies among factors, decision-makers can make sound choices based on a thorough understanding of the system at hand.

VI. Policy Formulation and Strategic planning: MICMAC analysis is a valuable tool for strategic planning and policy formulation. It aids in the identification of key drivers and dependencies, which in turn informs the development of strategies and policies that address critical factors and maximize desired outcomes.

VII. Communication and collaboration: MICMAC analysis facilitates effective communication and collaboration among stakeholders. Its visual representation of relationships and dependencies among factors simplifies the communication of complex information and encourages collaboration among different parties involved.

In summary, MICMAC analysis offers significant advantages in identifying influential factors, understanding interdependencies, categorizing factors, prioritizing actions and resources, enhancing decision-making, supporting strategic planning, and facilitating communication and collaboration. These advantages make it a valuable tool in research, analysis, and decision-making processes.

3.11 CONCLUSION

ISM can only be used as a tool to impose order and directives on the intricate interactions between the variables. The ISM technique has been determined to be suitable for modelling the critical factors (nine in all). The textile industry's effective adoption of digital technology has been attributed to a bottom-level independent crucial component known as "Adaptive Agility". Following digraph creation and with the assistance of professional opinions, the TISM model is created. The final model can be found in results section.

Further, MICMAC analysis is applied to gain a deeper and to get clear understanding of the relationships and influences among factors within a system. It provides valuable insights into the driving power and dependence among factors, allowing us to identify critical drivers, dependencies, and key factors that impact the system's behaviour.

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CHAPTER 4

RESULTS AND DISCUSIONS

The study includes of determining the critical factors that are influencing digital technologies implementation. The ISM model or Digraph, Total ISM model and MICMAC analysis done give results are illustrated below.

4.1 RESULTS

All results here are discussed and are shown with a set of figures and tables. The section comprises of ISM process, TISM model and MICMAC analysis. All are defined in a structure way in the research methodology section.

4.1.1 Digraph or ISM Model

The key success factors (CSFs) for implementing DSCM in the textile industry were identified through a systematic process in this study. The first step in this study was to conduct a thorough literature review to identify pertinent components, and then to use the ISM technique to analyse how those factors interacted with one another.. In second step, a team of experts were chosen who are familiar with the DSCM technologies and textile industry. The questionnaire for study was designed and distributed to collect their responses regarding the CSFs for successfully implementing digital DSCM in the textile industry. The questionnaire was distributed using an online platform to ensure convenient and efficient data collection. The responses provided valuable insights into the factors and their relationships, which were further analyzed using the Modeling technique. The questionnaire used in research aimed to gather valuable insights and expert opinions regarding the factors under investigation. Participants were provided with a list of factors and were asked to evaluate and analyze the relations between each pair of factors using the VAXO methodology. They were instructed to assign V (direct influence), A (influence received), X (mutual influence), or O (no relationship) based on the relationships between each set of factors. The questionnaire was designed to be comprehensive yet concise, allowing participants to provide their assessments efficiently. The responses collected through the questionnaire served as valuable input for analyzing the interdependencies and hierarchy among the factors using the ISM technique.

In third step, the responses were drawn into the SSIM matrix, which is shown in **Table 9**. This matrix depicts and shows the strength and direction of relationships, indicating whether factors directly influence, receive influence, have mutual influence, or have no relationship with each other. In the next step, this matrix was converted into RM by putting 1 and 0 in place of V, A, O, and X as described in the methodology section. Then, IRM was drawn refer **Table 10**, and transitivity was checked. After the iterations, the FRM was computed. **Table 11** shows the final reachability matrix. This table gives both driving and dependence power for each identified factor. The results shows that Adaptive Agility has more driving power and have a significant impact on the system and can drive changes in other factors.

Table 9 Self-Structural Interaction Matrix

Variables	1	2	3	4	5	6	7	8	9
Adaptive Agility		V	V	V	V	V	V	V	V
Synergistic Cooperation			A	A	A	V	A	V	A
Circular Economy Practices				V	X	V	X	V	X
Cost Efficiency					O	V	O	V	X
Risk Intelligence						V	X	V	O
Product Provenance							A	V	A
Proficiency								V	X
Customer Intimacy									A
IT Governance									

The factor 8, Customer Intimacy has more dependence power, and it shows that it is strongly influenced by other factors and rely on them for their own functioning or success. In fifth step, level partitioning was done, the final reachability matrix (FRM) was used to calculate antecedent set and reachability set.

Table 10 Initial Reachability Matrix (IRM)

Variables	1	2	3	4	5	6	7	8	9	Driving Power
Adaptive Agility	1	1	1	1	1	1	1	1	1	9
Synergistic Cooperation	0	1	0	0	0	1	0	1	0	3
Circular Economy Practices	0	1	1	1	1	1	1	1	1	8
Cost Efficiency	0	1	0	1	0	1	0	1	1	5
Risk Intelligence	0	1	1	0	1	1	1	1	0	6
Product Provenance	0	0	0	0	0	1	0	1	0	2
Proficiency	0	1	1	0	1	1	1	1	1	7
Customer Intimacy	0	0	0	0	0	0	0	1	0	1
IT Governance	0	1	1	1	0	1	1	1	1	7
Dependence Power	1	7	5	4	4	8	5	9	5	

Table 11 Final Reachability Matrix (FRM)

Variables	1	2	3	4	5	6	7	8	9	Driving Power
Adaptive Agility	1	1	1	1	1	1	1	1	1	9
Synergistic Cooperation	0	1	0	0	0	1	0	1	0	3
Circular Economy Practices	0	1	1	1	1	1	1	1	1	8
Cost Efficiency	0	1	1*	1	1*	1	1*	1	1	8
Risk Intelligence	0	1	1	1*	1	1	1	1	1*	8
Product Provenance	0	0	0	0	0	1	0	1	0	2
Proficiency	0	1	1	1*	1	1	1	1	1	8
Customer Intimacy	0	0	0	0	0	0	0	1	0	1
IT Governance	0	1	1	1	1*	1	1	1	1	8
Dependence Power	1	7	6	6	6	8	6	9	6	

Table 12 First Level Partitioning Iteration

Elements(Mi)	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1	1, 2, 3, 4, 5, 6, 7, 8, 9,	1,	1,	
2	2, 6, 8,	1, 2, 3, 4, 5, 7, 9,	2,	
3	2, 3, 4, 5, 6, 7, 8, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
4	2, 3, 4, 5, 6, 7, 8, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
5	2, 3, 4, 5, 6, 7, 8, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
6	6, 8,	1, 2, 3, 4, 5, 6, 7, 9,	6,	
7	2, 3, 4, 5, 6, 7, 8, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
8	8,	1, 2, 3, 4, 5, 6, 7, 8, 9,	8,	1
9	2, 3, 4, 5, 6, 7, 8, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	

Table 13 Level Partitioning Second Iteration

Elements(Mi)	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1	1, 2, 3, 4, 5, 6, 7, 9,	1,	1,	
2	2, 6,	1, 2, 3, 4, 5, 7, 9,	2,	
3	2, 3, 4, 5, 6, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
4	2, 3, 4, 5, 6, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
5	2, 3, 4, 5, 6, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
6	6,	1, 2, 3, 4, 5, 6, 7, 9,	6,	2
7	2, 3, 4, 5, 6, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
8		1, 2, 3, 4, 5, 6, 7, 9,		1
9	2, 3, 4, 5, 6, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	

Table 14 Level Partitioning Third Iteration

Elements(Mi)	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1	1, 2, 3, 4, 5, 7, 9,	1,	1,	
2	2,	1, 2, 3, 4, 5, 7, 9,	2,	3
3	2, 3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
4	2, 3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
5	2, 3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
6		1, 2, 3, 4, 5, 7, 9,		2
7	2, 3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	
8		1, 2, 3, 4, 5, 7, 9,		1
9	2, 3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	

Table 15 Level Partitioning Fourth Iteration

Elements(Mi)	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1	1, 3, 4, 5, 7, 9,	1,	1,	
2		1, 3, 4, 5, 7, 9,		3
3	3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	4
4	3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	4
5	3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	4
6		1, 3, 4, 5, 7, 9,		2
7	3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	4
8		1, 3, 4, 5, 7, 9,		1
9	3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	4

Table 16 Level Partitioning Fifth Iteration

Elements(Mi)	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1	1,	1,	1,	5
2		1,		3
3		1,		4
4		1,		4
5		1,		4
6		1,		2
7		1,		4
8		1,		1
9		1,		4

The level is decided by intersection set, which is of reachability and antecedent set. After the five iterations, the final level partitioning was formulated which is shown in **Table 17**. This tells that the factor 8, Customer Intimacy is at level 1 and Adaptive Agility is at level 5. The four factors are at level 2, Synergistic Cooperation is at level 3, and Product Provenance is at level 4. The final step is to create digraph and model formation. The model formulated is shown in **Figure 7**. This diagraph model typically shows a graphical representation of the factors, along with arrows which indicate the direction of influence. Depending on their degree of dependency and driving force, the factors are arranged into levels. This final model helps in understanding the relative importance of factors, identifying the critical factors that have the most significant and crucial impact on the system performance, and assessing the flow of influence among the factors. The arrow direction direct towards the influenced factor. In final model, this can be seen that the factor 1, Adaptive Agility has more outgoing arrows, so it means it has more driving power and factor 8 which is Customer Intimacy has less driving power and more dependence power as it has more incoming arrows than outgoing arrows. So, the CSF for implementation of digital technologies in textile industry is Adaptive Agility. The final model depicts that the Adaptive Agility is at level 5, then it influences factors 3,5,7,9. The factors at level 4 has influence on factor 2 which is on level 2. Then it directs towards the factor 6. The final factor which is at level 1 is influenced by all factors.

Table 17 Final Level Partitioning

Elements(Mi)	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi)∩A(Ni)	Level
1	1,	1,	1,	5
2	2,	1, 2, 3, 4, 5, 7, 9,	2,	3
3	3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	4
4	3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	4
5	3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	4
6	6,	1, 2, 3, 4, 5, 6, 7, 9,	6,	2
7	3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	4
8	8,	1, 2, 3, 4, 5, 6, 7, 8, 9,	8,	1
9	3, 4, 5, 7, 9,	1, 3, 4, 5, 7, 9,	3, 4, 5, 7, 9,	4

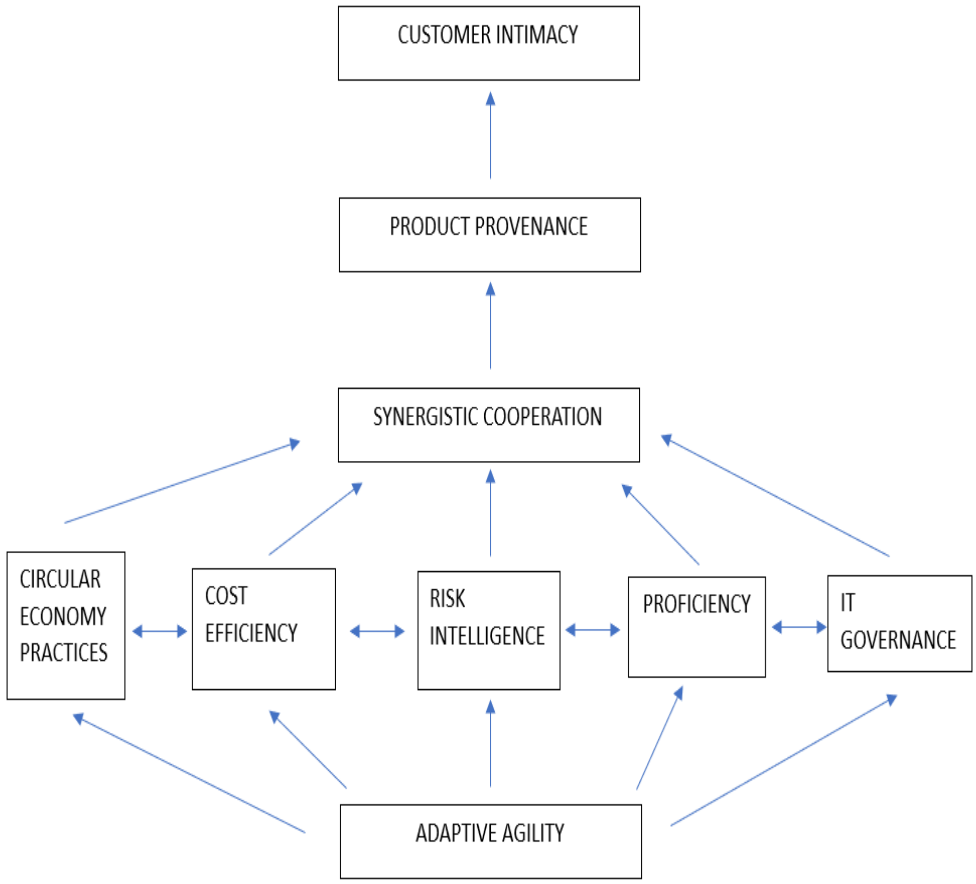

Figure 7 Digraph of factors influencing digital transformation

4.1.2 TISM Model

As we already figured out that the TISM model is more advantageous to the Ism model. The advanced and this modified model shows all links with a clear vision. The digraph shown in **Figure 7** is used to create the binary interpretive matrix. Interpretive matrix shows the relationship between the factors with transitivity in consideration. The binary interpretive can be shown with transitivity (1*) in the **Table 8**. Then through that matrix and expert opinions explaining the relationships between the factors can be shown in TISM Model. The TISM is shown in **Figure 8** . The links are explained in next section.

Table 18 Binary Interpretive Matrix

	1	2	3	4	5	6	7	8	9
1		1*	1	1	1		1		1
2						1			
3		1		1*				1*	
4		1	1*	1*	1*			1*	
5		1		1*					
6								1	
7		1			1				
8									
9		1				1*			

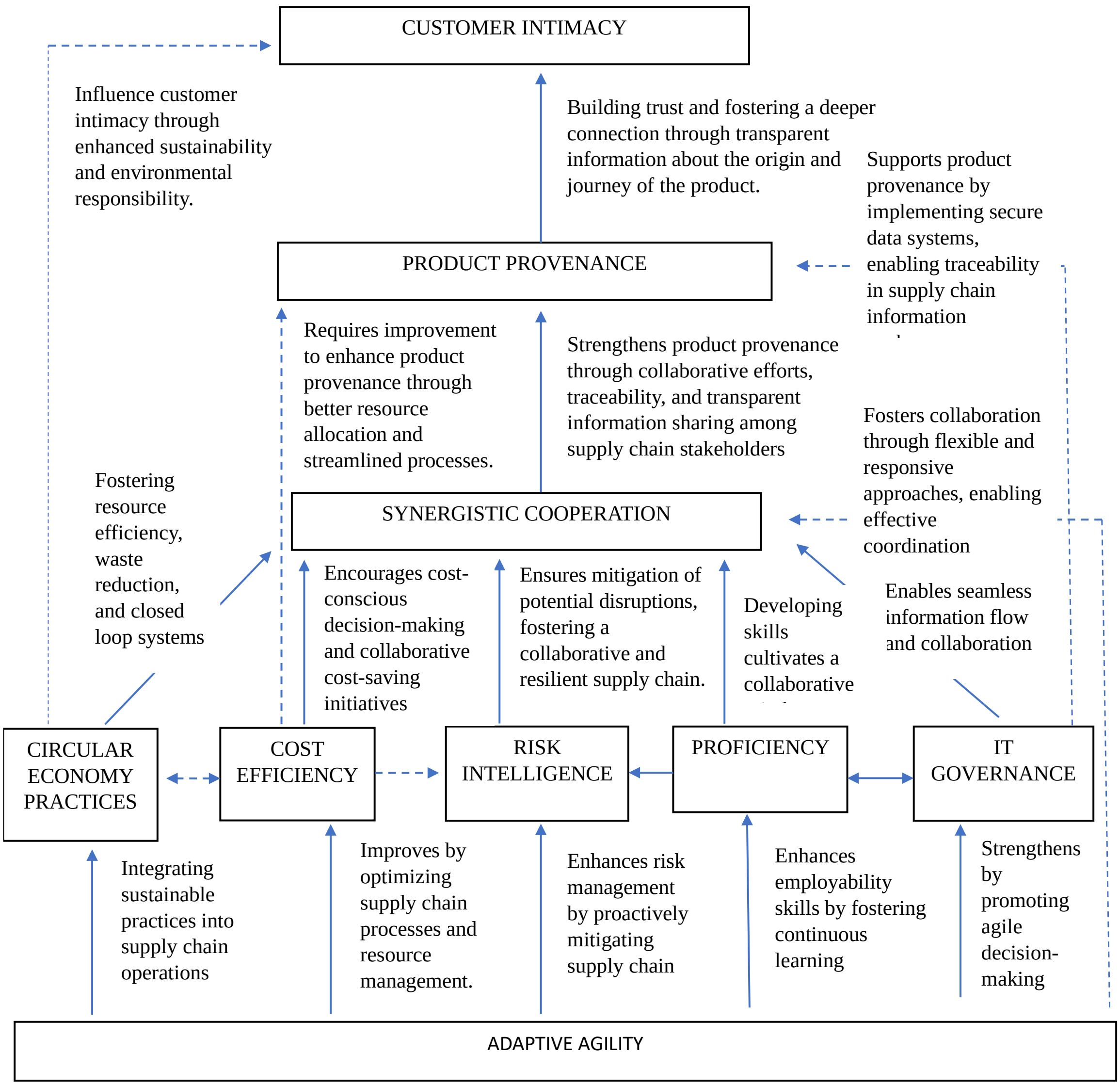

Figure 8 The TISM Model of all factors

4.1.3 MICMAC Analysis

This study shows MICMAC Analysis to examine the influence of factors in terms of their dependency and driving power. The driving power was represented on the X-axis, while the dependency power was represented on the Y-axis. MICMAC Analysis provide the factors in 4 quadrant and from that graph this can easily determine the driving power and dependence power. For this study, factors are plotted in graph as shown in **Figure 9** . The quadrants are explained as-

Autonomous quadrant: The quadrant where factors have low driving power and low dependency power is known as the autonomous factor’s quadrant. These factors are independent and do not have a significant influence on other factors, nor are they influenced by others. **Figure 9** illustrates that there are no factors in this quadrant.

Dependent quadrant: The factors which fall under this quadrant have been seen has they have low driving power, but they have high dependency. For this study the factors 2, 6, and 8 lie in this quadrant.

Linkage quadrant: Those factors which have both driving power and dependency power high lie in this quadrant. In this study the factors 3, 4, 5, 7, and 9 lie in this quadrant. They are very important because when one factor change it influence the others.

Independent quadrant: This quadrant is occupied by those factors which have highest driving power, but they have weak dependency. In this study of findings, the factor 1 lies in this quadrant. The drivers in the other quadrants are connected by this driver. The factor 1 lie on the boundary of this quadrant.

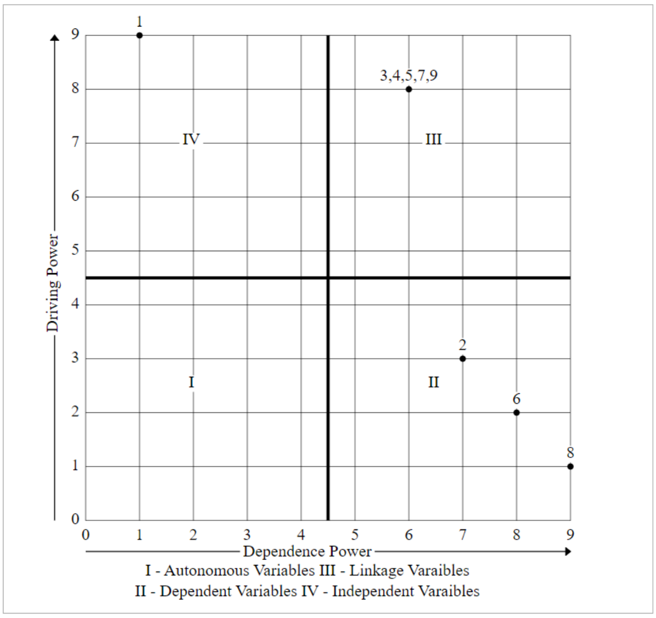

Figure 9 MICMAC Analysis of factors.

4.2 DISCUSSIONS

This consists of two subsections. In first subsection, all model strong links are discussed one be one. The second subsection discusses the MICMAC Analysis in context of textile industry.

4.2.1 Links between factors

There are two types of links between the factors. The solid lines show the direct link between the factors and the dashed lines shows the transitive links. The transitivity as already being explained in the methodology section. The model shows the brief description of the relationship between factors along the lines and arrows. However, it is necessary to analyse and have detailed knowledge of each links. It can help industry to grow and choose accordingly. Some links are weak links, so they are hidden links. They need not to considered in this study. The links are explained below-

Between Adaptive Agility and Circular Economy practices, Risk Intelligence, Proficiency, IT Governance, Cost Efficiency.

1. Adaptive Agility and Circular Economic Practices: Adaptive agility plays a crucial role in driving circular economic practices within the textile industry. The ability to quickly adapt and respond to changing market demands, customer preferences, and regulatory requirements allows companies to design and implement sustainable practices. By embracing agile approaches, textile businesses can efficiently implement recycling programs, product take-back initiatives, and resource optimization strategies. Adaptive agility enables companies to swiftly adjust their operations, redesign products, and develop innovative circular business models, contributing to the overall sustainability goals of the industry.
2. Adaptive Agility and Risk Management: Effective risk management is essential in the textile industry, given the uncertainties and complexities associated with global supply chains. Adaptive agility aids in risk management by enabling proactive identification, assessment, and mitigation of risks. Through agile practices, such as real-time monitoring, rapid response mechanisms, and collaborative decision-making, textile companies can effectively address supply disruptions, market fluctuations, and regulatory changes. The ability to swiftly adapt production processes, sourcing strategies, and distribution networks helps mitigate risks and ensure business continuity.

3. Adaptive Agility and Cost Efficiency: Cost efficiency is a critical factor in the textile industry's competitiveness and profitability. Adaptive agility supports cost efficiency by allowing companies to optimize their processes, resources, and operations. Agile practices enable rapid adjustments in production volumes, raw material sourcing, and inventory management, helping companies align their costs with market demands. Additionally, adaptive agility facilitates lean manufacturing principles, continuous process improvements, and supply chain optimization, resulting in reduced costs and improved operational efficiency.
4. Adaptive Agility and IT Governance: IT governance encompasses the management and oversight of information technology systems and processes within an organization. Adaptive agility plays a significant role in effective IT governance within the textile industry. By embracing agile IT practices, such as iterative development, flexible infrastructure, and quick adoption of emerging technologies, companies can respond to changing business needs and leverage technology to drive innovation. Adaptive agility enables seamless integration of digital tools, enhances data security, and facilitates efficient data exchange, thereby strengthening IT governance practices and supporting digital supply chain management.
5. Adaptive Agility and Proficiency: Adaptive agility has implications for the skill set and capabilities of employees in the textile industry. With the rapid evolution of technology and market dynamics, employees need to possess adaptive skills, including problem-solving, critical thinking, and agility in learning new tools and techniques. Adaptive agility fosters a culture of continuous learning, empowerment, and cross-functional collaboration, enabling employees to adapt to changing roles and responsibilities. By nurturing a workforce with adaptive skills, textile companies can enhance their ability to embrace digital transformation, adopt new practices, and effectively navigate the evolving industry landscape.

Between the Circular economy practices and Synergistic Cooperation, Customer Intimacy

1. Circular Economy Practices and Synergistic Cooperation: Circular economy practices exert a significant influence on synergistic cooperation within the textile industry. Companies that adopt circularity principles, such as recycling, waste

reduction, and closed-loop systems, foster a collaborative environment and facilitate information sharing among stakeholders. Through the collective efforts of suppliers, manufacturers, and waste management companies, synergistic cooperation is cultivated to effectively implement circular economy practices. This collaboration strengthens the overall adoption and implementation of sustainable practices within the textile supply chain.

2. Circular Economy Practices and Customer Intimacy: Circular economy practices play a vital role in cultivating customer intimacy within the textile industry. By embracing sustainable practices, including the use of eco-friendly materials, waste reduction measures, and promoting transparency in product information, textile companies meet the increasing customer demand for ethically and environmentally responsible products. Circular economy practices provide customers with the assurance they seek regarding the origin, environmental impact, and responsible production of the textiles they purchase. This transparency and alignment with customer values contribute to building trust, loyalty, and emotional connections with the brand, fostering customer intimacy.

Between the Cost Efficiency and Synergistic Cooperation, Product Provenance

1. Cost efficiency and Synergistic Cooperation: The link between cost efficiency and synergistic cooperation lies in how cost efficiency influences and drives synergistic cooperation within the textile industry. When companies prioritize cost efficiency, they create an environment that fosters collaboration and encourages synergistic cooperation among supply chain partners. By optimizing their processes and resource allocation, companies can offer competitive pricing, reliable delivery, and improved service levels, attracting the interest and participation of other stakeholders. Cost-efficient practices also encourage supply chain partners to collaborate closely, share resources, and align their efforts to minimize costs collectively. For example, efficient inventory management practices, such as just-in-time (JIT) inventory systems, enable companies to reduce holding costs and minimize inventory-related waste. This, in turn, encourages suppliers to synchronize their production and delivery schedules, leading to reduced lead times and lower overall costs. Furthermore, cost efficiency creates an environment of mutual benefit, as it allows companies to offer

competitive pricing and profitability to their partners. This, in turn, fosters trust, commitment, and long-term collaboration among supply chain participants.

2. Cost efficiency and Product Provenance: The link between product provenance and cost efficiency lies in the potential for cost savings and operational improvements and is a transitive links. Implementing robust product provenance practices enables companies to gain visibility into their supply chains, identify inefficiencies, and streamline processes. By optimizing supply chain operations, companies can reduce waste, enhance resource allocation, and achieve cost savings. Furthermore, effective product provenance practices contribute to risk mitigation and compliance. By ensuring the authenticity and traceability of products, companies can minimize the risk of counterfeits, improve quality control, and meet regulatory requirements. This, in turn, leads to reduced costs associated with product recalls, rework, and non-compliance penalties.

Between Synergistic Cooperation and Risk Intelligence, IT Governance, Proficiency

1. Synergistic Cooperation and Risk Intelligence: The link between synergistic cooperation and risk intelligence lies in how risk intelligence contributes to the success of collaborative efforts. By having a robust risk intelligence framework in place, supply chain partners can identify and address potential risks, allowing them to make informed decisions, develop contingency plans, and mitigate disruptions that may impact collaboration. Effective risk intelligence enhances synergistic cooperation by providing transparency, trust, and resilience. It allows supply chain partners to assess and share risk information, anticipate potential challenges, and collectively develop strategies to overcome them. With risk intelligence, partners can work together to identify shared risks, implement risk mitigation measures, and ensure the continuity of operations even in the face of uncertainties.
2. Synergistic Cooperation and IT Governance: The link between synergistic cooperation and IT governance lies in how IT governance provides the necessary structure, tools, and systems to facilitate and enhance collaboration. Effective IT governance frameworks, such as standardized communication platforms, shared databases, and collaborative software, enable seamless information exchange and facilitate real-time collaboration among supply chain partners. By implementing robust IT governance practices, companies

can establish clear roles, responsibilities, and processes for information sharing, decision-making, and problem-solving. This promotes efficient communication, reduces information asymmetry, and fosters trust among supply chain partners. IT governance also ensures data security, privacy, and integrity, instilling confidence in sharing sensitive information and fostering a culture of collaboration.

3. Synergistic Cooperation and Proficiency: Synergistic cooperation requires individuals with strong interpersonal skills, effective communication abilities, and a collaborative mindset. It relies on employees' ability to work together, share knowledge, and build strong relationships across different functions and organizations. Employee skills play a vital role in achieving synergistic cooperation by fostering effective teamwork, promoting open and transparent communication, and facilitating the exchange of ideas and best practices. Strong interpersonal skills enable employees to navigate diverse perspectives, resolve conflicts, and build trust among supply chain partners. Furthermore, employees with cross-functional expertise and a deep understanding of the industry contribute to the effectiveness of synergistic cooperation. Their skills and knowledge allow them to contribute valuable insights, identify areas for improvement, and actively participate in joint decision-making processes. By leveraging their skills, employees can facilitate collaboration, drive innovation, and enhance overall supply chain performance.

Between Product Provenance and Synergistic Cooperation, IT governance, Customer Intimacy

1. Product Provenance and Synergistic Cooperation: Product provenance and synergistic cooperation have a direct link in the textile industry TISM model of factors. Product provenance involves providing transparent and reliable information about a product's origin, manufacturing processes, and components. Synergistic cooperation refers to collaboration and coordination among supply chain stakeholders to maximize operational efficiency and shared benefits. Synergistic cooperation facilitates the establishment and maintenance of robust product provenance practices. Through collaboration, supply chain partners work together to trace and authenticate product information, ensuring transparency and trustworthiness. They share knowledge, align efforts, and establish standards for

tracing and verifying product authenticity and sustainability. In turn, synergistic cooperation contributes to achieving product provenance. By collaborating, supply chain stakeholders can address challenges related to sourcing sustainable materials, implementing responsible manufacturing, and promoting ethical practices.

2. Product Provenance and IT Governance: Product provenance and IT governance are interconnected and has transient link in the model formulated. Product provenance involves providing transparent information about a product's origin, while IT governance focuses on establishing frameworks for effective information technology management. IT governance plays a crucial role in achieving product provenance by ensuring the secure and reliable management of information related to product origin, manufacturing processes, and supply chain transparency. Through IT governance practices, companies can establish robust data management systems, secure information exchange, and implement traceability mechanisms. Furthermore, IT governance ensures data integrity, privacy, and security, preventing unauthorized access or tampering with product-related information. It establishes protocols for information sharing, collaboration, and verification, allowing supply chain partners to work together to validate product provenance claims.
3. Product Provenance and Customer Intimacy: Product provenance and customer intimacy are directly linked in the model developed under section TISM model. Transparent and reliable information about a product's origin, manufacturing processes, and ethical practices builds trust and loyalty among customers, fostering a closer and more personalized relationship with the brand. Product provenance contributes to achieving customer intimacy by enhancing transparency, instilling confidence, and meeting customer expectations for ethical and sustainable products.

4.2.2 ISM and MICMAC Analysis

This study applied the ISM technique and conducted a MICMAC analysis to identify critical success factors (CSFs) in the context of research. The analysis revealed interesting findings regarding the dependence power, driving power and interrelationships among the identified factors. Adaptive Agility emerged as a critical factor that significantly influences other factors within the system. This highlights its crucial role in the overall performance and success of the digital supply chain management in the textile industry. Another noteworthy finding was the factor of Customer Intimacy, which was positioned in the dependent quadrant. This indicates that Customer Intimacy has a high dependence power, implying that it is significantly influenced by other factors in the system. Customer Intimacy plays a crucial role in establishing and nurturing strong relationships with customers, which in turn impacts the effectiveness of the digital supply chain management in meeting customer needs and enhancing customer satisfaction. The other factors lying in same quadrant are Product Provenance and Synergistic Cooperation. On the other hand, the factors such as Circular Economy Practices, Cost Efficiency, Risk Intelligence, Proficiency, and IT Governance were positioned in the linkage quadrant. These factors exhibit both dependence and driving power, signifying their role as influential factors that are influenced by others as well. The presence of these factors in the Linkage quadrant highlights their interconnectedness and their contributions to the overall effectiveness of digital supply chain management in the textile industry. It is important to note that factors placed in the autonomous quadrant were not identified in this analysis, suggesting that there are no factors within the system that exhibit low dependence power and high driving power. Overall, this research provides valuable insights into the critical success factors of digital supply chain management in the textile industry. The identification of Adaptive Agility as a key CSF and the positioning and plotting of factors in the MICMAC analysis graph provide a clear understanding of the driving and dependence powers of these factors. This knowledge can guide practitioners and decision-makers in prioritizing their efforts and resources to optimize the implementation of digital supply chain management strategies, ultimately leading to improved performance and competitiveness in the textile industry.

CHAPTER 5

CONCLUSION

This chapter concludes the overview of the project with the results obtained by applying ISM and MICMAC on the factors of digital transformation in textile industry. The scope of the future research has also been analyzed in this chapter.

5.1 CONCLUSION

In summary, this research aimed to uncover the key factors that contribute to the effectiveness of digital supply chain management (DSCM) in the textile industry. Using the ISM technique and MICMAC analysis, we firstly developed TISM and then we obtained valuable insights into the critical success factors (CSFs) of DSCM. This analysis highlighted Adaptive Agility as a prominent CSF, emphasizing the significance of organizational adaptability and agility in managing supply chains in the digital era. Additionally, Customer Intimacy emerged as a factor with a strong influence on other factors, indicating its importance in DSCM. We also identified several factors, including Circular Economy Practices, Cost Efficiency, Risk Intelligence, Proficiency, and IT Governance, in the linkage quadrant, underscoring their interdependence and contributions to DSCM. These findings have practical implications for textile industry practitioners and decision-makers, enabling them to allocate resources strategically and prioritize efforts to enhance DSCM practices. By focusing on the identified CSFs, organizations can improve performance, enhance customer satisfaction, achieve cost efficiency, and enhance overall competitiveness. It is important to note that this study provides a foundation for future research in the field of DSCM, which can explore specific factors, analyze their intricate relationships, and assess their impact on various performance indicators. Furthermore, TISM is drawn and shows all possible links between the factors. It can be used to determine strong links and weak links. This study can also help decision makers in industry to decide accordingly taking all relations in consideration.

In conclusion, this research contributes to the understanding of DSCM in the textile industry by identifying key CSFs and their interrelationships. By embracing these findings and implementing effective strategies, organizations can position themselves for success in the digitalized business landscape of the textile industry.

5.2 LIMITATIONS

This study has provided valuable insights into the adoption of new emerging digital technologies in supply chain management (SCM) in the textile industry. However, it is important to acknowledge certain limitations that may have influenced the scope and generalizability of the findings. These limitations include:

- Sample Size: The study's findings and results are based on a specific sample size of experts and practitioners, which may limit the representation of diverse perspectives and experiences in the textile industry.
- Scope of Generalization: Due to the study's concentration on a particular geographical setting or a small number of enterprises in the textile industry, its conclusions might not be very generalizable.
- Subjectivity of Expert Responses: The responses collected from experts may be subject to individual perceptions and biases, which could introduce some level of subjectivity in the analysis.
- External Factors: The study mainly concentrated on internal issues linked to DSCM implementation, perhaps ignoring the impact of external factors like economic conditions and regulatory changes.
- Long-term Assessment: The study primarily examined the initial stages of DSCM implementation and did not extensively assess the long-term sustainability and impact of DSCM initiatives.
- Data Collection Methods: The reliance on online questionnaires and self-reported data may introduce response biases and limit the reliability of the findings.
- Lack of Comparative Analysis: The study did not include a comparative analysis with other industries or supply chain management approaches, which could have otherwise provided additional insights.

It is important to consider these limitations when interpreting the findings of the study and to encourage future research to address these gaps for a more comprehensive understanding of DSCM in the textile industry.

5.3 FUTURE SCOPE

There are various potential directions for further research and findings in the area of DSCM in the textile sector, building on the findings of this study. By providing insights into how to improve supply chain performance, efficiency, and sustainability, these guidelines can help to increase our understanding of the difficulties, advantages, and possibilities involved with putting DSCM practises into practise. The following areas merit exploration for future studies:

- Empirical Validation: Validate the discovered critical success factors (CSFs) and their interactions in the context of the textile industry through empirical study. This would offer verifiable proof of the elements' influence and their applicability to actual situations.
- Comparative Analysis: Compare and contrast various industries to find CSFs and tactics that are industry specific. By doing so, it would be possible to compare the textile industry's particular requirements and challenges to those of other industries, which would aid in understanding.
- Technological Innovations: Investigate the influence of emerging technologies, such as artificial intelligence, blockchain, and the Internet of Things, on DSCM in the textile industry. This exploration can shed light on the valuable and potential benefits and practical implications of adopting these innovations.
- Sustainability and Social Responsibility: Examine how DSCM may help the textile supply chain achieve its objectives for sustainability and social responsibility. Examine how using technology can ensure social compliance, ethical sourcing, and a less environmental effect.
- Performance Measurement: Develop tailored performance measurement frameworks to assess the effectiveness and efficiency of DSCM initiatives in the textile industry. This would provide guidelines for evaluating the outcomes and identifying areas for improvement.
- Change Management and Organizational Culture: Investigate the issues and solutions related to implementing change management and promoting a digitally friendly culture in the textile industry. Effective organisational transformation can

be aided by an understanding of the variables that affect the implementation and adoption of DSCM practises.

- Collaboration and Partnerships: For effective DSCM cooperation in the textile business, investigate collaboration platforms, information exchange procedures, and partnerships. Examine the elements that lead to productive collaboration amongst supply chain partners and the role that digital technologies play in enabling these collaborations.

These future research directions aim to enhance our knowledge and contribute to the development of practical frameworks, strategies, and guidelines for implementing and leveraging DSCM in the textile industry. By addressing these areas, researchers can make significant contributions to the field and enable textile companies to navigate the digital transformation journey with confidence and success.

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