

MASTER THESIS

*Investigating the Role of New Technologies in Optimising Global Corporation's
Logistics and Supply Chain Management*

Declaration of Originality

I hereby declare that this project is entirely my own work and that any additional sources of information have been duly cited.

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Acknowledgment

Abstract

In recent years, supply chain management (SCM) has emerged as a crucial management tool for companies of all sizes. Supply chains are increasingly using cutting-edge technologies like artificial intelligence (AI), machine learning (ML), blockchain, and digital twins to streamline and clarify their operations. Over the last decade, breakthrough technologies like Machine Learning (ML), Neural Networks, and Artificial Intelligence have completely reshaped the logistics industry. It's a paradigm change brought on by the need for faster shipping, lower prices, and greener business practices.

This dissertation provides a framework of supply chain IT competence as facilitating/inhibiting the supply chain's knowledge management capabilities by drawing on the resource-based perspective of the company and the relational view of the firm's competitive advantage. As supply chain aims move further than operational efficiency but towards continuing to pursue higher-order goals, such as analysing the market dynamics and finding new collaborative arrangements that can provide greater value to customers both researchers and practitioners need to have a solid knowledge of the capabilities needed for supply chains to keep their competitive advantages. In order to fill this information gap, this study examines the relationship between the supply chain's performance and its ability to manage collective knowledge. Using the resource-based company viewpoint and the relational view of the firm's competitive advantage, this dissertation gives a paradigm for how supply chain IT competence facilitates or inhibits the supply chain's knowledge management skills. An empirical research based on a survey and data collection was done first. In order to better understand how IT-enabled knowledge management activities effect long-term knowledge outcomes for organisations, a simulation model was created.

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List of Abbreviations

IS – Information System

IT – Information Technology

ML – Machine Learning

MPS – Master Production Plan

MRP – Manufacturing Resource Planning

OIP – Organisational Information Processing

PE – Political Economy

POS – Point of Sale

INDUSTRY 4.0 – Resource-Based View

RFID – Radio Frequency Identification

SCM – Supply Chain Management

SCN – Supply Chain Network

TCE – Transaction Cost Economics

VBA – Visual Basic for Applications

VMI – Vendor-Controlled Inventory

WLANS – Wireless Local Area Networks

WWW – World Wide Web

XML – Extensible Markup Language

Chapter 1: Introduction

1.1 Research Background

IT and communication technologies are playing an essential part in the optimization decisions being made for supply chain management (SCM) to achieve organisational competitiveness, improve service quality, decrease inventory, lower the costs associated with the supply chain, and reduce the risks associated with electronic hazards. These goals can be accomplished in a few different ways, including reducing costs along the supply chain, increasing service levels, decreasing inventory, and doing away with electrical hazards (e-risks). The use of information technology (IT) as a way of efficiently integrating and disseminating information across different organisations is necessary for supply chain management (SCM). Electronic data exchange (EDI), Radio Frequency Identification (RFID), Bar Codes, e-commerce, and many other applications of technology and information technology, such as Enterprise Resource Planning (ERP) packages and Decision Support systems, are paving the way for the development of virtual supply chains. These technologies are making virtual supply chains a reality. Because it is so easy to use, it is an excellent tool for reducing the risks associated with using the internet. The primary objective of this project is to acquire the knowledge necessary to the role of supply chain IT infrastructure in facilitating/inhibiting the knowledge management capability of supply chains.

In the days before computerised transactions and communication, both the transactions and the communication that took place along the supply chain took a significant amount of time and were prone to error. As a result of the rise of globalisation and the adoption of new communication techniques, it has become increasingly common for businesses to incorporate information technology into the networks that make up their supply chains to increase their efficiency and improve their business performance. This is being done

to raise the company's overall level of business performance. When it comes to supply chain management (SCM), the phrase refers to all the operations that take place before, during, and after a product is created and delivered to a buyer or customer. These operations can be broken down into three categories: before, now and after (Silver et al., 1998). The management of the supply chain is an intricate and linked notion that encompasses all these different processes and procedures. Growing data complexity leads to an increased risk of supply chain uncertainty, which in turn increases the risk of electronic hazards (Ivanov et al., 2019). The network that makes up the supply chain needs to be integrated at both the upstream and the downstream levels for it to be possible for supply chain management to achieve its goals. Using supply chain management that is enabled by information technology, it is feasible to exercise control over the flow of information, business processes, items, and money into and out of the networks. Increased quality decreased transaction risks, and lower coordination costs all contribute to the company's increased profitability (Ghadge et al., 2012).

The data chain that underpins every supply chain is massive, complicated, and expanding. In many cases, the information gathered from these supply chain activities is not centralised, and even when it is, it is seldom processed or interpreted in a way that benefits the company (Yang et al., 2021). That's why we must have cutting-edge technological solutions to proactively manage supply chain data. Supply chains are increasingly using cutting-edge technologies like artificial intelligence (AI), machine learning (ML), blockchain, and digital twins to streamline operations with transparency. Increased inter-organisational information sharing, providing information availability and visibility, and allowing decisions based on whole supply chain information, EDI, and inadequate enterprise without IT systems is a matter of great importance to SCM (Choudhary and Jadoun, 2016). It is now abundantly

evident to businesses that to create supply chains that are both profitable and efficient, they want an enterprise-wide information system that is not just reliable and strong but also correctly integrated.

Paper-based communication to electronic communication has become a major threat to cybercrime via computer facilitation or computer as a target as a result of the exponential growth of information and communication technology (ICT) over the past decade. This transition away from paper-based communication methods and toward electronic ones has had a significant impact (Varma & Khan, 2013). According to the Association of Certified Fraud Examiners (ACFE) report to the Nations on Occupational Fraud and Abuse from 2020, the annual amount of fraudulent activity is estimated to be a staggering \$5.3 trillion (ACFE, 2021). Companies invest time and resources into the identification, study, and analysis of potential risks, as well as the development of preventative measures.

It is necessary for authorities that investigate and identify crime to sift through huge data sets, which criminals use as a shield to protect themselves from being investigated and punished. The purpose of this study is to not only determine the many IT tools that are currently accessible but also to explore how innovative technology including big data analytics and Artificial Intelligence, has helped to increase efficiency and performance in global supply chain management functions.

As the importance of supply chain operations to the success of a business continues to grow, supply chain management (SCM) has emerged as a crucial management discipline. Supply chain management (SCM) is the coordination of material, informational, and monetary movements throughout a company's supply chain, from raw materials to final consumers. There has been a change in the last decade from market-based "arms-length" ties between organisations to "strategic partnership" connections. It has been recognised in both

the academic and practitioner literature that in many sectors, competition is no longer between individual companies but rather between supply chains. The emergence of a knowledge-intensive economy is a major factor in the fundamental change in supply chain (SC) interactions. In a knowledge-based economy, intangibles like technical expertise, product design, marketing, consumer preferences, and a grasp of value-added networks are crucial to the success of most product and service offerings. Because of the increasing complexity of developing new products and the increased volatility and competition in today's markets, it's unlikely that any one company has all the information and expertise necessary to provide value to its customers.

Companies that train their employees to effectively manage cross-functional knowledge resources will reap greater financial rewards. By sharing and using the information on product plans, exceptions, and projections with its merchants, Motorola was able to successfully lower the stock-out rate of its inventory of mobile phone handsets. The importance of knowledge and knowledge management in establishing productive relationships within the supply chain and maximising supply chain performance has been highlighted by researchers examining the strategic implications of knowledge management. To thrive and remain competitive in the value chain, knowledge creation is essential. Supply chain efficiency, as measured by cycle time, is largely predicated on the knowledge creation process, which is a strategic supply chain that includes information acquisition activities, knowledge dissemination activities, and the production of shared meaning. There has been a lack of systematic understanding of what makes up a supply chain's knowledge management competence and how to create knowledge management capability despite the widespread recognition of the importance of knowledge in supply chains. Taking a relationship-oriented approach to supply chain operations, such as aligning objectives and activities included in the

supply chain, is necessary for supply chain businesses to develop supply chain knowledge management expertise that is difficult to mimic by other supply chain partnerships.

Combining and transferring information, however, may be challenging and politically taxing for supply chain organisations owing to the aggregation of talents and interests of various enterprises. It's not uncommon for businesses to have objectives that seem to directly contradict one another, which further adds to the complexity of knowledge management in supply chains. Knowledge-based networks might consist of companies with varying sizes, specialisations, and management styles.

Consequently, the supply chain does not always provide the expected outcomes to the companies with which it collaborates. For instance, a small supplier with an emphasis on operational excellence could care more about its expertise on the order interface than it would about its knowledge of the product or its customers. Partners in the supply chain must have strong organisational and technical foundations to facilitate the use of the supply chain's knowledge management capabilities. The usage of ICTs in supply chains has been found to have a significant effect on SC operating efficiency and network maintenance. Supply chain management (SCM) relies on information technology (IT) such as supply chain management systems (SCMS), the Internet/Web, electronic data interchange (EDI), radio frequency identification (RFID), and mobile technologies to facilitate the timely and accurate exchange of information between companies, the precise execution of plans, and the efficient performance of various SC functions and activities. Technologies like electronic data interchange (EDI) have been utilised for decades in supply chain management because of their ability to automate transactions between trade partners. However, there is a lack of theoretical and empirical studies on how supply chain IT helps or hinders a supply chain's capacity to manage knowledge.

In order to do this, this dissertation aims to comprehend how supply chain IT infrastructure helps connect supply chain enterprises and facilitates the development of the supply chain's knowledge management competence.

1.2 Research Objectives

The primary goal of this dissertation is to comprehend the influence of distribution network knowledge management capabilities enabled by supply chain IT on supply chain performance. The theoretical framework was derived from the resource-based perspective and its extension, the relational view, that addresses the competitiveness of enterprises in inter-organizational connections. The initial goal of the dissertation is to investigate the function of distribution network IT infrastructure in enabling supply chain knowledge management capabilities, and how this affects supply chain performance. To achieve this goal, an empirical research approach was employed to study the research topics suggested. The second purpose of the study is to investigate the use of information technology (IT) for training programs and its impact on the long-term knowledge results of firms in a supply chain. The third goal is to identify the various IT-employed SCM for Information flow and to explore the influence of IT on SCM (both positive and bad). The implementation of the industrial revolution 4.0 model (refers to the present trend of automation as well as data exchange in production technology, which includes advancements in intelligent machines, the Internet of Things, and robotics) for the advancement of the supply chain sector is also part of the study's goal. This study's overarching research issue is the impact of IT-enabled information business acumen on supply chains.

1.3 Research Problem:

There is minimal available data that includes various types of technology used in Supply Chain Management. So far, investigations on the relationship between business performance and infrastructure have primarily concentrated on one business framework. When the supply chain members are not all from the same organization, knowledge may be a substantial source of coordination and, as a result, is critical to supply chain functioning. As a result, this study seeks to synthesize data from many studies on the use of various types of technology in the supply chain, such as selecting reputable vendors, completing agreements, sending items, and lastly assuring strong communication between suppliers and recipients organisations.

1.4 Research Aims and Question:

The goal of this discretionary study is to determine what type of solutions these IT advances may provide to current supply chain networks and how this impacts supply chain performance.

The research focuses on five major research challenges and concerns:

- What IT advancements are utilized/can be employed in SCM for information flow?
- What are the difficulties in integrating IT technology in SCM?
- What are the benefits of incorporating IT advancements into current SCM?
- How have IT innovation technologies aided in more efficient day-to-day supply chain management operations?
- How has every digital technology influenced SCM in the years since its initial integration??

1.5 Contributions to Research:

It is anticipated that this dissertation research will contribute in several ways to both academic study and real-world application. First, this dissertation makes a theoretical contribution by creating a theoretical construct for SC capacity. So far, studies examining the link between business success have mostly concentrated on a single company's infrastructure. Knowledge may be a significant source of coordination and, therefore, is crucial to supply chain functioning in a supply chain when the supply chain partners are not all from the same company. Supply chain value creation may be better understood using a theoretical framework that accounts for the function of Industry 4.0 by examining how supply chain enterprises might use knowledge resources across organisational boundaries. The dissertation's second contribution to IS research is that it will deepen our knowledge of the connection between IT competence and supply chain efficiency. There has always been a focus in the IT value research stream on elucidating the connection between IT deployment and business outcomes. The purpose of this dissertation is to provide new information to IT business value research by exploring the connection between the IT capacity of a supply chain and the performance of the supply chain from a knowledge management viewpoint.

The computer simulation study provides a solid groundwork for future research into the IT-enabled inter-organisational process of the supply chain, which is the dissertation's third theoretical contribution. The use of IT for knowledge management in the context of the supply chain is seen as an important but little-explored issue in the field of information systems. Using a simulation technique, this dissertation broadens the scope of previous research on IT-enabled supply chain processes and sustainability beyond the confines of a single firm, focusing instead on the dynamics between businesses. Experts in the field of supply chain management will also find this dissertation's conclusion useful and instructive.

To begin, in today's fast-paced business world, supply chain organisations cannot afford to operate independently with little knowledge of the consumers, technology, and business processes that make up the competitive landscape. This study will aid companies in formulating supply chain strategies that make the most of the synergies that may be achieved via the sharing of information and expertise with trading partners. Secondly, supply chains may be more adaptable to customer needs if knowledge resources are developed and used effectively. This dissertation will aid in enhancing practitioners' comprehension of how knowledge management skills may be used to reap operational and strategic advantages in supply chain performance. Finally, supply chain companies may build knowledge management efforts on the back of their increased use of IT. Professionals in the supply chain may make better use of and decisions about the management of their company's portfolio of IT resources if they have a clear grasp of how IT facilitates knowledge activities throughout the supply chain.

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Chapter 2: Literature Review

2.1. Introduction

Evidence suggests that IT is a useful tool for managing institutional knowledge. Research on the role of IT in establishing supply chain management capabilities is warranted considering the growing importance of knowledge management. This dissertation builds its theoretical advances on three separate but increasingly convergent streams of literature, all to understand the complicated phenomena of utilising IT to manage information in supply chains. First, the IT business value literature lays the groundwork for a comprehensive understanding of IT capabilities and how they might contribute to a company's bottom line (Gurtu & Johny, 2019). The literature on IOS and supply chain management (SCM) then provides context for understanding the variables driving IT adoption in SC and how IT has enhanced supply chain performance. Third, studies in information systems, management, organisational learning, and strategic management all meet in the knowledge management literature. It adds to our knowledge of how information technology may be used to enhance knowledge management procedures inside and across companies.

IT ROI studies analyse how information technology influences business outcomes. Efficiency and effectiveness are the foundations around which IS scholars build their definitions of performance. Focusing on internal indicators like cost savings and productivity increases, or "performing better at what they do", is central to the concept of efficiency. As opposed to efficiency, which looks inward at internal operations, effectiveness considers how well a business does in the marketplace (Ben-Gal, 2019). As businesses spend more and more on IT, both academics and industry professionals are eager to learn how this technology impacts productivity and efficiency. IT artifacts are seen differently depending on the specific IT business value research methodology used. Information technology (IT) in particular is

seen as the physical manifestation of abstract concepts like financial investments, strategic information systems, and organisational capacities. Researchers in the field of information systems have used a wide range of microeconomic theoretical frameworks, such as production theory, consumer theory, and option-pricing models, to investigate the connection between IT investments and company performance. It has been shown in this body of work that IT expenditure may either boost or hinder a company's bottom line (Ben-Gal, 2019). The contradictory findings prompted academics to question the methodology used in this line of inquiry. Some academics have proposed conducting studies close to the point of usage to identify the financial advantages of information technology more precisely. Measure the effects of IT using a process-oriented approach, and you'll discover that it makes a big contribution at the juncture (strategic business units).

Using a meta-analysis to sort out the contradictory findings on the link between IT spending and ROI. They find that the size of the sample, the sector examined, whether the research is cross-sectional or longitudinal, and the dependent variables used are all likely to result in contrasting assessments of IT's worth (Ju et al., 2020). The economic value of the IT research stream provides insight into how IT may improve an organisation's bottom line by tracing the impact IT has on economic performance via intermediary business processes. Studies of strategic information systems examine the potential of strategic IT to help businesses save expenses or create a competitive advantage.

Computer reservation systems like SABRE at American Airlines and ASAP at American Hospital Supply are just two examples that directly contributed to a company's competitive edge by bringing in more customers and more money. This line of inquiry has been criticised for its purported myopic concentration on individual computer systems and its failure to consider the socially complex organisational setting in which these systems are

implemented. However, placing an excessive amount of weight on certain information systems is not enough to gain a sustainable competitive advantage because of the simplicity with which other organisations might imitate the strategy. Most technological resources are commercially available. Because of this, it's doubtful that technological advancements can ever provide a reliable source of competitive advantage (Attaran, 2020). IS scholars are increasingly seeing IT's core concept as a capacity for businesses. According to this IT perspective, businesses may pool their IT-related resources to create unique, valuable, imitative, and irreplaceable IT capabilities. The present modular and interoperable architecture of IT makes it more difficult for businesses to erect entry barriers that are built purely on proprietary technology, in contrast to many of the strategic systems in their early years.

So, according to the capability perspective of IT, it's not the information systems themselves but rather the capabilities made possible by those systems that provide businesses with an edge in the market. It is the resource-based view of the organisation that provides the theoretical underpinnings for the capabilities perspective on IT (Industry 4.0). Industry 4.0 stresses the significance of developing differentiated, heterogeneously dispersed skills to gain an edge in the market. Researchers examining the worth of IT may use Industry 4.0 as a foundation to draw favourable conclusions about the impact that IT has on business success (Muninger, Hammedi & Mahr, 2019). This dissertation takes a capabilities perspective of IT to investigate how IT collaboration across businesses affects efficiency in the supply chain.

Organisational scholars have largely accepted the resource-based perspective of the company to better understand the consequences of firm resources on efficiency and competitive advantage. It proposes that a firm's resources are not uniformly distributed, that some of these resources are necessary for gaining a competitive advantage, that others are

necessary for achieving superior long-term performance, and that there are at least four characteristics that any given resource must have to provide a sustainable competitive edge. Four characteristics make anything unique: high price, scarcity, imitation, and replacement. To begin with, the resource must be of high quality for the company to profit from it. In addition, if the resource in question is very scarce, the business will have a comparative advantage if its rivals do not also own it.

To maintain an edge in the market, a company needs a valuable and scarce resource that is only partially imitable and for which there are no suitable alternatives. Determining what is meant by the term "resource" is a crucial challenge for Industry 4.0 theorists. Different definitions and categorisations of central terminology have emerged in the industry 4.0 study. In particular, there is a lot of fuzziness in the literature about the differences between assets, resources, and capabilities (Koh, Orzes & Jia, 2019). All the firm's assets, competencies, organisational procedures, information, and expertise that contributed to the creation of competitive advantage are collectively referred to as "the firm's resources." This definition, which was one of the first to appear in the Industry 4.0 of company resources, did not provide much clarity on the distinctions between assets, resources, and capabilities. For the sake of identifying and reacting to market opportunities and challenges, resources are defined as assets and capabilities that are both readily accessible and usable. Further, assets are everything of value that the company may use in the generation, manufacture, and distribution of its goods and services.

2.2. Use of technology in Supply Chain Management:

The term "Supply Chain Management" (SCM) refers to the management of a network of interconnected businesses that are ultimately accountable for the delivery of product and service bundles that are required by end customers (Copacino, 2019). The drivers of the

supply chain can collaborate toward the achievement of the common objective of integrated and coordinated supply chains thanks to the flow of information across the many networks that comprise the supply chain. The efficient operation of the supply chain is facilitated because of this. The provision of transactional processes and opportunities for decision makers at the exact time they require them, and in the format, they require using data not only improves the performance of supply chains but also helps to reduce the risk that is connected with these chains. The application of information technology (IT), which includes both computer hardware and software, has become an essential component of contemporary life. The utilisation of information technology has a significant role in making possible the integration of various parties, including suppliers, producers, distributors, and consumers. Businesses can acquire a competitive edge by making efficient use of supply chain management (SCM) to collect vital information along the entirety of the supply chain and respond rapidly to any changes in the market that are predicted (Majeed and Rupasinghe, 2017). In the context of supply chain management (SCM), the goals of information technology include making data accessible and transparent, providing a single point of contact for data, allowing decisions to be made using information about the entire supply chain, and facilitating communication with partners. It has been determined that the three basic purposes of information technology in the supply chain are assistance with decision-making, teamwork, coordination, and transparency in the transactions that take place along the chain (Singh & Raghuram, 2017).

Better supply and demand matchups between members of the supply chain are one of the expected outcomes, along with a solid foundation for integrating with external partners in the supply chain via IT systems. This foundation will include data integrity, real-time availability, visibility, and the capability to process information (Chang et al., 2019).

Cybercrime, which includes "computer-assisted" crimes like hacking and phishing, and "computer-focused" crimes like hate crimes and telemarketing/internet fraud, is on the rise because of the increased use of information technology in supply chain activities. This includes both "computer-assisted" crimes like hacking and phishing and "computer-focused" crimes like hate crimes. Cybercrime, digital crime, e-crime, internet crime, and online crime are some of the other names for illegal activities that involve the use of computers. These and other names are all part of the broader category known as "online crime." Because of this, many people now believe that information technology is an essential component of logistics and supply chain management (Khan and Estay, 2015). In the field of supply chain management, information technology also plays an essential part in the management of e-risks (SCM).

Planning is linked to all major supply chain stages, from manufacturing or logistics to warehousing. Data must be pulled from the various software that works on each stage individually (Pal, 2020). For example, data analysis from WMS is helpful for inventory planning and manufacturing (Pal, 2020).

The supply chain is far more complex than it seems, and there are many stages involved in the process. the second stage is Logistics and transportation management is one of the most important, taking up 80-90% of supply chain costs. This process needs to function at 100% efficiency for a successful business. Logistics and transportation used to require many data, but now it just requires some basic information. So, it is important to coordinate internally within the department and externally with agencies and other partners (Ngatilah et al., 2020).

Machine learning and artificial intelligence make supply chain analytics much more efficient. These technologies analyse data, create algorithms and find solutions humans

normally would not think of to keep an organisation's supply chains running smoothly. IoT constantly works in the background to collect and provide data for AI. Digital twins and Control Tower come into play for better management of supply chains (Pramono, Ulkhaq and Naufal, 2021).

Organisations will not miss a beat with control towers closely monitoring supply chain operations and suggesting necessary corrective actions. New technologies like digital twins allow strategies to be managed more closely and show an overall improvement in the supply chain (Pramono, Ulkhaq and Naufal, 2021).

2.2.1 Electronic Records Management

Electronic Records Management is a collective term for a collection of technologies that allow for paperless corporate transactions. These technologies include enterprise resource planning (ERP) systems, automatic identification (Auto ID), and electronic data exchange (EDI) (Cole et al., 2019). The objective of ensuring accountability throughout the process flow can be accomplished with the use of ERM in SCM; as a result, the number of cybercrime risks (also known as e-risks) created by electronic communication will be reduced.

Electronic records should be organised logically, making them easy to find and use. They should be arranged into folders and sub-folders with all records about the same subject and electronic documents, including emails. A shared drive is a default space for storing electronic records. A shared drive should have an administrator to take care of day-to-day running and an owner with access and control over the drive's content. Records management is the term for the process of organising and storing important business documents in a disciplined manner (Ngatilah et al., 2020).

2.2.2 Bar code Scanner

There are two possible orientations for bar codes: a ladder orientation, in which the width lines are arranged horizontally, and a picket fence orientation, in which the width lines are ordered vertically. The data can be stored magnetically or optically. The Management of Supply Chains and the Implementation of Information Technology because it is a representation of a number or code that can be read by a computer, it not only provides crucial precision and timeliness of information, but it also helps to limit the number of errors that occur (Apiyo and Kiarie, 2018). It is not uncommon for the bullwhip effect to cause major inefficiencies in the consumer products industry. Some examples of these inefficiencies include excessive inventory investment, poor customer service, lost revenues, erroneous capacity planning, inefficient transportation, and missed production schedules. Although bar codes and scanners have been developed and implemented across the supply chain to reduce the likelihood of errors, these inefficiencies continue to exist. Wal-Mart's application of this technology on the company had a huge increase in earnings beginning in 1983 and continuing through 1987 once it began utilising satellite links for real-time inventory data (Acharya et al., 2018). The measures that Walmart undertook were the primary factor that led to its success. This is being done to ensure that Mart's FedEx can give its clients real-time tracking information that is both comprehensive and up to date.

Product identification, speeding up data entry, improving data accuracy, reducing on-hand inventory, improving customer service, reducing product recall, verifying orders at receiving and shipping, reducing work-in-process idle time, monitoring, and controlling shop floor activity, improving shop floor scheduling, optimising floor space, increasing product yield while reducing scrap, attendance recording, automatic teller machine cards, debit cards,

and credit cards (Papetti et al., 2019). Utilizing bar codes is one way to reduce the risks associated with supply chain management, which have recently become more prevalent because of human error or the submission of fraudulent data by an insider. Using biometric authentication and permission to prevent redundancy in the process of manufacturing bar codes is one way to mitigate the potential hazards associated with electronic transactions.

Although it is possible to tamper with data, there are several different ways that it can be accomplished. These include making unauthorised changes to the information before it is entered, adding fraudulent information while it is being entered, changing, or omitting the information that was intended to be entered, posting transactions incorrectly, and posting only part of the information that was intended to be posted, erasing the data and replacing it with fake data, or injecting a virus that modifies data (Kumar and Tripathi, 2019).

2.2.3 Radio Frequency Identification (RFID)

Radiofrequency identification (RFID) tags, which are a relatively breakthrough in artificial security tags but are also simple to incorporate into existing supply chains, play a key role. RFID tags are an example of an artificial security tag. Since RFID tags are validated and one of a kind, the organisation is in a stronger position to prevent product duplication. This also lessens the likelihood that fraudulent activity may occur because of the manipulation of the entry or authorization that is transferred from the supplier to the consumer. The only limits that can be circumvented are those relating to cost and implementation. For RFID tags and smart cards to be kept secure, specialised cryptographic methods are required to be used.

RFID technology can be distinguished by its use of tags that can transmit and receive a one-of-a-kind serial number of an item via wireless radio signals. In addition, RFID

technology can make use of readers that can gather and transmit data conveyed by tags into an organization's information system for further investigation or analysis. Tags send and receive an object's unique serial number using radio waves that are transmitted wirelessly. Radio Frequency Identification is the abbreviated form of RFID. Bar codes and radio frequency identification, or RFID, are two forms of automatic identification technology (Jayaram, 2016). While both technologies can be used to scan printed labels, bar codes utilise optical laser or image technology, whilst RFID makes use of radio frequency signals. To perform their functions, bar codes and RFID both make use of automatic identification technologies. RFID enables verification, a reduction in channel volume, and improved forecasting and planning, to name just a few of the technology's many advantages (Musa and Dabo, 2016). Several factors could contribute to an improvement in the supply chain, including an enhanced understanding of client wants efficient business procedures, accurate and dependable order predictions, greater productivity, and decreased operating expenses (Wen et al., 2020). RFID cards have a function that allows for authentication. RFID cards have a function that allows for authentication. RFID systems already have authentication built in. The Radio Frequency Identification (RFID) system includes a technique for validating identities. The authentication process is one of the most important uses of RFID technology (Oghazi et al., 2018). The authentication process is one of the most important uses of RFID technology.

RFID is used to control the warehouses for Amcor (Nair and Anbuudayasankar, 2016). The year 2003 marked the beginning of Wal-practice Mart's informing its suppliers of the dates on which they were expected to begin using RFID tags on their products (Tan et al., 2018). Amcor keeps track of its warehouses with the help of RFID technology. The use of

radio frequency identification technology has increased lately, particularly in the areas of logistics and supply chain management.

2.2.4 Enterprise Resource Planning (ERP)

In the context of a supply chain, enterprise resource planning (ERP) is a type of organisational planning system that focuses on the core activities of a company and incorporates all the logical interfaces that are required to establish a smooth flow of information throughout the organization (Tarigan et al., 2021).

A significant number of ERPs are linked to computer networks located outside of the company. It includes an umbrella term for different types of software that are used to control and coordinate a significant portion of a company's resources, assets, and operations. These types of software include administrative (finance and accounting), human resources (payroll), and Manufacturing Resources Planning (MRP) (procurement, production planning). The ability of an enterprise resource planning (ERP) system to integrate a company's myriad of different business processes and transactions is one of the most essential features of such a system (Aziz et al., 2018). ERP solutions are designed to assist businesses in automating and integrating many business processes and Supply Chain Management operations. ERP solutions. It is possible to compile all of an organisation's data into a single software package that does not require any interaction from a human being. This package can include information on everything from the raw materials to the end user.

It is feasible that enterprise resource planning (ERP) systems could result in a wide variety of benefits, such as reduced costs in internal operations, increased supply chain efficiency, and greater customer service. The development and widespread use of enterprise resource planning (ERP) systems have provided the necessary framework for successfully

transitioning from a one-time event to a continuous activity. This modification was necessary to ensure a smooth transition (Kuhn et al., 2010).

The demand for improved integration and planning, as well as the desire to foster innovative thinking, were the driving forces behind the development of ERP.

2.2.5 A pioneering application of the closed-loop MRP

The MRP was connected to other planning techniques, such as priority planning and capacity planning, to account for swings in demand and supply by incorporating information from tactical plans and execution levels in an industrial environment that is constantly changing (Özcan and Çimtay, 2016). This was done to keep up with the ever-evolving industrial environment. This closed structure is referred to by its official name, the closed loop MRP.

2.2.6 Production control and inventory management system from the 1980s (MRP II)

Manufacturing Resource Planning is a system for production planning that translates Master Production Plans (MPS) into planned release orders. This system is known as Manufacturing Resource Planning (MRP-II). In MRP II, the MPS is one of the variables that can be used in the decision-making process (Özcan and Çimtay, 2016). This is because MRP treats the MPS as both an input and an output, therefore MRP II also uses it in this dual capacity.

2.2.7 An updated version of the enterprise resource planning system

The next generation of enterprise resource planning (ERP) will incorporate supply chain management into the planning concept, and trade partners will be a part of the process.

This enables a virtual business to exist by supplying real-time visibility across the entirety of the organisation, which is made possible through the utilisation of electronic commerce. All these areas will be impacted, including business process reengineering (BPR), adjustments to organisational structure, personnel changes, and change management.

2.2.8 SAP

The enterprise resource planning (ERP) software that was developed by SAP, a business that was started in 1972 by five former IBM systems engineers, is the ERP software that is utilised all over the world the most. The corporation provides services to 17,500 different client organisations located in more than 120 different countries (Angolia and Pagliari, 2018). In addition to third-party fraud detection technology and organisation's proprietary relational databases, numerous SAP systems are currently in use. These SAP systems include those for the purchase-to-pay, the order-to-cash, and human resources (HR) processes. In each of these cases, there is a risk to the data's security as well as its governance, which leads to a reduction in the amount of data that can be examined. The HANA-based SAP Management system was made available to customers in 2013. Process Control, Access Control, Risk Management, Global Trade Management, Business Objects, and Business Intelligence are the components that make up SAP's Governance, Risk, and Compliance (GRC) product range (Ahmad et al., 2020).

Since there is constant adoption of these new technologies, companies are now able to conduct analysis of any fraudulent activity in real-time, which is a significant improvement. Even in situations with many transactions, SAP HANA can detect, evaluate, and analyse potential cases of fraud as well as prevent further occurrences of the problem. The capabilities of SAP HANA are strikingly comparable to those of Oracle and Baan. Using

SAP software, it is feasible to detect fraudulent activity and take preventative measures in an electronic setting (Deepalakshmi, 2017). In the case of the issue with the False Vendor Payment, a lack of task division causes the same person to be responsible for the formation of the vendor (the bank account number, for example, must be changed), as well as for creating and approving the invoice for that vendor. This results in the issue. If the appropriate reasoning for the separation of tasks is specified and put into practice, it is simple to uncover and prevent problems from occurring.

2.2.9 Electronic Supply Chain (ESC)

The term "Electronic Supply Chain" (ESC) refers to a supply chain that is controlled electronically in the form of transactions carried out via EDI or the Internet between and among the many organisations that take part in the chain. It is possible to describe it as a "Virtual Supply Chain," which is a network that links businesses to facilitate the purchase, sale, and movement of goods, services, and money using Internet-based applications (Ramesh et al., 2020). When it is simplified to its most basic form, it can be thought of as a "virtual supply chain." Over this network, transactions including goods, services, and even currency are all possible. Due to the collaborative efforts of everyone involved, CPFR, Vendor Controlled Inventory (VMI), Efficient Customer Response (ECR), and Quick Response are all very easy to keep under control.

Intel was able to realise the relevance of the Internet as a corporate communication channel by taking a "brochureware" approach to the dissemination of information and the sale of Pentium central processing units. Through the implementation of this strategy, Intel was able to capitalise on the ever-increasing use of the internet (Mohammed and Hussein, 2020).

2.2.10 E-Commerce

Electronic commerce refers to the use of digital communications and computer-based systems to conduct business transactions (e-commerce). Covisint is an example of a business-to-business (B2B) company; Amazon.com is an example of a business-to-consumer (B2C) company; priceline.com is an example of a C2B business-to-consumer company; and so on, with the Internet and websites taking the form of B2C (Business-to-Customer) B2B (Business-to-Business) and C2C (Consumer-to-Customer). In 1995, Intel established the Internet Marketing and E-Commerce Group (IM&E) to consolidate the company's different web marketing initiatives (Yu et al., 2016). Integrated supply chain management plays a significant part in both the evolution of business dynamics and supply chain management itself (SCM) (Brzozowska and Bubel, 2015).

2.2.11 E-Procurement

As the administration of supply chains grows more computerised, it is anticipated that electronic procurement will eventually become a component of the more extensive purchase-to-pay (P2P) value chain. The utilisation of a software application that contains functions for both the administration of suppliers and the conduct of complicated auctions is what makes electronic procurement (e-procurement) possible (Kumar and Ganguly, 2020). The value chain for this application incorporates not just Indent Management but also e-Tendering, e-Auctioning, Vendor Management, Catalogue Management, and Contract Management as well. E-procurement takes the form of ERP, or enterprise resource planning, which is a type of e-procurement that makes use of a software system that is based on the Internet to create and approve purchasing requisitions, issue purchase orders, and receive

commodities and services. Instead of purchasing product-related MRO materials, participants in e-MRO, for which the acronym stands for "Maintenance, Repair, and Overhaul," invest in web-based ERP solutions and services (Chibani et al., 2018). E-sourcing, e-tendering, e-reverse auctioning, and e-informing are all possible applications for technology based on the Internet. In its first month of operation, Intel's online ordering system smashed the previous record for the most amount of money in product orders with one billion dollars. More than 85 percent of Intel's total revenue comes from the company's online sales, which are conducted by an overwhelming majority of the company's customers (Vaidya and Campbell, 2016). Intel is making an effort to eliminate the use of paper in its purchasing, shipping notification systems, and deployment processes.

2.2.12 Authentication Code

The law in the United Kingdom requires the use of digital signatures on any papers that are sent in by electronic means. This is done to assure the documents' legitimacy as well as their level of security (Mason, 2016). When the document is provided electronically, this is the only means to guarantee both its safety and its authenticity.

2.2.13 Secure Electronic Trading (SET)

To handle credit card transactions online, a brand-new industry standard is currently in the works. During a transaction, it is the responsibility of each party to keep track of two digital keys, one of which is public and the other of which is kept secret. These keys serve as the basis for the structure of the entire system (Liu and Li, 2020). From their respective financial institutions, customers receive both keys and a digital certification that verifies the originality of the documents in question. For a client to successfully conduct an online

transaction, the consumer must first provide the merchant with the public key as well as the certificate that verifies the authenticity of the certificate. In addition to providing certificates, the store also demonstrates its authenticity and makes it possible for the transaction to be completed by delivering its public key (Salami, 2022). Both the distribution of keys and the identification of customers could potentially provide challenges when attempting to guarantee a one-to-one link between accounts and customers.

2.2.14 Extensible Markup Language (XML)

Document structures can be recognised using a markup language, and structured information includes things like text, graphics, and other components that are essential to the flow of data and exchanges across a supply chain network. The standard for adding markup to documents and data in XML, which stands for "extensible markup language" (Li et al., 2017) With the use of this technology, content may be processed and distributed across a broad variety of computing devices, operating systems, and applications with a minimum of intervention from a human being. As a result, information that is intricately organised may now be found on the Internet. Transporting XML documents can be done with virtually any form of computer language, operating system, or application type imaginable. In addition, a broad variety of software development tools and utilities are compatible with XML, making it a very versatile format (Pal, 2019). XML-based solutions offer a significant alternative to traditional EDI and lower the threshold for entering the realm of e-business (El-Ebiary et al., 2019). EDI is an electronic data interchange that allows for the transfer of data from one system to another at a reduced cost. XML documents have a wide variety of uses, one of which is the processing of e-commerce transactions.

2.2.15 Spreadsheets (Microsoft Excel)

When compared to the total cost of ownership of a commercial software-based decision-making supporting tool, the total cost of ownership of Microsoft Excel is significantly lower. This is one of the reasons why many businesses are choosing to use it as their standard desktop software and as a decision-making tool in their supply chains. Supply Chain Networks (SCN), which may also benefit from using it, may also benefit from using it because it has various capabilities built in to perform and implement quantitative modelling approaches. One of the many reasons why it is valuable is because of this fact (Bozarth, 2016). Microsoft Excel is a tool that is always available and is frequently utilised for data analysis. Spreadsheets are easy to navigate, and they provide a significant amount of flexibility. Excel's capabilities include analysis (both horizontal and vertical, ratios, trend analysis, performance measures, statistics, and stratifications), data management and analysis (append/merge, calculated field/functions and cross-tabulation, duplicates, export, gap analysis, index sort, join/relate, sample, summation), user form design; macros and Visual Basic for Applications (VBA); and analysis (both horizontal and vertical, ratios, trend analysis; and stratifications). In addition to that, it includes a data visualisation tool that is integrated right in (VBA). As a result of the complexity of the supply chain network data, it is feasible for dishonest individuals to perpetrate fraud that is beyond the capabilities of the organisation's internal controls. On the other hand, it is possible to locate bogus data in a supply chain network data set by utilising the Benford distribution in conjunction with an Excel spreadsheet (Varma & Khan, 2012).

As a result, it has become the de facto standard for the management and analysis of organisational data within SCN. This is done to increase efficiency while also reducing instances of financial fraud such as bid rigging, the use of phantom bids, and nepotism.

Additionally, this is done to detect fictitious accounting entities such as ghost employees and fake vendors, fake customers or vendor payments, or falsified hours.

2.2.16 Data Mining and the Data Warehouse

Due to its process-oriented and topical focus, as well as its integration with other databases, the Data Warehouse (DW), which is a collection of many databases from throughout a whole organisation, may help managers make better decisions. The DW is a collection of databases. Data mining seeks to accomplish both the discovery of previously unknown patterns and relationships in data as well as the derivation of rules from the data that can be applied to the prediction of potential future outcomes (Kamble et al., 2015). Data mining can be accomplished in a few ways, including through the use of statistical analysis and modelling. The process of using occurrences that statistically differ from expected behaviour to produce alerts is what constitutes the detection of anomalies. Predictive models are statistical models that are constructed from event characteristics that are indicators of previous instances of fraud. "Social network analysis" refers to the process of issuing warnings based on an evaluation of how closely the recent event is related to previous ones.

2.2.17 Intranet/Extranet

Internal computer networks within an organisation typically make use of Internet-based protocols like HTTP and FTP to connect with one another; however, these connections are typically inaccessible from the outside world. Organisations can improve their internal information systems and connect previously incompatible computer groups in supply chain networks by combining internal systems with Web browsers and server software (Kisler et al., 2020). This combination is called a hybrid solution. Because of this,

considerably less time is spent manually interfering. The Extranet is protected by a firewall, which allows users to access the Intranet of the firm in addition to other information and services that are not available on the Intranet. Connecting employees to the company's data, such as product price and benefits, is one of the most popular purposes for internal networks today.

When an internal network is expanded to include a company's customers and suppliers, it can be converted into an "Extranet" for a fraction of the cost of developing a proprietary network. This is something that can be done because all the internal networks use the same language and are seamlessly connected to the public internet.

2.2.18 Internet

The effective management of a company's supply chain is essential to that company's success. The scope of supply chain management may extend beyond the confines of a single organisation to exchange information not only with retailers, but also with manufacturers, distributors, and suppliers (Ben-Daya et al., 2019). The Internet assumes an increasingly important function at this juncture. When it comes to improvements in technology and communications, the adoption of internet applications in the business and mass media sectors is possibly the most crucial development. Because of the Internet, a mind-boggling variety of organisations, individuals, and information sources are immediately available on a worldwide scale. Concerns over one's right to privacy and the safety of personally identifiable information are of primary importance when using the internet. This is due to the difficulty that actors in the supply chain have in freely exchanging information with one another. Internet users could become the victims of cybercriminals' predatory behaviour. Customers and other parties in the supply chain placed the greatest importance on internet security as the highest priority overall.

2.2.19 World Wide Web (WWW)

The World Wide Web (WWW) is the Internet system for hypertext connecting multimedia materials. It enables users to navigate from one website to another on the internet and access the information that is available on those websites. They don't have to follow complicated instructions or follow specific protocols to acquire the information, which frees them up. On the world wide web, one can access an increasing number of websites devoted to various aspects of supply chain management. Enterprise Transportation Management, a platform developed on Oracle Web Applications Server, has just been made available by Metasys Inc. With this technology, information on transportation and distribution applications is transmitted all through the supply chain.

Websites are made up of HTML and come in various forms - from simple to complex pages. Links within a webpage also help find different information pieces more easily (Clark and Goble, 2013). Hypertext allows one to jump from one area to the next and even break down information on a word-by-word level. A web screen is given an online address called a Uniform Resource Locator (URL). A particular collection of screens belonging to a specific URL is called a website. The internet is basically like an electronic library with millions of data reposted on servers worldwide (Lowe et al., 1996).

A single website usually stores all of its pages on one server, but larger or more global websites split up their pages so that when a user in a specific country searches for them, they can get what they need locally. So, the internet is a worldwide platform for users to interact and exchange information (Clark and Goble, 2013). The internet is a global computer network that connects billions of people. The word "internet" means a network of networks.

This includes government, academic, corporate, and other private networks and connections to remote offices, home computers, and mobile devices (Javatpoint, 2013).

2.2.20 Systems that Assist in Making Decisions

The management of decisions about demand forecasting, logistics network architecture, sales, and marketing area assignment, and the allocation of distributed resources is an essential component of supply chain management. The acronym "DSS" stands for "decision support system," and it provides automated aid in making tough, non-routine, and partially structured decisions on the operations of a company's supply chain. With the help of decision support systems, decision makers might find it simpler to plan and run integrated supply chains. This would be an advantage for businesses. Decision makers will be better equipped to detect and prevent fraud at all levels of the supply chain by using Decision Support Systems (DSS), and they will also be able to suggest parts of the chain where improvements may be made.

Decision support systems provide detailed information by gathering and analysing data. They differ from operations applications, which collect data but do not analyse it (Elia, 2022). In an organisation, a DSS is often used by the planning departments like operations which collects data and provides reports for managers (Alyoubi, 2015).

A DSS can primarily produce sales projections, manage inventory and operations data and present easy-to-understand information in a customer-facing manner (Alyoubi, 2015).

DSSs can be applied to various fields, such as organisational knowledge, forest management, and medicine. A DSS can be beneficial if a company is using JIT inventory management. For example, it can generate real-time reports, which help track incoming and outgoing inventory changes (Hak, Guimarães and Santos, 2022). The three main components

of a decision support system include a model management system, a user interface, and a knowledge base. Managers can use model management systems to store models that predict demand and help make VP/HR decisions. The user interface includes tools that make the work with a DSS easier. The Knowledge Base is a collection of information from various internal and external sources, which may include anything from transaction data to newspaper articles (Hak, Guimarães and Santos, 2022; Alyoubi, 2015).

2.2.21 E-business

According to Farooqui & Farooque (2016) research, "the use of the Internet or other digitally enabled inter- or intra-organisational information technology for business activities. To put it another way, conducting business over the internet is what is meant by the term "e-business." In their research, Geoffrion and Krishnan identified three distinct types of online businesses (2001). The first group is focused on consumer-oriented activities like business-to-consumer and business-to-government; the second category is based on business-to-business and business-to-government, and the third category is based on the underlying technology infrastructure. Aside from digital marketplaces, item identification, and content management, the most important technologies and methods used in e-commerce are electronic data interchange (EDI) and extensible markup language (XML). Other important technologies and methods include digital marketplaces, item identification, and content management. Cybercriminals will take advantage of a company's lackluster security measures if it is possible for them to do so. The ownership of intellectual property and copyrights are both protected by law in every country.

2.2.22 Computer Software

A software agent can be characterised by having one or more of the following attributes: intelligence, autonomy, adaptability, perception, or the capacity to act proactively on behalf of a user. An agent must be able to carry out tasks or activities based on its understanding before it can be regarded as intelligent. Buyer agents, which are also known as shopping bots, can retrieve information on goods and services from networks. Monitoring and surveillance agents, which monitor and report on equipment, most common computer systems, are also capable of doing the same thing. Agents such as data mining agents and user agents, often known as personal agents, are examples of agents that possess this functionality (which finds trends and patterns in information gathered from a variety of sources).

Data is protected by software agents in the form of encryption. Since it involves conducting business over the internet, electronic commerce places a high premium on the confidentiality of customer information. Software agents, which are capable of being utilised to convey communication, are extremely important to the success of effective communication in the business world.

In B2B e-commerce, the software agent's major duty is to guarantee that the customers are pleased with the products they have purchased. The significance of software agents in online commerce can thus be demonstrated. Because there aren't any software agents involved, online business is analogous to "a person having his leg cut" (Ramya S. Gowda, 2013).

Services that are Made Available by the World Wide Web A web service was developed as a software solution to ease communication between machines that are connected via a network. It provides a machine-processable interface in a standardised manner and has this interface (specifically WSDL). To the Web service's requirements, other

computer systems receive SOAP messages that are transmitted between the Web service and them. These messages are frequently transmitted by utilising HTTP in conjunction with an XML serialisation and several other Web-related standards.

2.3 Information Technology & Supply Chain Management

Studies have shown that supply chain linkages may be divided into three categories: operational, tactical, and strategic. These three layers of contacts are defined by the information-sharing activities of supply chain businesses. At the functional level of supply chain interactions, payment reduction initiatives like Vendor Managed Inventory, as well as the communication of transaction-based data among parties via interfirm information exchange technologies like EDI or extended ERP, are addressed (VMI). Knowledge transfer occurs across 20 divisions or operating departments in or between enterprises, in addition to individual departments within businesses, at the tactical level. Sharing knowledge increases production and income in ways other than transactional efficiency. Programs for tactical SCM include Point-of-Sale (POS) demand data interchange, Collaboration, Planning, and Resupply (CPFR), and Continuous Replenishment (CRP). Strategic interactions in the supply chain need the gathering and sharing of competitive knowledge as well as the requirement for IT systems' decision-supporting capabilities. SC collaborations may be extremely cooperative or include one party managing the exchange of information protocols with another, regardless of the subject matter of information sharing (Malhotra et al. 2005). The majority of the study on IT's effects on SCM has focused on how certain innovations and technologies, including EDI, CRP, and RFID, may enhance SC business operations and performance. According to the report, suppliers who utilise EDI to support production in a Just-in-Time (JIT) environment have higher delivery effectiveness in terms of shipping inconsistencies Raghunathan

emphasises the benefits of continuous replenishment, which CRP makes possible for suppliers and participating shops alike. I suggest that by improving customers' perceptions of value, a company's competitive advantage might change from efficiency to customer loyalty. In conclusion, supply chain IT may increase supply chain effectiveness by lowering the uncertainties brought on by information asymmetry, incompleteness, and unavailability.

2.4 Emerging Information Technology Solutions for SCM

Solutions for new information systems are still in the early phases of development, but they are already inspiring interest and rising investment. In the next three to five years, new technologies—which aren't yet widely adopted—will virtually surely enhance communities and economies. The technology should ideally be created by many companies. Finally, as a result of sector disruption or modification brought about by future breakthroughs, new ways of doing things emerge (CSCMPI'S SUPPLY CHAIN, 2020). Thirteen companies that provide and create cutting-edge solutions and technology have identified the top three technologies' effects on supply chains. Big Data, the Internet of Things, and blockchain are these. This integration of IoT, AI, and blockchain with more conventional systems for managing supply chains and corporate network operations has the potential to open up new possibilities and levels of creativity and effectiveness (Opentext, 2020).

2.4.1 Artificial Intelligence (AI) and Machine Learning

According to Loo Saw Khuan and Santhiram R. Raman (2018), buying professionals may use artificial intelligence to locate, classify, and match products with the relevant suppliers. Additionally, it may be utilised to alert customers about impending price rises and supply shortages. The neural network may also be used to notify supply management and contract renewal.

2.4.2 Blockchain

Blockchain, according to McDaniel and Nordberg (2019), is a cutting-edge method for exchanging and storing information. It is a completely decentralised ledger that enables private information transfer without the use of a middleman. Nodes are people and their computers, and they may exchange money and carry out other transactions with other endpoints. Consensus is used to validate each transaction, meaning that no one person may alter it. Immediately following the transaction's network validation, all information is connected to a block. As a result, a new phone block is added to the chain and several copies of the exact data are recorded in various places. Then, because each block creates a complicated chain, it is nearly impossible to make any modifications, making it extremely safe due to its users. Kshetri (2018: 80) predicts that blockchain will completely disrupt the supply chain. Growing emphasis on the usage of Internet-of-things (IoT) applications is one of the trends that will affect SCM. Shipments and containers may be tracked at every stage using IoT, RFID, GPS, and chips. This makes it possible to manipulate objects more precisely and instantly. The first clear benefit of blockchain is that it could be able to address the problem of identity management. Blockchain may be used to track who is doing what in a supply chain.

Additionally, the events' start and end times might. Blockchain allows the accurate & effective assessment of results and crucial SCM process outputs, according to Koetsier (2017) 14. Data that is kept on a public blockchain is irreversible. Orders, delivery, and chain development may be tracked by additional vendors as well. Blockchain encourages supplier confidence in this tactic. By doing away with middlemen auditors, quality may be improved while costs are cut. According to Kshetri (2018), blockchain also offers a great method for determining an item's consistency while it is in transit. All parties in a supply chain, for

instance, would be able to determine whether an item was delivered to the incorrect location or remained at a single site for an excessive amount of time by analysing travel path and time data. According to Mougayar (2016), blockchain has several advantages for users. Lower costs are one gain from doing away with the requirement for third parties. Blockchain technology enables transactions to be completed much more quickly since there is no central authority. Privacy is improved and this level of accountability is now possible thanks to the scrutiny of all actions. Faster processes and reduced mistake rates lead to higher output and better outcomes, which enable higher profits and business growth. In the supply chain, new technologies are opening up interesting possibilities, according to the Deloitte article "Using blockchain to boost supply chain visibility." Utilizing blockchain technology can reduce management costs while enhancing efficiency and transparency throughout the supply chain. Participants may use the blockchain to track pricing, time frames, addresses, quality, licences, and other crucial information to better manage the supply chain (Monrat, Schelén & Andersson, 2019). A company's reputation as a pioneer in ethical manufacturing may be enhanced by the availability of this data within the blockchain, which will also help to decrease losses on the grey market and obtain visibility and regulation over the creation of outsourced goods. There are several obstacles to overcome, including the fact that the technology is still in its early stages of distribution system testing, the business is still learning about safety, costs, and implications, there are persistent problems connecting blockchain to actual items, and there is uncertainty surrounding persuading all stakeholders to use blockchain.

2.4.3 IoT

The article by Shafique et al (2020) has shown IoT. The Internet of Things, or IoT, refers to the billions of physical devices that are presently connected to the internet

throughout the world and collect and exchange data. Because of the advancement of low-cost silicon processors and the pervasiveness of wireless networks, anything from a pill to an aeroplane might be transformed into an IoT component (Shafique et al., 2020). Machines that would otherwise be stupid obtain artificial intelligence by connecting and attaching detectors to all of these numerous devices, allowing them to communicate data in real-time without the need for a person. The Internet of Everything makes our surroundings smarter and more adaptable by connecting them.

Chapter 3: Methodology

3.1 Overview

This inquiry makes use of the survey methodology. The research unit is a dyadic SC relationship between such a provider and a customer company. The proposed constructs were only examined at the SC dyad level from the viewpoint of a single supply chain partners. In a number of studies assessing the impact of SC tactics or SC information management on SC performance, this method has been employed to gather SC-level data. Members of each of the two supply chain trade groups as well as supply chain experts with direct responsibility for and awareness of the SC function in their organisations make up the sample frame for the survey (ISM and APICS). The procedure and selection of measures for the empirical inquiry are described in this section. The development of instruments, effective construction execution, and sample development are three crucial issues that are thoroughly discussed.

3.2 Research Design

Based on the specifications presented in the literature, a survey was created. Existing measurements were changed whenever feasible to create the questionnaire. Additional measurements were generated when current scale parts became unavailable. The past literature was extensively analysed to ensure the content validity of the measures, and a complete list of feasible items for each category was generated. Furthermore, two professors with expertise in survey design as well as information and supply chain management assessed the measures many times, increasing their validity and presentation validity. Participants were asked to recall a product line or service from the supply chain connection that existed between their companies and their partner companies. Based on the informant's company's involvement in the selected supply chain link, the informant was sent to a survey designed for

the client's or supplier's point of view. The significant factors in the questions are evaluated using a Likert scale. To encourage more comments, in addition to Likert scale alternatives, each issue included "Does Not Apply" and "Don't Know" options. 80 pilot tests were conducted to assess instructional clarity, language appropriateness, item wording, answer structure, and survey scales. The preliminary test was carried out. Paper questionnaires were distributed to 50 supply-chain experts who were randomly selected to attend an annual global supply-chain management conference. Participants were requested to complete this survey and submit it in a pre-mail-back envelope by May 30th. Of the 50 responses, 11 filled out the paper survey. The 11 participants' feedback was carefully examined, and changes were made to the questionnaire as a result. In June of this year, a second pilot study was conducted with a large number of MBA students enrolled from the researcher's university as well as several PhD students from the study's department. Every MBA student has prior knowledge in supply chain management. There were in-person interviews and email exchanges, and the survey was modified in response to the comments.

3.3 Research Method

Through the use of formative and reflective multi-item assessments, the study's variables were operationally defined. Formative signals contain the following characteristics: they don't always covary, they aren't interchangeable, and they produce a latent construct with each indication describing a different aspect of its variation. On the other hand, reflective indicators are interchangeable, must vary, and are brought about by the latent construct. The survey instrument is located in Appendix B.

Efficiency of the supply chain. Instead of the organisational value of either of the supply chains, the research focuses on the effectiveness of the company exchange link

between a coherent set and a supplier firm. Operational and strategic supply chain performance were combined to generate the hybrid architecture known as SC performance. Process-based performance metrics are referred to as operations management. It has been shown that operational measurements for SC success are preferable than financial indicators because they more accurately and promptly reflect the effects of SC activities. Operational policies might change as a result of market demands. Operational metrics may also provide SC partners opportunities for ongoing development. Businesses that fully utilise the potential of inter-organizational links achieve strategic success. An increase in business volume in a buyer-seller partnership is an illustration of strategic performance. Unlike operational indicators, which are restricted to a specific process, strategic measures are more concerned with overall performance outcomes that are bigger and more aggregated. As a consequence, operational and strategic objectives work well together.

The performance measures were based on the articles that investigated dyadic performance. The operational performance was categorised by the researcher as a formative first-order framework and the requisite techniques as a reflecting first-order construct. In order to find a broad pool of measuring items that may be used as markers of strategic and operational success, a thorough literature study was done when developing the performance measures. The researcher ensured the potential items in this stage encompassed the whole range of the two buildings. A variety of criteria were used to select and improve the measurement items. First of all, all vendors, not just one, should be included in the measures. In plenty of other words, the measurements must be applicable at the dyadic level of the supply chain. Businesses on both ends of a supply chain interaction were required to comprehend key metrics in order to fill out survey questions under the second 85 criterion. The third criteria were that the functional performance foundational measures should cover

all process improvement spectral bands when combined and should not be in direct competition with one another. The last criterion selected metrics from of the literature using conventional standards for reading comprehension, length, clarity, and jargon avoidance.

A collection of random strategic and operational performance measurements was developed as a result of the technique utilised to define the indicators. To evaluate the effectiveness of the supply chain and a specific plan performance measure, a 5 Point likert scale was employed (growth in business volume). The scale was utilised, ranging from "Significantly Worse Than the Industry Average" to "Significantly Better As Industry Average." On a five-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree," with a moderate midway anchor, the following strategic performance indicators were scored.

This study looked at how dependent the company was on its supply chain partner as well as how dependent the business thought the partner was on it. The five indicators of a supplier's dependence on a client are as follows: 1) The extent to which the customer is merely a key customer for the provider's good or service, 2) The extent to which the provider's relationship with the buyer is crucial to the company's performance goals, 3) The extent to which other clients are available, 4) The same great change in substituting the consumer with such a broad range of consumers, and 5) The provider's revenue and profit loss. The distributor's perception of its role in meeting the client's needs for the product or service, the company's perception of the supplier's importance to the user's desired outcomes, the company's awareness of how simple it is for the consumer to consider other providers for the accurate brand, and the user's switching costs all played a part in determining the customer's reliance on the provider.

It's time to take your relationships seriously: A six-item scale with options ranging from "less than 1 year" to "21 years or more" was used to measure the length of the relationship; the other four possibilities were each worth five years.

cooperative expectations: Building a relationship climate conducive to performance gains requires cooperative standards. A single question was used to measure cooperative norms.

Long-term thinking: To assess long-term orientation among supply chain partners, a single-item measure asking if a supply chain partnership has long-term partnership goals was utilised.

Environmental uncertainty: Market turbulence and variety are indicators of environmental instability. Market variety is the degree of difference in end customers' needs and preferences, whereas market volatility is the frequency with which market dynamics change. Measures of environmental uncertainty were changed. Three items that defined the end market environment for the good(s)/service(s) transacted in the 90 supply chain connections) were given to the participants to use as a means of expressing their level of confidence. A five-point Likert scale was used, with options from "Strongly Disagree" to "Strongly Agree."

Product unpredictability: Product unpredictability can have a detrimental effect on supply chain efficiency. Unpredictability and product complexity are two elements that contribute to product unpredictability. As a consequence, two items, each evaluating one of the construct's dimensions, were used to indicate product uncertainty. Responses ranged from "Strongly Disagree" to "Strongly Agree" on a 5-point Likert scale.

3.4 Data Collection

Over five months, data were obtained using an online survey. With the support of two supply chain professional organisations, the Association for Operations Management (APICS) and the Association for Supply Management, the survey was sent to supply chain professionals (ISM). Participants who completed the questionnaire were given the chance to win one among 5 \$50 Amazon gift cards as a reward for taking part in the poll. The researcher began by gathering information from a random sample of 2,480 APICS members. The informants chosen were middle or senior managers who have direct responsibility for their firms' supply chain management functions. APICS did not provide the e-mail addresses of the chosen members for privacy considerations. However, it consented to send out an email on the researcher's behalf requesting those members to participate. To encourage answers, the researcher promised to give APICS and curious members an executive overview of the findings. In mid-July, the poll invitation email was issued in two rounds, with the next round serving as a reminder one week following the first. There were several 83 answers. There was a 3% response rate. 791 of the 83 replies were eliminated owing to insufficient missing information, leaving 76 viable responses. Customers responded in droves, with 46 responding and suppliers responding in droves. Second, the researcher emailed the boards of directors and executives of 145 ISM members to invite them to participate in the study. They were also requested to transmit the survey's links to other ISM members who might be interested in the study topic. Lastly, all Executive Officers of each affiliate were approached via e-mails and phone calls to request their assistance in disseminating the survey to their affiliates' members. To entice participants, the researcher presented an executive summary of the report's results to ISM members and interested members. The researcher was permitted to distribute the poll to 14 affiliates. The ISM population provided a total of 97 answers. Nine of

the 97 replies were eliminated owing to insufficient missing information, leaving 88 viable responses. Customers responded in droves, while suppliers responded in droves. The APICS and ISM samples were compared in terms of supply chain parameters such as the length of the supplier relationship, yearly dollar acquisition cost in the supply chain, and the proportion of the responding firm's entire transaction value accounted for by the supply network. The comparison was carried out using analysis of variance (ANOVA). The findings revealed that the supply chain data gathered from the two supply chain organizations did not differ substantially in terms of those supply chain characteristics. In terms of respondent experience within supply chain management, there wasn't a statistically significant distinction between the two samples 92. As a result, there was no sample bias in the data, and the APICS and ISM samples may be pooled for further study. The ANOVA test results are shown in the TABLE 1.

Table 1 ANOVA Tests Comparing APICS and ISM Sample Responses

Factor	Source	Sum of Squares	Mean Square	F	Sig.
Relationship time	Between	1.12	1.12	0.56	0.46
	Within	324.50	2.00		
	Total	325.62			
Transaction volume (\$)	Between	1.48E+16	1.48E+16	0.07	0.79
	Within	2.98E+19	2.11E+17		
	Total	2.98E+19			
Relative transaction volume (%)	Between	0.03	0.03	0.57	0.45
	Within	7.47	0.05		
	Total	8.41			
Respondent's years of experience in SCM	Between	12.39	12.39	2.81	0.10
	Within	683.43	4.41		
	Total	695.85			

Non - response bias may be looked into by comparing information from both early and later people surveyed. However, the survey displays that the researcher used to collect

data did not record the time that each questionnaire was completed. Assessing nonresponse bias became challenging as a result of the researcher's inability to differentiate between responses received prior to and following the recall message. The ISM sample responded to the survey afterward than the APICS specimen, but the lack of statistically significant differences between the two specimens in terms of supply chain characteristics and respondent characteristics offered some proof that non-response bias had been unlikely to be an issue in the data.

The supply chain aspects and respondent characteristics of the supplier and customer samples were compared using ANOVA. The results of the ANOVA are displayed in TABLE 2. The findings showed that there were no statistically significant differences in the responses to those traits between the two sides. Since the two organisations' supply chains were connected in a similar way, the information provided by both parties may be looked at as a whole.

Table 2 ANOVA Tests Comparing the Supplier Responses and Customer Responses

Factor	Source	Sum of Squares	Mean Square	F	Sig.
Relationship time	Between	3.63	3.63	1.82	0.18
	Within	323.91	2.00		
	Total	327.68			
Transaction volume (\$)	Between	4.11E+16	4.11E+16	0.20	0.66
	Within	2.90E+19	2.06E+17		
	Total	2.90E+19			
Relative transaction volume (%)	Between	0.00	0.00	0.01	0.95
	Within	5.31	0.06		
	Total	5.31			
Respondent's years of experience in SCM	Between	4.86	4.86	1.08	0.33
	Within	697.50	4.50		
	Total	702.42			

Chapter 4: Data Analysis and Results

4.1 Measurement Model

Each was verified individually since the strategy uses both formative and reflective metrics. SC IT assimilation (ITINT), SC IT versatility (ITFLEX), SC have it (PROINT), SC information exchange capability (CREAT), SC information exchange capability (TRANS), SC knowledge management capability (RETEN), SC cognitive learning capability (APPL), as well as 95 environmental uncertainty are some of the reflective constructs (ENV) (Hair, Howard & Nitzl, 2020). SC collaboration (COL), SC operational performance (OPER), product uncertainty (UNPRED), reliance on SC partner company (DEPONP), and dependency on SC partner company (DEPONP) are a few examples of formative structures (DEPOFP). The process of rating reflective concepts was examined using the standards for evaluating internal logic, convergent validity, and reliability of the constructs (Gefen and Straub 2005). For formative assessment, validity & multi-collinearity were investigated.

The initial step was to utilise SPSS to measure the internal consistency of such regarding the surrounding. For each reflecting first-order construct, Cronbach's alphas were calculated. Except for STRAT (Cronbach alpha = 0.52), all constructions have Cronbach's alpha values of more than 0.6, which is the ideal value for experimental studies (Nunnally and Bernstein 1994). Following a principal component analysis of the five STRAT measures, strat1 and strat3 were loaded on two distinct factors and were separated from the remaining three STRAT measures. As a result, strats 1 and 3 were deleted from the scale to maintain the construct's internal coherence. STRAT's Cronbach's alpha was 0.62 after strat1 and strat3 were removed. TABLE 3 shows Cronbach's alpha values for each reflective construct.

Table 3 Test of Measurement Reliability

Construct	Cronbach's Alpha
STRAT	0.62
ITINT	0.83
ITFLEX	0.87
CREAT	0.91
TRANSF	0.94
RENT	0.88
APPL	0.90
PROCINT	0.92
ENV	0.74

The validity of the takes different forms was assessed using exploratory factor analysis. TABLE 4 displays the data-driven factor structure. According to the factor analysis results, there was 1 dimension for KM capacity measurements and one dimension for IT capability measures. The measuring model was updated to match the factor analysis findings. Following refining, the SC IT capability (ITCAP) construct became a first-order construct measured with 8 reflecting indicators, while the SC KM capacity (KMCAP) construct became a 1st order construct measured with 13 reflective indicators.

Table 4 Factor Analysis Results

	Components			
	1	2	3	4
STRAT2				0.40
STRAT4				0.75
STRAT5				0.64
ITINT1		0.67		
ITINT2		0.73		
ITINT3		0.79		
ITINT4		0.73		
ITFLEX1		0.73		
ITFLEX2		0.64		
ITFLEX3		0.73		
ITFLEX4		0.73		
CREAT1	0.74			
CREAT2	0.77			
CREAT3	0.75			
CREAT4	0.85			
TRANSF1	0.89			
TRANSF2	0.88			
RETEN1	0.80			
RETEN2	0.79			
RETEN3	0.75			
APPL1	0.78			
APPL2	0.80			
APPL3	0.76			
APPL4	0.76			
PROINT1			0.70	
PROINT2			0.78	
PROINT3			0.70	
PROINT4			0.61	
PROINT5			0.56	

Notes: The components were extracted using the principal components approach, and the rotation method was Varimax. All factor loadings less than 0.40 were eliminated.

To validate the filtered measurement model, confirmed factor analysis using SmartPLS (Purwanto et al, 2021) was performed. A repeating indicator model, or multi-hierarchy model, was established since the model featured two second-order components - SC relational capability (RELCAP) & SC performance (SCPERF). The model for the factor analysis confirmatory test contained seven control variables (98). The control variables were the firm's overall transaction volume (PERCT), the percentage of SC

transactions (PERCT), the number of years in the connection (TIME), cooperative norms (NORM), trust (TRUST), lengthy orientation (LONGTERM), enviro uncertainty (ENV), and item unpredictable nature (UNPRED).

The factor loadings weights were investigated for formative constructs. The weights of the four indicators on their particular construct were not significant. Col5 (t = 1.0), oper1 (t = 0.1), unpred1 (t = 1.0), or 2 (t = 1.61) were the four indications. Because oper1 has such a lighter density, it isn't a good indicator of OPER. As a result, oper1 was removed from the scale. Because of their relatively low t values, col5, unpred1, and unpred2 were kept. After oper1 was removed, the model fit weights and their level of significance was verified again. In addition to col5 and unpred1, all creative indicator outer values were significant this time. TABLE 5 shows the weights of the outer models.

Table 5 Outer Model Weights

Latent Construct	Indicators	Weights	Standard Error	t Values
COL	col1	0.40	0.07	5.38***
	col2	0.16	0.06	2.52**
	col3	0.16	0.07	2.25**
	col4	0.15	0.05	2.85***
	col5	0.07	0.07	1.03
	col6	0.31	0.07	4.33***
OPER	oper2	0.46	0.25	1.81*
	oper3	0.57	0.17	3.29***
	oper4	0.48	0.20	2.42**
UNPRED	unpred1	-0.56	0.54	1.03
	unpred2	1.04	0.56	1.87*

*p<0.1, **p<0.05, ***p<0.01

Multicollinearity across indicators can lead to nonsignificant items, which is troublesome for formative conceptions. The variance inflation coefficient (VIF) is a helpful

statistic for evaluating multicollinearity. VIF values less than 3.3 indicate a lack of cointegration (Diamantopoulos and Siguaaw 2006). For this dataset, all VIF tests were done in SPSS. VIF values were generated for five DEPONP indicators, five DEPOFP indicators, four OPER indicators, six COL indicators, and two UNPRED indicators. These five constructions have the greatest VIF scores of 2.7, 2.1, 1.9, 2.8, and 1.1, accordingly. All were less than the 3.3 criterion. As a result, multicollinearity is not an issue with formative constructions.

4.2 Test of Hypotheses

In SmartPLS, a route model was constructed to evaluate the hypotheses. Factor scores for RELCAP and SCPERF's first-order constructs were calculated as weighted composites of corresponding indicator values. RELCAP & SCPERF were then modelled as first-order entities with composite factor scores as indicators. The statistically significant difference in structural routes was tested using a bootstrap sample of 500 people. FIGURE 3-2 depicts the route analysis findings for the structural model. TABLE 6 summarises the findings.

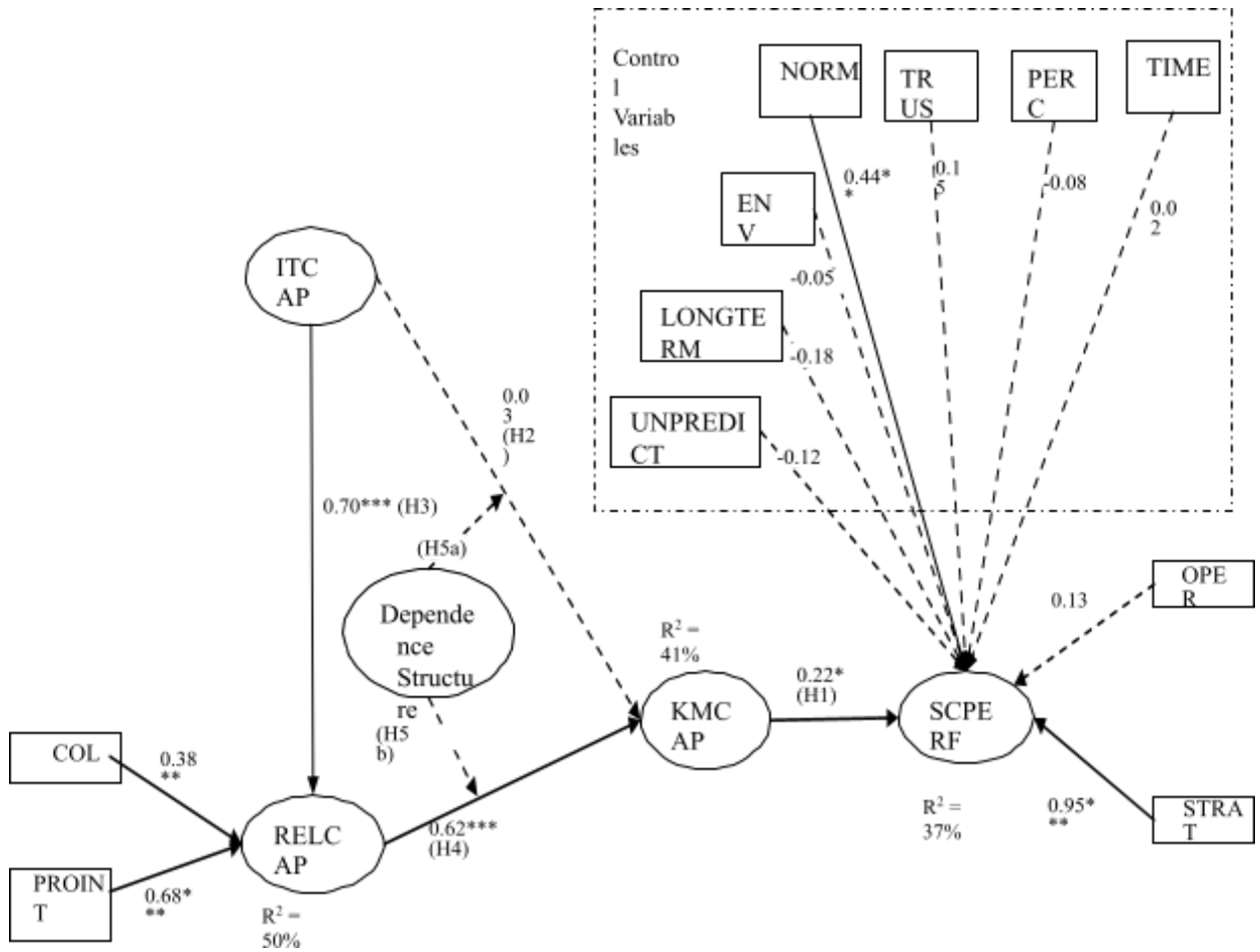


FIGURE 3-2. Path Model Results

* p < 0.1
 ** p < 0.05
 *** p < 0.01

Table 6 Path Analysis Results

	Path Coefficients	Standard Error	T statistics
	RELCAP		
PROINT	0.68	0.16	4.44***
COL	0.38	0.17	2.21**
ITCAP	0.70	0.06	12.58***
<i>R</i> ²	<i>0.50</i>		
	KMCAP		
ITCAP	0.03	0.12	0.24
RELCAP	0.62	0.12	5.08***
<i>R</i> ²	<i>0.41</i>		
	SCPERF		
OPER	0.13	0.28	0.47
STRAT	0.95	0.21	4.44***
KMCAP	0.22	0.12	1.87*
<i>R</i> ²	<i>0.37</i>		
Controls			
ENV	-0.05	0.13	0.41
LONGTERM	-0.18	0.15	1.20
NORM	0.44	0.16	2.84***
PERCENT	-0.08	0.08	1.00
TIME	0.02	0.10	0.26
TRUST	0.15	0.15	1.00
UNPREDICAT	-0.12	0.09	1.36

* p< 0.1
 ** p<0.05
 *** p< 0.01

Path coefficient showed that the model explained 37% of the variance for supply chain performance. All except one path in the model (ITCAP KMCAP) was important, offering assistance for hypothesis 1, 3, and 4. The performance of the supply chain framework was not overburdened by operational performance. Finally, the cooperative norm was discovered to be the only variable that was substantially connected with supply chain performance.

Because the relationship between operational and SC efficiency was not statically important, performance cannot be used to predict SC performance. This finding revealed that

SC performance should not be formed by combining operational and strategic 105 performance. As a result, a second route model was developed, with SC operating efficiency and SC strategies required to serve as endogenous performance structures. Each of the performing components' interactions with KMCAP was investigated. The outcomes are shown in FIGURE 3-3. The findings revealed that KMCAP has a considerable influence on both SC's operational and strategic performance. The model can explain 37% of the variation in SC strategic and 17% of the variation in SC operational performance.

4.3 A post-hoc power analysis

A series of regression models are used to estimate PLS models (Chin 1998). As a result, the strength of PLS path analysis may be evaluated like evaluating power in regression analysis. To calculate power, the greatest number of predictors - formative indicators or pathways from Latent Variables exogenous - should be employed. SCPERF contained 9 exogenous variables, which was the highest number of variables in this model. G*Power was used to do a post-hoc power analysis. A two-tail test using alpha 0.05 and a mean effect size with R² 13% was set. The test's statistical power was 88% when the sample was 164. A post-hoc statistical test for independent - samples t was performed to assess the efficacy of the inter-comparison test. A two-tail experiment with an alpha of 0.05 was chosen. A d 0.5 medium effect size was employed. Its power was 87% when the size of the sample was 100 and 64. When moderate effect sizes were considered, the findings showed that the route analysis provided an appropriate power level to detect true effects (Zhang et al., 2019).

4.5 Discussion

The empirical research's findings suggest that SC IT infrastructure competency supports SC relationship competency, which in turn improves supply chain performance both

strategically and operationally. This section analyses the findings and discusses how they may be applied in practise.

According to the study's findings, organisational learning capacity is not a second-order construct denoted by organisational terms like knowledge-generating capacity, exchange of information capability, effective learning, and knowledge capability. Instead, it is a human construct. The indications from all of the four factors of knowledge management competency greatly affected one component in the main principal components. The results of this study suggest that supply lines that are effective in one of the 4 main learning processes—creation, transfer, utilisation, and preservation—are more likely to be successful in the other three. These results provide organisations with a framework for empirically understanding their distribution internet information management skills.

The information obtained via supply chain exchanges is one type of complementary asset highly valued by participating companies. By collaborating to manage, mobilise, and utilise knowledge-based resources, networks may be increased throughout time, based on the relational method. The findings corroborate this relational approach by showing a positive association between supply chain knowledge creation competency and performance. The supply chain's strategic and operational efficacy was assessed. Operational efficiency, which is involved with the regular running of a supply chain, was quantified using operations expenditures, fulfilment time, the percentage of products satisfying requirements, and demand forecast performance. The strategic effectiveness of a supply chain affects how successful it will be over time. The study shows that what a supply chain's ability to manage its information is crucial to improving both its day-to-day operations and also its strategically targeted life objectives.

The potential of SC IT architecture was examined from two angles: connection and flexibility. Supply chain companies may link application areas and communicate reliable data courtesy to SC IT integration. SC IT flexibility is the level of readiness of SC IT software and hardware programmes to be modified to meet new company needs. Despite the fact that the research revealed a close relationship between SC IT connectivity and flexibility, SC IT architectural competence was suggested as a creative second construction with these two dimensions. The two characteristics are the end product of SC IT capabilities, a key process. According to some IS study results (Birkel & Hartmann, 2019), the degree to which data across diverse functions is consistent and understandable determines how easily IT infrastructure may be updated or expanded in response to company evolution.

The findings demonstrate that SC IT proficiency has a considerable influence on SC relationship abilities, including supply chain collaboration and integration. According to Birkel a supply chain's relational competency is defined as the ability of supply chain firms to jointly deploy complementary relation-specific assets, such as human assets, data, and procedures. An analysis of the hoisting weight training for the two primary aspects of SC correspondence framework found that supply - chain integration is only slightly more important than collaboration, despite the fact that both trying to measure devices, development pipeline and collaboration, are essential to supply chain interpersonal capability. Through shared data standards and tightly connected applications, the SC IT connection and flexibility provide a seamless environment to ease process flows across organisations. Linked and adaptable IT infrastructure improves information flow, allowing businesses to find possible cooperation partners' competencies or assets. The necessity for collaborative supply-chain operations is highlighted by efforts made by supply chain companies to improve SC IT capabilities.

The results show that relational competence completely mediates the influence of IT growth on supply chain knowledge management system, regardless of the supply chain prediction of the dependent variable, in contrast to the connection that is here provided. In this study, we emphasise the significance of especially applicable expertise in achieving performance gains from the growth of knowledge management skills. We may better understand how relational capacities act as mediators by using the knowledge-based view (KBV). According to KBV, the capacity to manage knowledge is a more improved organizational competency that is based on the knowledge of different persons, groups, and divisions (Novianti, 2019). Employee initiatives or processes which mobilise employees' knowledge are likely to enhance a company's management competence since workers act as that of the conduit for knowledge management. With the adoption of SC processes, supply chain visibility is improved, making it easier for 116 people to comprehend and control supply chain operations. By collaborating to establish product standards, for instance, businesses may communicate both explicit and implicit data across the supply chain. As a result, supply chain companies must first focus on building partnerships that are based on integration and collaboration if they are to benefit from using IT to handle intangible knowledge assets.

Overall, the findings support both the asset and relational points of view by emphasising the importance of supply networks' capacity to use complementary resources to achieve competitive supply-chain performance. The study also has effects on supply chain management tactics. Supply chain knowledge resources are crucial resources that, when managed collaboratively, will add to their enhanced long-term outcomes (Gölgeci, & Kuivalainen, 2020). When searching for possibilities to hire experts, companies with supply chains should look outside their boundaries and pay more attention to distribution channels

because a firm's success is heavily reliant on the effectiveness of its supply chain. Businesses should include intangible knowledge assets even if the exchange of commodities and services has traditionally been the main objective of supply chains. The perspectives, expertise, judgments, and concepts of supply chain relationships should all be consistently under control. According to the study's results, supply chains that value data and engage in knowledge management are more likely to succeed in the long term by promptly responding to market changes. Additionally, this study provides empirical evidence in support of the notion that supply chain IT-enabled cooperation and integration lay the foundation for the development of knowledge management expertise. SC and IT are crucial for optimising supply chain procedures and encouraging collaboration.

4.6 Limitations and Future Research

The study's shortcomings and future directions for research are explored. Utilizing arbitrary supply chain efficiency measurements was the first step. Since people surveyed are anonymous, it is difficult for the researcher to obtain objective data to support the subjective judgements. In a later study, measurable performance measurements may be included using a different approach. Second, data were only gathered through one side of each SC contact in order to assess supply chain architecture. In order to ensure that the responses were representational of the supply chain, the respondents were asked to select a distribution network connection between their firms and one of their companies' customers or suppliers with that they were most familiar. Future research may use two businesses as the data collection unit to gather information by both ends of such a distribution system dyad. The model might also incorporate the type of distribution system IT and information to increase our understanding of IT-enabled organisational learning capabilities in a variety of settings.

Chapter 5: Conclusion

Along with the transmission of commodities or services, supply chains also involve the flow of information. Partners within the supply chain might provide companies more knowledge-based resources. Given that supply networks constitute a key gauge of performance in today's global marketplaces, measures to assist supply chain enterprises in adapting and gaining a competitive edge just at supplier level are crucial. The goal of this dissertation is to shed light on the developing but little-researched area of distribution network IT-enabled organisational learning. In supply chain organisations, the research focuses on the technical underpinnings and performance benefits of knowledge management (Núñez-Merino et al., 2020). Using only a supply chain dyad as a lens, the dissertation first offers survey data that investigates the link between the IT capabilities and data management capacity of the supply chain as well as the influence of knowledge process management on supply chain performance. In accordance with the findings, distribution network enterprises' capacity to handle knowledge resources cooperatively is a crucial prerequisite for supply chain organizational orientation. Additionally, supply chains may manage knowledge because of their IT capabilities and relational capabilities.

The implications of utilising KM-IT in handling the external and internal information of supply chain organisations were investigated using a simulation model. By simulating the usage of KM IT, a specific kind of production process IT, both inside and outside of firm borders, the simulated research, which is focused on the focal firm in a distribution system dyad, broadens the range of the questionnaire survey. The internal and external management tactics employed by the organisations are also included in the simulation study, which expands the scope of the empirical research. A simulation study that looked at supply chain connections to determine the interconnected impacts of KM IT and businesses' external and

internal data management techniques on the firms' longterm average employee knowledge level. Because workers are the primary source of information, it is possible to assess a company's knowledge capability by examining the level of knowledge held by the typical employee. The findings demonstrate that boosting long-term employee knowledge levels in target organisations is more successful using electronic communications systems (ECN), a kind of KM IT that encourages employee contact, than with knowledge bases & portals (KRP). This result supports the empirical study's conclusion that supply chain IT enhances knowledge management competency by enabling and using relational assets in the supply chain. This overall result supports both the relational & resource-based conceptual points of view. The simulated research also demonstrates the interaction between a firm's internal and external OL strategies. When a company's internal training is delayed, the benefits of fast learning from supply chain participants are highest. This is especially true when the smaller company is part of a symmetrical distribution chain or has an asymmetrical connection with the bigger company. The two topics that comprise my dissertation's research topics and main findings are shown in TABLE 7.

Table 7 Summary of Research Questions and Findings

	Empirical Study	Simulation Study
Research Questions	How does a supply chain's IT competence influence its knowledge management capability? What impact does a supply chain's KM	How do KM IT and organisational learning tactics impact organisations' knowledge outcomes when they learn from supply chain partners?

	capacity affect its performance?	
Main Findings	<p>1) The operational and strategic role of supply chain is positively impacted by the knowledge management skills of the supply chain.</p> <p>2) SC IT skills can only have a positive impact on SC ability to manage knowledge when supply chain links are asymmetrical or have little dependence.</p> <p>3) In all types of supply chains, SC relational capability affects SC knowledge management skills.</p>	<p>1) When it comes to promoting both internal and external learning in enterprises, ECN is a more effective KM IT than KRP. The proportional magnitude of the businesses in the distribution chain, however, dictates the optimal level of ECN utilisation. Smaller organisations are likely to benefit from a balanced use of ECN & KRP in internal and external learning in asymmetric supply chain links.</p> <p>b) Big firms with asymmetries in their supply chains have a higher chance of reaping the rewards of broad use of ECN for both internal and external learning.</p> <p>2) A organization's internal and external OL strategies are connected. A company's internal</p>

		<p>information probability may be low, but if it has a reasonably high learning probability, it may be able to gain the most information.</p>
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Overall, this dissertation advances our understanding of supply chain IT's a function in managing knowledge assets in supply chains. First, the empirical analysis articulates SC IT's function in enabling knowledge management and, as a result, providing a competitive advantage. Much IS research has discovered an indirect association between IT and performance. IT influences business and supply chain efficiency because it allows them to mobilise additional organisational resources. From a knowledge standpoint, this dissertation demonstrates that relational capacity and knowledge management competence are crucial for IT to improve supply chain performance (Cole et al., 2019). This knowledge may help supply chain companies deploy and operate their IT infrastructure more successfully. The scientific work also offers a fresh look at supply chain performance. The theoretical and practical value of technology knowledge in supply chains is shown by the association between knowledge management capabilities and performance. The findings may also be used to assist researchers and practitioners in developing knowledge competence

assessments for supply chain collaborations (Ivanov, 2021). The simulation study's findings help theory building in IT-enabled interfirm learning by identifying crucial inter-organizational learning components and the methods through which those factors interact. A framework is designed to assist supply chain organisations in selecting acceptable both internal and external management strategies, as well as in developing an organizational learning technology infrastructure to support those strategies. Finally, the simulation study aids practitioners in their knowledge of how to use businesses' relationships with supply chain suppliers to produce long-term technological knowledge gains.

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Appendix

Appendix A: Transcript 01 - Interview with General Manager

I.1 Digital tools used within SCM

Digital advancements have touched most phases of the commercial world from raw materials to end customers and throughout the processes that help the materials in meeting the end users. Today there are IoT tracking solutions, warehouse management systems, blockchain, robots, drones, artificial intelligence, machine learning, predictive analytics, 3D printing tools, software for planning, procurement, manufacturing, inventory, warehousing, and the list goes on.

I.2 How Digital Tool affected SCM after Integration

There are different ways that each tool has impacted the SCM since its integration. Some tools have reduced costs, some have reduced processes, and some have increased costs but increased visibility and information sharing, and so on. But the bottom line is that each technology that has penetrated globally has had positives attached to it which is why it received that level of penetration in the first place.

I.3 How Businesses benefit from Technology usage in Supply Chains

Again, each type of digital tool has its own ways of benefiting the supply chain. Blockchain increases transparency and visibility within the process of the supply chain. The internet of things upends traditional practices within supply chains and improves communication while delivering insights for decision making. AI, machine learning, analytics, and similar digital tools improve operations, reduce time, and improve deliveries, operations, and processes to meet customer and stakeholder needs. Robots and automation related digital tools reduce

costs, increase efficiency, and boost accuracy. 3D printing gets you close to customers to meet their demand and needs in the minimum possible lead times.

I.4 Difficulty in Implementation of New Technology

Anything that is not planned well is hard. Proper planning, past experience, and knowing your people will assist in smooth transitions. Decisions that are made by leadership flow down the hierarchy and so should the strategy so that everything is done with planning to minimise hardships of transition.

I.5 Transition from Analogue to Digital Tools

The transition was amazing and still is. Today we are not using 3D printing and manufacturing something that a 3D printer could effectively do is like an analogue. The transition would be amazing but in due time. Having said that not everything is digital but soon will be I believe. The transition is ongoing on multiple fronts, and it is always amazing.

I.6 Implementation leading to Organisational Downsizing

Again, anything that is not planned well is hard and has consequences. If the transition is well-planned, it will not necessarily lead to downsizing. Even if it does it would only mean for some time till the benefits start kicking in and you need more human resources for your scaled-up work.

APPENDIX B: SURVEY INSTRUMENT

I. Welcome Message

Thank you for logging onto this URL to participate in my survey!

The survey's goal is to find out more about the advantages supply-chain management systems have for businesses. This study will highlight important aspects of supply chain information systems and examine how utilising them affects an organization's capacity for commercial performance across a variety of supply chain relationships. I appreciate you offering your expertise in supply chain management; it will be very beneficial to my dissertation study.

You are under no obligation to participate in the study and are constantly free to exit at any moment by closing your web browser. The header of each page has a counter that shows how much research you've already done. The survey should take you between ten and twenty minutes to complete. The information gathered will be kept strictly confidential and won't be used to trace any particular respondent. The analysis and presentation will be performed in average throughout.

The Institute for Supply Management (ISM) and also the Association for Operations Management (APICS) would provide its members with a summary of the survey's findings and suggestions for comparison shopping and member outreach. I'm happy to provide copies of the final speech to interested parties upon request. The survey findings will be published in academic and professional publications for supply chain management and information technology.

As a thank you and appreciation for your time, all survey participants will have the option of entering their e-mail addresses into a random lottery to win one of five prizes.

If you have any questions or comments regarding this survey, please contact me at **704-444-666**.

Sincere

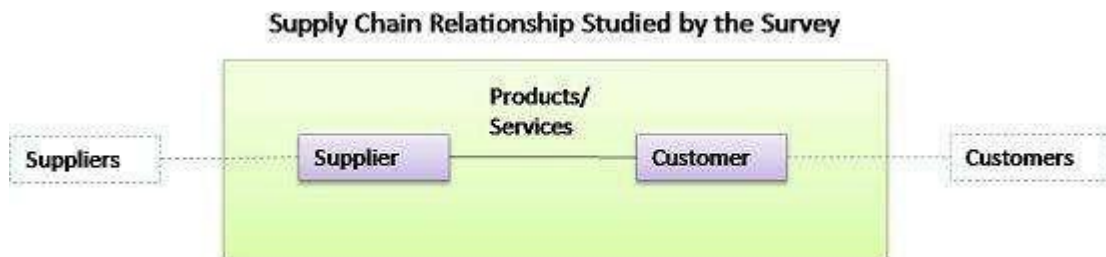
ly,

XXX

II. Survey Introduction

For this study, a supply chain connection is defined as a business-to-business relationship between two businesses where one firm acquires goods or services from the other to provide offers for a downstream market. In other words, the supply chains that trade goods and services associated with manufacturing are the focus of this survey. This poll excludes business partnerships involving non-production goods and services (such as office supplies for internal use).

The figure below helps illustrate the supply chain relationship that this survey focuses on.



Please consider a product line or service in a supply chain between your company and another company that you are most familiar with (i.e., the product line or service about which you know the most or for which you have direct responsibility).

III. Measures

SC KM Capabilities

1. Please explain how your business and the [SC Partner Firm] are involved in each of the upcoming phases.
2. encouraging cross-functional conversation and activities
3. Developing new knowledge from the supply chain partner's expertise
4. Endorsing a range of viewpoints (e.g., conducting brainstorming meetings, establishing joint teams, formation of special interest groups)
5. Including various information sources and kinds in the supply chain
6. Knowledge-sharing with a supply chain partner
7. You and the supply chain partners discuss concepts and ideas.
8. Documenting information, ideas, and experiences related to the supply chain
9. Maintaining the veracity and correctness of the supply chain data
10. Thinking back on previous experiences and occasions (such as pricing fluctuations, demand shifts, and supply chain partners' reactions to policy changes)
11. Using past supply chain partners' suggestions more effectively to fortify present connections
12. Linking information sources to issues and problems
13. Examining the relationship to the supply chain and, if necessary, altering how the

connection is maintained.

14. Developing action plans based on new consumer, technology, and supply chain information.

Scale: 1 = 0% - 20% of the time; 2 = 21% - 40% of the time; 3 = 41% - 60% of the time; 4 = 61% - 80% of the time; 5 = 81% - 100% of the time

Operational SC Performance (Except item 5)

Please assess the performance metrics listed below for the supply chain between your business and [SC Partner Firm] for the type of product/service previously mentioned (in contrast to the industry average).

1. The time it takes to finish orders.
2. The proportion of delivered goods or services that are up to par.
3. Supply chain operational expenses
4. Accuracy of demand forecasts for a certain product
5. An increase in sales volume from the prior year

Scale: 1 = Significantly Lower than Industry Average; 2 = Lower than Industry Average; 3 = Same as Industry Average; 4 = Higher than Industry Average; 5 = Significantly Higher than Industry Average

Strategic SC Performance

1. Rate how much you agree or disagree each of the assertions below that characterise the supply chain among your company or the [SC Partner Firm] in terms of your business.

2. The distribution network might be quickly modified to incorporate new products or services.
3. The supply chain finds it challenging to adapt to changes in the commercial environment.
4. The supply chain had boosted the marketability of our business. (For clients)
5. The supply chain has increased competitiveness for [SC Partner Firm] in the market. (Only for suppliers)
6. The objectives of the supply chain have been met.

Scale: 1=Strongly Disagree; 3 = Neutral; 5 = Strongly Agree

SC IT Infrastructure Capabilities

1. Please indicate which of the following claims about the usage of information technology in the given supply chain applies to you.
2. Since the data is only input once, both parties may access it.
3. Real-time communication between the [SC Partner Firm] and our company's supply chain software. Software for supply chains' transactions and planning are two examples.
4. The great majority of business-to-business software programmes for supply chains are integrated.
5. All supply chain software programmes are cross-platform compatible.
6. The supply chain applications are scalable.
7. Supply chain applications are made to respond to changing company needs, such as modifications to product specifications and changes to transaction

volumes.).

8. It is simple to modify supply chain software to enable the brand-new supply chain operations.
9. The way supply chain applications are organised allows for speedy technological changes.

Scale: 1 = 0% - 20% of the time; 2 = 21% - 40% of the time; 3 = 41% - 60% of the time;

4 = 61% - 80% of the time; 5 = 81% - 100% of the time

SC Relational Capabilities

1. Please rate how closely each of the following statements describes the supply chain including your business and also the [SC Partner Firm].
2. The enterprises collaborate on supply chain methods and procedures.
3. Regular supply chain protocols are codified to enable clear communication between firms.
4. The information and material flow via the supply chain has been simplified.
5. The supply chain operations and routines of the organisations are intertwined.
6. The supply chain's various businesses communicate well with one another.
7. Our business works in conjunction with [SC Partner Firm] to handle supply chain logistics.
8. Our company & [SC Partner Firm] collaborate to create delivery and manufacturing schedules.
9. We work together on performance metrics with [SC Partner Firm].
10. Demand estimations are created in collaboration between our company and the

[SC Partner Firm].

11. Our business and [SC Partner Firm] work together to develop cutting-edge brands for the collaboration. Our firm and the [SC Partner Firm] work together to perform competitive analysis and formulate strategies.

Scale: 1 = 0% - 20% of the time; 2 = 21% - 40% of the time; 3 = 41% - 60% of the time;
4 = 61% - 80% of the time; 5 = 81% - 100% of the time

Buyer-Supplier Dependence (For Customers)

1. Please rate your agreement or disagreement with all of the following comments.
2. The [SC Partner Firm] only makes a major contribution to the product or service portfolio of our business.
3. The cooperation of our organisation like [SC Partner Firm] is crucial to achieving our performance goals.
4. Other vendors may replace [SC Partner Firm] as our company's provider of this line of goods or services.
5. Switching to a new supplier's products or services would be quite inexpensive.
6. If our partnership as [SC Partner Firm] ended, we would find it difficult to make up for the lost profits and sales.
7. The [SC Partner Firm] views our company as a big customer for this kind of good or service.
8. In order to achieve the goals established by the [SC Partner Firm], our connection with them is essential.
9. Other businesses might supplant us as customers of [SC Partner Firm product]

in the future.

10. If another company were to take our position as the client for the particular product, the [SC Partner Business] may only pay minimal costs.
11. The [SC Partner Firm] would have trouble making good the sales and earnings that our company gained if indeed the [SC Partner Businesspartnership] stopped with us.

Scale: 1=Strongly Disagree; 3 = Neutral; 5 = Strongly Agree

Buyer-Supplier Dependence (For Suppliers)

1. The [SC Partner Firm] is a crucial client for the good or service.
2. In order to achieve our performance goals, our cooperation in [SC Partner Firm] is essential.
3. Some potential customers could decide to use this product or service instead of [SC Partner Firm].
4. If we found another company to be the client for the same product line or service, we would spend much less money.
5. If our relationship to [SC Partner Firm] were to an end, we would find it difficult to replace the sales and profits they made.
6. [SC Partner Firm] receives a significant amount of business from our organisation.
7. For a [SC Partner Firm] to achieve its performance goals, a [SC Partner Firmconnection] with our company is essential.
8. Instead of our company, other companies may give the trade to a [SC Partner

Firm].

9. The [SC Partner Firm] would incur little costs if it switched to a different vendor again for specific product.
10. If indeed the [SC Partner Businesspartnership] with our company terminated, [SC Partner Firm] would find it difficult to make up for the lost sales and revenues.

Scale: 1=Strongly Disagree; 3 = Neutral; 5 = Strongly Agree

Control Measures

Transaction Volume

1. What was the total dollar amount of transactions between our company and [SC Partner Firm] for such mentioned previously product line/service in the previous year?
2. How much of your company's total purchase price was accounted by the [SC Partner Firm] product line/service in the previous year?

Relationship Time

1. How often has your company done business with [SC Partner Firm]?
___Years

Cooperative Norms

1. We have a cooperation partnership with [SC Partner Firm].

Scale: 1=Strongly Disagree; 3 = Neutral; 5 = Strongly Agree

Long-term orientation

1. Our business and [SC Partner Firm] have long-term partnership objectives. Scale: 1=Strongly Disagree; 3 = Neutral; 5 = Strongly Agree

Trust

1. Our firm considers the relationship with the [SC partner firm] as built on trust.

Scale: 1=Strongly Disagree; 3 = Neutral; 5 = Strongly Agree

Environmental Uncertainty

1. What's the market situation for the service or product that your company and [SC Partner Firm] trade?
2. Consumer preferences and wants change fast.
3. Market rivals frequently use aggressive tactics to increase their share of the market.
4. This industry has seen major product/service innovations in recent years.

Scale: 1=Strongly Disagree; 3 = Neutral; 5 = Strongly Agree

Product Unpredictability

1. How would you describe the goods or services exchanged between your business and [SC Partner Firm]?
2. The line of goods or services is frequently fairly intricate.
3. The specifications for the product line or service are uniform

Scale: 1=Strongly Disagree; 3 = Neutral; 5 = Strongly Agree