Tampere University of Applied Sciences

The Use of Technology for Enhanced Supply Chain Performance in Global Logistics: Efficiency and Connectivity.

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ABSTRACT

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The recent emerge of technology changed the way businesses operate. The impact can be seen in many industries including manufacturing and transportation. The focus of multinational corporations is on meeting the needs and requirements of customers whilst improving return on investment, and efficiency of its operations.
Supply chain is one of the key business processes, therefore companies should take advantage of disruptive technologies including Internet of Things (IoT), robotics, and Artificial Intelligence (AI).

IoT allows companies to communicate and connect in real time, supporting the decision-making process, increasing the visibility, and enhancing the supply chain management processes. Industry 4.0 is transforming the manufacturing sector through technologies such as IoT, bringing many benefits to companies including increased efficiency, and improved quality.

Technology in supply chain management creates competitive advantage, improves performance, whilst decreasing the risk. Moreover, the demands from customers can be met more efficiently through the integration of agility, collaboration, and sharing of information.
Adoption of IoT, RFIDs, and sensor technologies improves the visibility, traceability, resource planning whilst allowing companies to meet the demands of customers.

Lastly, the emerge of companies such as Amazon, shows that the heavy use of technologies is crucial for firms in order to stay competitive and meet the demands. To do so, heavy investment in automated warehouses led Amazon to ensuring efficient supply chain through the connectivity between physical infrastructure and digital technologies.
The advancements in technology allow Amazon to reach its peak efficiency and flexibility, offering fast delivery of items to the customers.

Key words: technology, supply chain, global logistics, amazon

CONTENTS

GLOSSARY or ABBREVIATIONS AND TERMS (choose one or other)

TAMK	Tampere University of Applied Sciences
cr	credit
AWS	Amazon Web Services
AS	Automated Storage
B2B	Business to Business
HR	Human Resources
IoT	Internet of Things
IT	Information Technology
MNC	Multinational Corporation
PERT	The Program Evaluation and Review Technique
RFID	Radio Frequency Identification
ROI	Return on Investment
SCM	Supply Chain Management
VR	Virtual Reality
3PL	Third-party Logistics

1 INTRODUCTION

1.1 Thesis Topic

The constantly changing business environment, and the desire of businesses to meet customer needs, has led companies to turning towards advanced technological innovations. The importance of technological advancements is crucial for companies in order to be sustainable and to achieve success. The technology offers process integration that enables companies to increase their operational performance. (Fatorachian & Kazemi, 2020).

Recent emerge of technology has had its impact on all industries including manufacturing, transportation, food and beverage or health. The technologies that can potentially influence global supply chain include, but are not limited to machine learning, virtual/augmented/extended reality, Internet of Things (IoT), blockchain, and 3D printing. Therefore, the connection between supply chain performance and technology is clear. (Pagano & Liotine, 2020, 37-38).

Technology is being taken advantage of by businesses for improved return on investment (ROI) by better utilisation of sources such as equipment and people; efficient and reduced inventory levels, improved cycle times; and by improvements to lead times, flexibility and availability of products based on customer demand. Furthermore, this leads to improved customer base and increased value. (Pagano & Liotine, 2020, 37-38).

In order to support business strategy, supply chain as a key business process can be used. Challenges such as company-supplier communication, sourcing, inventory, and risk can be tackled by use of technology. (Pagano & Liotine, 2020, 8-9).

According to Rejeb, Keogh, and Treiblmaier (2019), in order to help companies monitor, track, and observe their products and processes, Internet of Things (IoT) can be helpful. Furthermore, the utilisation of IoT can be seen in monitoring of a product in transportation, manufacturing, and warehousing. Moreover, Rejeb et al. (2019) argues that IoT together with blockchain can contribute to enhanced transparency of value chain and increase in trust in B2B, whilst increasing the

efficiency and effectiveness of supply chains. (Rejeb, Keogh & Treiblmaier, 2019).

Weng (2020) argues that the devices of IoT give an information about information on product traceability including humidity, temperature, or chemical composition whilst giving a better idea about the product to the customers.
Moreover, Waters (2007, 177) argues that one of the critical aspects of supply chain management (SCM) performance is information, knowledge, and data leading to planning, organising, and coordinating the processes and operations. Additionally, information technology (IT) is being used in order to improve the processes and enhance productivity and efficiency, whilst reducing the costs of operation.

1.2 Thesis Objective, Purpose, and Research Questions

The main focus of the thesis is to analyse and understand how multinational corporations (MNCs) can take advantage of technology for enhanced, more efficient supply chain management.
The aim of the thesis is to investigate how technology can be used as a supporting tool, and to gain clear picture of the current status and future challenges related to the use of technology in supply chain.
Additionally, the aim is to analyse and understand the role of technology in context of global logistics for enhanced supply chain. The thesis evaluates subjects such as Internet of Things (IoT), supply chain practices, and global logistics. The focus of the thesis is to provide recommendations on how the technology can improve efficiency and connectivity in multinational corporations (MNC).

The thesis investigates following research questions:

- How can adoption of technology and particularly Internet of Things (IoT) improve supply chain efficiency and connectivity in multinational corporations (MNCs)?
- What are the key benefits to the organisations who use technology?
- How the use of advanced technologies, including IoT, can transform the experience for customers through improved warehouse operations?

- How Amazon's strategic technological initiatives contributed to Amazon becoming the market leader in e-commerce?

1.3 Research Data and Methods

The thesis consists of two parts. First part focuses on literature review, with the use of available books and articles for completing theoretical framework. The focus of the thesis is on explanation of the technologies used in supply chain and global logistics operations, with identification of the leading technologies.

Second part focuses on case study with the technology company Amazon. Amazon as one of the biggest companies in the world, heavily leverage the use of technology in its operations, providing customers with reliable and fast delivery of goods.

The chosen research method is qualitative research. The data is being analysed by theoretical model such as statistics, and text. Furthermore, the data is being analysed by applying the theory into practice.

The data is collected from secondary sources such as libraries, market research providers, government, private companies, educational institutions, and research articles.

2 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Information Technology

According to Marchewka, and Setterstrom (2024) in the United States the investment into technology reached $1.94 trillion in 2021, as the IT systems are crucial to the company's success. Moreover, Soriano (2016) argues that there are no limits to the investments into information technology by firms, and the numbers are rising each year as companies are trying to achieve the success that leading companies achieved.

Balakrishnan and Ramanathan (2021) argue that the usage of the technology in supply chain grows each year due to the globalisation and is further fuelled by the internet, social media, mobile devices, and networks. The digitalisation helps to create value with increased revenue by 9%, 26% impact on profitability, and market valuation at 12% more. (Balakrishnan and Ramanathan, 2021).

As an essential enabler of effective supply chain management, Information Technology plays crucial role in managing risks and helping with adaptability to changes. The objective of Information Technology in Supply Chain Management (SCM) is to provide visibility and accessibility of information, providing a single point of contact for data, allowing collaboration whilst enabling decision making based on whole information. This leads to better coordination between demand and supply but also with external partners in the supply chain, therefore, IT is essential in order to properly manage supply chain. (Varma and Khan, 2014).

Supply chain has been greatly impacted by digitalisation, as digital technologies serve a fundamental platform for conducting business in supply chain domain, allowing collaboration with other firms. (Balakrishnan and Ramanathan, 2021).

The new ways of managing supply chain are emerging due to the advancements in Information Technology (IT). Dong, Xu, and Zhu (2009) argue that the biggest companies such as Dell or Wal-Mart are taking advantage of Information Technology in order to coordinate their supply chain processes, such as procurement, production, sales, customer service, and information sharing.

The impact of the advancements in the technology can be seen across various sectors including energy, food and beverage, transportation, and manufacturing to only name a few. Technologies such as Internet of Things (IoT), machine

learning, blockchain, robotics, or big data influence supply chains globally, therefore, the correlation between the performance of a company and the technology they implement in their operations is clear. (Pagano and Liotine, 2020).

Pagano and Liotine (2020) argue that technology enabled improvements in supply chain and logistics operations, however, as the times are changing and so are the trends, the changes in society and business can be seen with social media, cloud computing, and ecommerce drastically changing the landscape of supply chain and logistics operations. The technologies that change the landscape include maturing technologies, which aim to improve efficiency and service including sensors/telematics; data warehouse and integration; optimisation software; automated storage (AS); growth technologies (growth rate at about 20% with prediction to increase in the next 3-5 years) including data analytics; social media; wearability, and mobility. Emerging technologies include (growth rate at 10%), considered as disruptive include drones, 3D printing, and autonomous vehicles. Lastly, the exponential technologies which are relatively new, including Internet of Things (IoT); Blockchain; Virtual Reality (VR); and machine learning. Moreover, using emerging technologies can lead to money and time savings for the business. (Pagano and Liotine, 2020).

Lastly, Pagano and Liotine (2020) argue that the biggest impact on supply chains globally is seen in automation and robotics, big data, IoT, AI, drones and driverless vehicles.

2.1.1 Internet of Things (IoT)

Haddud, DeSouza, Khare, and Lee (2017) define Internet of Things as “the integration of physical objects communicating with one another and through the Internet to achieve some useful objectives” (Haddud, DeSouza, Khare, and Lee, 2017). Moreover, Haddud et al., (2017) argues that the information regarding the supply chain and flow of goods and services is exchanged in trusted and safe way, bringing the benefits to the business. Due to the IoT, the operational processes within a firm can be improved, costs can be reduced, and risks can be reduced or eliminated through transparency, flexibility, traceability, scalability, and adaptability of the system. However, there are some challenges that need to be overcome in order for the IoT to bring results such as technical and social issues.

Three elements that make IoT include web-based, things-based, and semantic-based. Furthermore, with the ability to enable ubiquitous and pervasive computer scenarios, IoT is one of the most disruptive technologies. Alternatively, IoT can be describes as a network of software, hardware, database, sensors, and systems that are all cooperating in order to benefit humanity. Through information sharing and coordination of decisions, IoT enables physical objects to see, think, hear, and perform tasks. Underlying technologies including ubiquitous and pervasive computing, communication technologies, Internet protocols, and applications allow these physical objects to become intelligent. Moreover, Haddud et al., (2017) argues that some elements of IoT will be incorporated in more than 50% of new businesses, with the expected growth in logistics, retailing, energy, manufacturing, home appliances, insurance, and airlines to only name a few. (Haddud et al., 2017)

According to Pagano and Liotine (2020) a good example of IoT are drones, electronic shelving, or AS and RSs, as IoT is the network that connects those objects to the internet.

Pagano and Liotine (2020) argue that the IoT impact on supply chain is significant, including improvement of operational efficiencies such as forecasting, vendor relations, inventory, or scheduled maintenance, and revenue opportunities. However, in order for IoT to be effective, global supply chains should be connected. (Pagano and Liotine, 2020).

Based on the results of the survey, Pagano and Liotine (2020) argue that the IoT leads to increase in speed, throughput, efficiency, and quality. (See Appendix 1).

Internet of Things plays major role in supply chain globally. Gunasekaran, Subramanian, and Gunasekaran, Subramanian, and Tiwari (2016) argue that in order to fulfil the expectations of customers, companies need to incorporate emerging technologies such as IoT into their strategy.

The implementation of IoT can result in increased information and material flow visibility and transparency in business operations. Therefore, the significance of real-time information availability and accuracy together with ability to track and trace products can be clearly seen. Moreover, better inventory control and management, and increased integration of processes within the business leads to improved performance and efficiency of a firm. (Haddud et al., 2017).

Fatorachian and Kazemi (2020) argue that Internet of Things (IoT) is one of the key enabling technologies in Industry 4.0 and is considered as “the centre of connectivity for all the connected and intelligent devices, processes and systems” (Fatorachian and Kazemi, 2020). Moreover, IoT allows for a constant communication and connectivity with decision making support through feedback. Integration of smart technologies and intelligent systems such as sensors. IoT is revolutionising the entire industries and organisations, bringing a new paradigm in corporate operations. (Fatorachian and Kazemi, 2020)

According to Fatorachian and Kazemi (2020) IoT is expected to revolutionise supply chain and improve operations’ advanced visibility, through embedment of its intelligence into processes, manufacturing, products, inventory, and logistics, therefore all the IoT enabled objects are connected to each other but also to the Internet. The real time connectivity can lead to increased visibility and enhancements in supply chain management. (Fatorachian & Kazemi, 2020).

IoT creates opportunities for businesses through enabling technologies such as Radio Frequency Identification (RFID), which allows for self-monitoring and communication in real-time. Moreover, through that, IoT allows for high level responsiveness, flexibility, and proactivity, whilst enabling automation through integration of systems, processes, and connection to the Internet. Therefore, improvements in productivity, efficiency, and quality control in supply chain operations can be associated with enabling technologies. (Fatorachian & Kazemi, 2020).

2.1.2 Industry 4.0

Otherwise known as the Fourth Industrial Revolution, Industry 4.0 essentially involves digitalisation of the industrial sector. Nowadays, many well established companies use digital technology to adjust their supply chain strategy, and to provide value to customers (Hahn, 2020). Moreover, Hahn (2020) argues that the developments in technology have impact on several sectors within the industry and supply chain processes, including logistics.

The key players in Industry 4.0 include big data and analytics particularly for supply chain management, additionally 3D printing, autonomous vehicles, and robots are anticipated to enhance supply chain systems (Hahn, 2020).

Companies are investing heavily in technological innovation such as automation and robotics, which are associated with fourth industrial revolution, and are bringing notable benefits to the company's processes such as manufacturing. (Fatorachian & Kazemi, 2020). Fatorachian and Kazemi (2020) argue that the improvements for the companies and especially in supply chain and logistics management can be clearly seen and associated with Industry 4.0 and its technologies. This is largely due to increased efficiency and productivity through automation of a business systems, together with improved quality this leads to encouragement to introduce the Industry 4.0 in different areas such as supply chain management (Fatorachian & Kazemi, 2020).

The focus of Industry 4.0 is on transformation of the manufacturing by implementation of disruptive technologies including Internet of Things (IoT), Cloud Computing, or Cyber-Physical Systems. Moreover, Frederico (2021) argues that only companies that take Industry 4.0 into consideration will be able to keep their position in the competitive market, as the technology creates value which has led to many countries including United Kingdom to put Industry 4.0 on their government's agenda. Disruptive technologies including Internet of Things (IoT) are core components of the Supply Chain 4.0 framework with project management being essential component of the management side in order to effectively deploy those technologies throughout the supply chains. Moreover, Frederico (2021) states that the technologies of Industry 4.0 are crucial for further expansion of supply chain operations. The technologies include Cloud Technologies, Robotics, IoT, Big Data Analytics, Virtual Reality, and 3D-printing to only name a few. Furthermore, other benefits such as improvements on products and services, new markets, new business models, economic impacts, and environment changes can be associated with the utilisation of IoT and Cyber-Physical Systems. (Frederico, 2021).

Hahn (2020) argues that the technologies in industry 4.0 can be utilised in order to enhance the supply chain efficiency in internal operations, businesses can offer packaged customer-specific services through the networks connected by the Industry 4.0 technology. Finally, Industry 4.0 enables the use of software and data to provide added-value services for digital services.

To address the integration challenges, numerous companies are introducing Industry 4.0 technologies in their supply chain management practices as the advanced levels of connectivity and comprehensive integration can revolutionise supply chain management, resulting in the improvements of performance of supply chain. (Fatorachian & Kazemi, 2020).

According to Fatorachian & Kazemi (2020) the Industry 4.0 key capabilities and their impact on supply chain are as follows: Internet of Things (IoT) capabilities include connectivity between internet-enabled and smart systems and objects, continuous communication, enhanced operational visibility, the ability to monitor oneself, and advanced automation. This results in ability to monitor and communicate performance in real-time, enhanced responsiveness, proactivity, flexibility, enhanced quality control, increased productivity and efficiency, and better decision making.

Furthermore, Fatorachian and Kazemi (2020) state that the supply chain processes and manufacturing and the connectivity between them are possible due to the technological innovations such as IoT, and through real-time information sharing allowing for better responsiveness, customisation, and adaptation of products to meet the needs. Moreover, this can result in improved product quality. Effective order fulfilment management can be achieved through the technologies of Industry 4.0 used to share information and improve responsiveness in the supply chain. The improvement of the supplier relationship management can be achieved by improved decision making and visibility together with real-time information accessing in order to audit the supplier's ensuring compliance. Lastly, during the production and assembly, the machines enabled by Industry 4.0 can identify problems in production and correct the actions ensuring product quality (See Appendix 2). (Fatorachian & Kazemi, 2020).

2.2 Project Management

According to Kerzner (2018) for a long time project management was not considered as a necessary process to have for a firm. Nowadays, project management is crucial to build the trust between parties and customers, and development of products. Companies realised that the benefit of having project

management within the organisation can lead to not only delivering the deliverables but also to provide value.

Joshi (2021) describes project management as a methodology that outlines the steps, tools, and strategies needed to complete the project's deliverables and satisfy the needs of its stakeholders. Moreover, the project management tools can be used across industries, however, this would be dependent on project manager carrying out the project. In order to use the tools efficiently, these must be integrated by the project manager. To ease the process for project managers, the use of advanced technology tools is becoming more important. To effectively manage teams and projects, technology and tools are still required according to Joshi (2021). In the IT industry, 75% of completed projects are successful due to the project management information system.
Joshi (2021) argues that in the technology advanced world of the future, project managers will require new competencies. The development and application of hybrid mythologies tailored to the specific needs of each project demonstrated improved project performance outcomes.

2.2.1 Project Management in Supply Chain

Effective project management and supply chain are crucial to company's success. Despite being different, Lone Star Technology, LTD (2023) argues that the relationship between them is beneficial, and if executed properly can result in high volume, lower costs, and improved profitability. Moreover, project management focuses on organising and driving systemic changes within the system whilst supply chain management focuses on continuous movement of goods and services. Therefore, as they are closely connected to each other, project managers must understand the environment of supply chain in order to be effective (See Appendix 3). (Lone Star Technology LTD, 2023).

According to Arestenko, Harkava, Goncharenko, Ippolitova, and Lozova (2023) supply chain project management relates to the standard of planning and administrative duties in supply chain hierarchy. Futhermore Arestenko et al. (2023) argues that the supply chain management differs from the logistics management, as supply chain involves aspects such as tariffs, legislative

structure, as well as implementation of high-quality technologies in order to advance these methods.

Moreover, even though that project management is distinct from logistics management, it is related to operations and logistics department within an organisation.

2.2.2 Technology in Project Management

Created in 1950s, The Program Evaluation and Review Technique (PERT) is associated with pioneering the use of computers in project management. PERT is used as a decision-making tool, allowing to finish the project two years before its due date. (Song, Cao, and Li, 2013).

The recent developments in technology lead to changing project management approaches. Hirman, Benesova, Steiner, and Tupa (2019) argue that the companies can take advantage of technology in order to guarantee flexible and fast production. The emergence of new technologies led to the expansion of industry and emergence of 'Industry 4.0'. The primary goal of the idea is to transform existing factories and to establish a new smart factory (machines, IT systems, and sensors) which will be linked to Cyber-physical systems. This includes Internet of Things (IoT), simulations, big data, cloud computing, and virtual and augmented reality to only name a few. Therefore, the changes in the standard production can be seen leading to optimized, automated, and fully integrated production flow. Moreover, the connection between machines to other machines, humans with humans, and machines with humans will create vast amount of data called Big Data. This is crucial for companies to analyse as it helps to manage present production and predict possible problems. (Hirman, Benesova, Steiner, and Tupa, 2019).

According to Arestenko et al. (2023) the technology in project management is a feature that helps to create a steady supply flow, but also enhance the quality of business organisation whilst creating microeconomic security for the organisation. This is essential to any corporation in the context of the socioeconomic crises and the shift in geopolitical leaders in the raw material supply chain.

Arestenko et al. (2023) argues that given the advancement of contemporary digital technologies, each supply chain should be viewed as a distinct local project of the business, organised with digital technologies, and thoroughly integrated into the global information system in order to find suppliers and transportation routes. Therefore, project management in supply chain should be supported by specialised digital technologies in the context of the development of digitalisation processes. (Arestenko et al., 2023).

Joshi (2021) argues that project management is impacted by technology and its tools regularly used to collaborate, communicate, schedule, manage the budget and mitigate the risks, therefore, technology is used to smooth those operations whilst increasing the productivity. Therefore, improved quality of the project management and the success of a project can be associated with utilisation of information systems with a rate of 75% successful projects. (Joshi, 2021)

The software applications allow project managers to access various information such as financial resources, sales, or stock, with ease whilst making the decision-making easier and quicker. Moreover, the software allows for easy access to the project status at any time, and the issues can be rectified faster. There are many tools that can be used in project management lifecycle such as Gantt, Microsoft project, Primavera, Microsoft 365, or Skype to only name a few. Those tools allow for better communication between stakeholders (Joshi, 2021).

2.3 Supply Chain Management

Hahn (2020) describes Supply Chain Management as “the planning, implementing, and controlling of primary activities (esp. procurement, manufacturing, and logistics) that create and deliver value to the end customer”. (Hahn, 2020).

Panday and Panday (2015) describe supply chain management as “the process of planning, implementing, and controlling operations of the supply chain while satisfying customer requirements as efficiently as possible. The process includes all finished products, components, parts and assemblies, and their delivery”. (Panday & Panday, 2015).

Global Supply Chain Management allows to maintain supplier relationships through supplier management, negotiation, procurement, and evaluation skills.
On the other hand, strategic Supply Chain Management helps organisations to complement its competitive strategy through operational competencies of a supply chain e.g., through planning, production planning and scheduling, design management, inventory management, and distribution networks. (Panday & Panday, 2015).

According to Varma and Khan (2014) in order to create coordinated and integrated supply chains, the collaboration and sharing of the information between supply chain drivers can help, but also improves the performance, and decreases the risks whilst it presents opportunities for decision makers through access to executed transactions at the right time and in the format that they require. Therefore, the role of IT becomes significant through software and hardware applications. This leads to the integration between parties such as manufacturers, suppliers, distributors, and customers, assuring the right quality and quantity of the products available. Moreover, the businesses are able to gather necessary data across the whole supply chain, whilst allowing for a real time reaction should the changes appear, giving the company competitive advantage. (Varma and Khan, 2014).

The importance of technology in supply chain can be seen through four sections including supply chain model design to highlight the usage of corporate resources in order to gain competitive advantage; supply chain tractability which highlights the importance of information exchange between supply chain entities to improve the transparency through various security levels; supply chain sustainability and achieving high sustainability levels through technology; and supply chain finance focusing on decreasing the costs and improvements in transparency whilst increasing the performance. (Mahdikhani, Mahdikhani, Gonzalez, and Teixeira, 2023).
Risk in sourcing, costs, speed of delivery and quality in supply chain is often faced by companies, therefore, opportunities created by the technological rapid advancements can be used to gain competitive advantage by the company, expand the business, and cross borders whilst the risk is minimised, and company’s profit increased. (Pagano and Liotine, 2020).

Technology can be used to overcome challenges that the firm may face such as resource and skills gap, whilst improving traceability in global supply chains. Therefore, the supply chains must adapt to the advancements in technology in order to maintain the health of individual businesses. (Pagano and Liotine, 2020). Tavana, Khalili, Ahmadabadi, Amiri, and Mina (2023) argue that the supply chain can benefit from Internet of Things in many ways including cost reduction, fraud preventions, transparency, and data protection.

The effects of digital revolution on supply chain can be seen. Haddud et al., (2017) argues that as everything will be connected via the Internet, as a key business priority, Supply Chain Management needs to make appropriate adjustments in order to improve business performance. The key characteristics of supply chain integration include collaboration, sharing of information, and agility. This integration would lead to higher visibility for each individual item in the chain, where the attributes of the chain can be determined at any given time. Furthermore, this would lead to higher profits, fast response to the customer needs and supplier availability, better inventory levels, and optimized shipments ensuring complete deliveries. Businesses which adapt the IoT can respond to the demands of the dynamic market and regulate production levels leading to improvements in operational performance. Lastly, the businesses who adapt to this change quickly, gain competitive advantage and achieve greater benefits. Additionally, more efficient delivery of goods and services to the market can be achieved, reducing the impact of unpredictable changes in demand and supply. (Haddud et al., 2017).

Haddud et al., (2017) argues that many companies fail due to the inadequate supply chain technology integration. This can be due to not enough knowledge on the potential benefits of such implementations, and not enough skilled labour.

The pressure put on supply chain related to longer lead times, raising number of suppliers, customers, partners, countries, logistic channels, and increased costs such as labour costs, fuel, and landed costs can be seen. (Panday & Panday, 2015).

One of the main components in relationship management of supply chain is information sharing, together with promoting success of the performance of

supply chain. The information sharing can be ensured by use of technological innovations whilst the collaboration, and improvements in supply chain can be enhanced. In order to enhance business performance, connectivity and process integration in supply chain parties and processes is crucial, leading to information exchange that is effective and end-to-end processes are created. Furthermore, this leads to cost, service level, quality, and variety improvements. (Fatorachian & Kazemi, 2020).

The combination of Industry 4.0 and supply chain management has introduced the concept of Supply Chain 4.0, focusing on delivering advantages to stakeholders in supply chain. (Frederico, 2021).
According to Frederico (2021) Project Management methodologies are crucial in order to implement Supply Chain 4.0 through managerial components and skilled leadership making project management a key element in implementation of effective Industry 4.0 supply chain. Therefore, for a successful project implementation, integration of aspects such as scope, cost, time, quality, procurement, risk, stakeholders, human resources (HR) and communication is crucial.

2.4 Global Logistics

Rosenberg (2020, 83) describes logistics as a movement of products and goods and makes a part of supply chain, therefore, the person responsible for managing the supply chain within the business is also responsible for the logistic aspects such as third-party logistics providers (3PL), delivery and shipping companies, and freight forwarders.

Panday and Panday (2015) argue that organisations are attempting to establish and manage effective and strategic networks due to globalisation. These networks are called global logistics, concentrate on connecting the sourcing, production, and delivery of products.

The productivity and efficiency in logistics management can be improved by the use of IoT such as embedded intelligence in goods, cities, infrastructure like automobiles and mobile equipment. The use of RFID tags and sensors leads to improved visibility, tracking capabilities, which in effect leads to improved

planning and controlling of resources throughout the supply chain, leading to better availability of products, responsiveness, and fulfilment of customer demands (See Appendix 4). (Fatorachian & Kazemi, 2020).

According to Mikl, Herold, Pilch, Ćwiklicki, and Kummer (2021) the globalisation is mainly driven by the technological advancements and innovation in global logistics sector, and the complexity of supply chains in today's world. Nowadays, global logistics sector face challenges related to newly established companies, that use disruptive technologies, and digitalisation. These innovative technologies are frequently associated with products and systems that improve efficiency in the global logistics sector.

3 ANALYSIS OF DATA

3.1 The Role of Technology

Technology plays crucial role in supply chain including production control, distribution planning, inventory management, logistics whilst helping with language, time zone, and currency differences. However, Panday and Panday (2015) argue that the biggest benefit for the companies who implement technology into their business is the ability to integrate their processes, convert information, and a real-time collaboration.

The new business models and the transformation of the landscape can be seen. Industry 4.0 and its enabling technologies have influenced many processes including manufacturing and have improved the efficiency opening the opportunities for other sectors such as supply chain management. Therefore, the businesses must create new operational capacities and integrated supply chain frameworks. (Fatorachian & Kazemi, 2020).

The primary drivers of Industry 4.0 have the capacity to connect and integrate devices, processes, and people at a high degree by linking them to the Internet, and each other. The ability to link, communicate and control systems, people, and machines can result in the development of intelligent and interconnected supply chains. The supply chain is affected by the Industry 4.0 enabling technologies through integration and transparency, allowing for a holistic approach to supply chain management. Therefore, there is an increased communication and collaboration throughout end-to-end supply chains with high levels of information exchange and access. This leads to improved decision making, planning, and performance through better responsiveness, quality of products, flexibility, effectiveness, and efficiency allowing for a real-time communication between supply chain partners. Moreover, this allows for an improvement in performance and a holistic approach to supply chain management. Lastly, the digitalisation and automation of supply chain processes leads to introduction of analytical capabilities (Fatorachian & Kazemi, 2020).

3.2 Amazon

Amazon Inc. started as a bookstore, and originally took 1 week to deliver to customers, is now the second-largest retailer (USD 469bn as of 2021) in the United States, and the market leader in e-commerce in the US with market share of 39% in 2020. Amazon established its dominance in the e-commerce industry due to the use of disrupting technologies making the company a tech company and not a retailer. (Rus, 2022).

According to Miler and Rabolt (2018) Amazon is widely recognised as one of the most innovative firms in the world. The utilisation of digital technologies comes in a form of provided shopping experience to the customers both online and in physical stores. Amazon applies technological advancements and invests in innovation across its businesses, such as creation of the first cashier less convenience grocery store, that utilises cameras and sensors to determine customer purchases. Transactions are debited from customer's Amazon account. (Miler & Rabolt, 2018).

3.2.1 Logistics in Amazon

Amazon has over 354 million products in the warehouses, 300 million active users, and 200 million Prime members, making the logistics aspects challenging. Therefore, the investment in infrastructure and information technology is crucial to keep up with the customer demand, hence Amazon employs 1.6 million people worldwide, and 200,000 robots. (Rus, 2022).

Amazon is known for setting up the standards very high for the e-commerce. The increasing use of on-demand technologies, such as real-time tracking, coupled with the extensive usage of smartphones, calls for retailers worldwide to swiftly adjust to remain relevant to its customers. Therefore, this has an impact on the whole supply chain, as the companies must ensure exceptional service is being provided for its customers, whilst the efficiency in the supply chain is increased. (Cohen, 2018).

According to Hassel and Sieker (2022) Amazon leverages its transaction sales data to enhance the efficiency of its logistical operations. This is achieved by the collection of data regarding the quantity of orders for particular products, as well

as the corresponding time and date, therefore, Amazon is able to optimise its warehouse operations and enhance efficiency of their last mile route planning.

Amazon invested vast amounts of money in information technology systems, to support its operations and led to building Amazon Web Services (AWS).
To guarantee prompt and efficient delivery of goods the e-logistics were introduced. (Potiker, Smith, Ciccantell, Sowers, and McKenzie, 2024).

Computers, handled devices, and systems located at various delivery stations, sortation centres, Prime Now hubs, and airport hubs allow for real time tracking of the delivery fleet. Workers use smart devices which help them to easily locate the product, pack, and ship it due to the fastest real time information flow and exchange of information between systems and humans. (Chandra, 2017).

3.2.2 Technology in Amazon

Amazon invested in automating warehouse operation, and in 2012 purchased robots which are made to collaborate with humans who work in the warehouses, leading to more affordable and efficient supply chain. Moreover, the company is investing in drones to support its logistic operations. (Ivankova, Mochalina, & Gonchariva, 2020).

The company is currently putting a lot of effort into becoming a cyber-physical system, an intelligent network of computers and machines as well as advances information and communication technology systems to improve customer experience and strategically manage its supply chain and internal operations.
Amazon sets itself up as a smart factory to enhance its value proposition. The way in which its digital technologies and physical infrastructures are connected forms an intelligent network throughout the value chain. Its reach expanded to include transport logistic operators for deliveries due to the introduction of ‘cyber’ products such as Kindle, Amazon TV, Alexa, and Echo. (Bagnoli, Albarelli, Biazzo, Biotto, Marseglia, Massaro, Messina, Muraro, & Troiano, 2022).

Bagnoli et al., (2022) argues that in order to achieve maximum efficiency and flexibility in its operations, the company pursues algorithmic management (M2M),

which leads to dynamical, and autonomous reconfiguration of the placement, lifting, and packaging of items. This is due to the predetermined parameters and big data and analytics. The backbone of Amazon operations lies in the digital technology that allows for automated control of the intelligent network that connects logistical and manufacturing operations. (Bagnoli et al., 2022).

Amazon adopts solutions such as IoT technologies, sensors, and artificial vision systems with further expansion such as drones for home goods delivery, which leads to minimising the delivery times whilst increasing the service level to its customers. Since the beginning of its operations, the main focus of the company is on scaling and automating the operations. (Bagnoli et al., 2022).

According to Chandra (2017) Amazon's investment in IT infrastructure has changed the supply chain of the firm. Amazon is able to deliver millions of products around the world (185 countries) due to the real time information exchange within the supply chain. Moreover, the investment in smart warehouses allows the company to fulfil the demand of customers due to the usage of robots. Excellent IT platforms and infrastructure enable fast information flow, facilitating seamless real-time information interchange between automated systems and human workers. (Chandra, 2017).

Chandra (2017) argues that Amazon has the most advanced order management system which ensures that items can be delivered the same day or faster.

3.3 Results

The Amazon's product selection and superior logistical capabilities make it hard to compete for other online retailers. The introduction of Amazon Prime in 2004, changed the business by guaranteeing customers a two-day delivery on certain goods. Moreover, the data collected from the customer has led to strengthening the relationship with customers. (Walker & Jiwani, 2016).

The developments in technology have led to Amazon promising to be able to deliver customers' orders by drones or flying Avs. Moreover, the advancements in driverless vehicles were also happening, opening the door for merchants to deploy a fleet of both drones and autonomous vehicles. The goods could be delivered more efficient, as there would be no need for a driver to take breaks (if

the journey was longer than 12hours). Given that robotic functions within the vehicle have the potential to perform automotive jobs in a safer and more efficient way than human. (Walker & Jiwani, 2016).

The growth of Amazon and other online retailers with comparable logistical operations has demonstrated the growing significance of the logistics sector, in particular for platform companies. The logistics industry is undergoing a significant digital revolution that will have a negative impact on employment conditions. The introduction of new software and technologies, such as telematics, analytics, or software as well as traceability and route optimisation algorithms has triggered this shift. Amazon leveraged its digital platform to create innovative business models for the core of their system, including the logistics chain. (Hassel and Sieker, 2022).

Since the beginning, Amazon took advantage of digital transformation and establish itself as a leader in e-commerce. The use of data allows Amazon to operate its business intelligently, through understanding what is happening in real time, identification of current trends and customer behaviour, and through understanding the motivation of its customers and their choices. Therefore, making Amazon a data-driven business. (Bagnoli et al., 2022).

Previously mentioned theory suggested that through the development of integrated end-to-end business processes and the introduction of a high degree integration and information sharing in individual supply chain processes leads to improvement in performance of the entire supply chain. According to the study's findings, improving the overall performance of the supply chain can also increase the performance of its individual processes such as system components or parts. (Fatorachian & Kazemi, 2020).

The literature review showed that the managerial aspects such as decision making in organisations can be enhanced by the use of technology. The impact of Industry 4.0 on supply chain management is demonstrated by the capabilities of the Industry 4.0 and can lead to supply chain improvements, allowing for integration, and better performance within. (Fatorachian & Kazemi, 2020).

Amazon is a highly successful global brand. The success of a company is closely related to the strategy or strategies that are implemented in its operations. Moreover, strategy is a key component in determining the success of a business. The company's success is due to the innovation and technological aspects that were taken advantage of at the time, such as building a place where customers would be offered convenience, through the possibility of searching, selecting, purchasing, and receiving deliveries without leaving the house. The main focus of the company is to offer a large selection of items at a lower price, that can be delivered efficiently. This is achieved by Amazon through heavily leveraging the technology, assuring the access to information in real-time. Amazon is known for reliable, speedy delivery which is ensured by the use of technology including advanced logistics, Amazon robotics, and warehouses operating 24/7. The heavy investment into robotics and new warehouses strategically placed near large cities is one of the key components contributing to the success of Amazon. Recently, Amazon started also invest in Artificial Intelligence to improve its logistics and supply chain processes. (Ukeni, 2022).

4 DISCUSSION

The objective of this research was to analyse the impact of technology on Multinational Corporations and its supply chain and logistics. The substantial investment in technology, reflects its pivotal position in driving company success and competitiveness. The research highlighted the importance of utilisation of Information Technology by organisations in order to enhance visibility, collaboration, and decision-making across supply chain networks. Moreover, the convergence of automation, IoT, Ai and other disruptive technologies signals a shift in supply chain dynamics, offering unprecedented potential for optimisation and value creation.

Therefore, the path of supply chain management and global logistics is intricately intertwined with technological advancements, such as robotics, automation, big data, and AI, to only name a few. In order for businesses to meet the market demand and expectations, leveraging technology is critical to sustain competitive advantage.

Internet of Things (IoT) enhances the operational processes and reduces costs and risks by providing seamless communication and exchange of information between objects. The impact of IoT on supply chain can be seen through improved operational efficiency, and revenue opportunities.

Industry 4.0 provides a fundamental change in production and supply chain processes. The efficiency, productivity, and quality improvements are being driven by key technologies such as robotics, and IoT.

The integration of IoT and Industry 4.0 enables real-time monitoring, enhances responsiveness, and improves decision-making within supply chain management. The research showed the benefits of connectivity, visibility, and automation in optimising supply chain processes, from production to supplier management and order fulfilment, whilst offering businesses the opportunities to streamline operations, drive innovation, and deliver value to customers.

In today’s dynamic business landscape, the interconnectedness of effective project management, technology, supply chain and logistics is a key component contributing to company’s success.

Technological advancements allow for flexible and fast production, enhancing supply chain transparency and decision-making processes, whilst driving productivity and quality improvements.
Through the research it can be concluded that effective project management methodologies are crucial for implementation of initiatives related to Supply Chain 4.0 which ensure the alignment of the key project components. The introduction and implementation of sensors, RFIDs, and IoT leads to improved visibility, tracking, and resource planning allowing the companies to better meet the requirements and demands of customers in global market. Therefore, the combination of effective project management, supply chain management, global logistics, and technology is crucial for companies' survival in increasingly competitive and interconnected environment.

The transformative power of technology can be seen through companies like Amazon. Amazon adapted strategy of leveraging disruptive technologies, and innovation revolutionised the shopping experience for millions of customers both online and in-store (cashier-less grocery stores). The optimisation of its logistical operations is driven by investing in technologies such as IoT, robotics, or AI, which led to enhanced value proposition, and seamless customer experience.
Through the thoughtful integration of technology into every aspect of its business, Amazon has become a leader in cloud computing through Amazon Web Services as well as e-commerce.

All in all, the success of Amazon is largely due to company's strategy to leverage disruptive technologies by adopting solutions such as AI, IoT, or robotics leading to strategically managed supply chain and enhanced customer experience whilst ensuring operational efficiency.

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APPENDICES

Appendix 1. Five top technologies and its implications.

Table 1. Top five technologies and its implications (Pagano & Liotine, 2020).

Table 3.1 Survey results for top five technologies by MHI industry report 2018.

	Current disruption or competitive advantage (%)	Implications	5-Year projected adoption rates (%)
Robotics and Automation	65	Increase in productivity, efficiency, order fulfillment rate, order delivery	73
Predictive Analytics	62	Increase in traceability, visibility, forecasting, and customer and vendor relationship management, efficiency, job performance	82
IoT	59	Increase in efficiency, speed, throughput, quality	79
AI	53	flexibility, reliability, speed, productivity, accuracy, and reduce in product losses	47
Driverless Vehicles and Drones	52	Improving accuracy, efficiencies, and reducing costs and aligning costs to business strategy, improving service quality, and conserving human capital	50

Note. From Pagano & Liotine, 2020.

Appendix 2. Impact of Industry 4.0 on the supply chain process.

Table 2 Impact of Industry 4.0 on the supply chain process (Fatorachian & Kazemi, 2020).

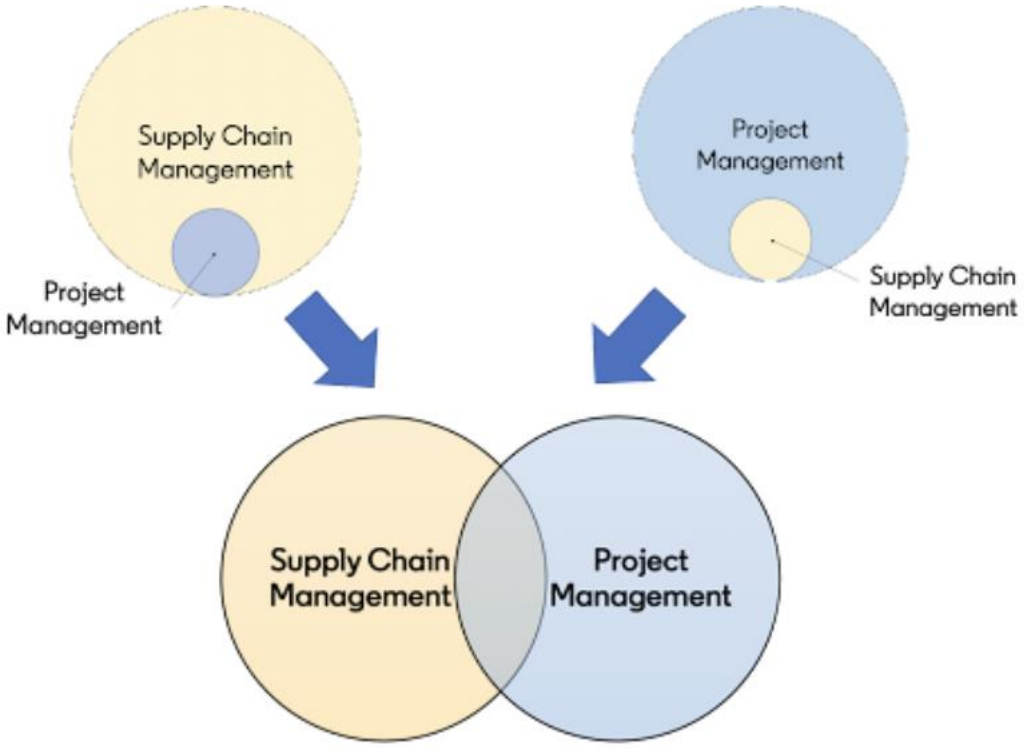
Table 4. Impact of Industry 4.0-enabling-technologies on supply chain processes and the resulting performance improvements.

Supply chain process	The potential impact of Industry 4.0 on the supply chain process (Descriptive themes)	Performance improvements (Analytical themes)
Product development and production	• Detailed analysis of demand patterns and fluctuations (Li et al. 2016; Zhong et al. 2015) • Identification of process constraints such as the capacity of machinery and changeover times (Banker 2015; Huang et al. 2008) • Visualisation and simulations of operations (Jung et al. 2016) • Rapid implementation of individual customer requirements enabled by a high level of flexibility (Helo and Hao 2017; Oberg and Graham 2016) • Customisation and tailoring products to an individual or local level (Park et al. 2016; Brettel et al. 2014) • Developing collaborative design (Shamsuzzoha et al. 2016). • Detecting variations in production or assembly performance enabled by self-controlling capabilities (Chung 2015) • Reduced waste and rework resulting from predictive and self-monitoring capabilities (Chung 2015) • Enhanced product innovation and development (Tan et al. 2015; Hsu, Tan, and Zailani 2016; Lang et al. 2014; Christensen, Olesen, and Kjaer 2005) • Rapid product design and prototyping and reduced time to market (Kache and Seuring 2017; Tan et al. 2015; Baur and Wee 2015)	• Improved production planning and control • Improved product design/development and production process • Enhanced production efficiency and productivity

Note. From Fatorachian & Kazemi, 2020.

Appendix 3. The connection between Supply Chain and Project Management.

Figure 1 The connection between Supply Chain and Project Management (Lone Star Technology, 2023).



Note. From Lone Star Technology, 2023.

Appendix 4. Effect of technology on customer demands, availability, and responsiveness.

Table 3 Effect of technology on customer demands, availability, and responsiveness (Fatorachian & Kazemi, 2020).

Fulfilment, procurement, and logistics	• Real-time traceability and interoperability of resources (Qiu et al. 2015; Zhang et al. 2011) • Enhance tracking and tracing of products throughout the supply chain (Kache and Seuring 2017; Modrak and Moskvich 2012) • Optimised freight transportations (Harris, Wang, and Wang 2015) • Efficient navigation and traffic congestion detection (Bishop 2000) • Enhanced product safety, quality, and speed of delivery (Bishop 2000) • Reduction of fuel consumption and emission of gases unfavourable to the environment (Banker 2014) • Enhanced product delivery and dependability by predicting possible delays and disruptions (Kache and Seuring 2017)	• Improved planning and control • Improved distribution • Effective order fulfilment management • Reduced Bullwhip effect • Improved procurement and supplier relationship management • Effective purchasing

Note. From Fatorachian & Kazemi, 2020.