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Digital Threads and IT Power: Decoding Their Combined Effect on Manufacturing Performance

Farnoosh Farzaneh

Vice Chair and Assistant Professor, Department of Quantitative Studies MBA-Program, University Canada West, Vancouver British Columbia, Canada

A R T I C L E I N F O

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A B S T R A C T

This research aims to evaluate the impact of digital supply chain on that of organizational performance in the manufacturing industry with IT capabilities as mediating factor. Quantitative approach is utilized to conduct this research, using a snowball sampling approach, focusing on the five largest organizations that manufacture oil and gas. Overall, a sample of 170 Digital Supply Chain Managers is gathered to provide valuable insight with the help of an online survey questionnaire. Findings suggest that funding in continuous training, nurturing culture of innovation, enhancing cybersecurity measures, adopting advanced IT infrastructure and leveraging data analytics are crucial for maximizing the advantages of digital supply chains. The aforementioned strategies facilitate organizations to attain substantial progress in strategic agility, and operational efficiency; thereby, maintaining competitive advantage in a technology-driven corporate environment. The discussion highlights pivotal role of IT capabilities in elevating supply chain processes through AI and IoT which enhance predictive analytics, supports strategic planning, improves organizational performance and improve operational efficiency. Survey data analysis revealed a strong positive relationship between digital supply chains, organizational performance and IT capabilities. Regression analysis also validated the relationship, with an adjusted R square of 0.934, signifying a vigorous correlation. Besides, ANOVA results confirmed minimal variance, supporting the consistency of data. The analysis offer valuable insights and emphasize on the significance of integrating digital supply chain with modern IT capabilities so as to drive organizational success particularly for manufacturing organizations.

1. INTRODUCTION

In a highly competitive business world, solitary organizations can no longer attempt to establish themselves as independent ones that abide by varying systems of supply chain (Novais *et al.,* 2019). The modern day's dynamic business paradigm necessitates supply chain workers to take part in capability and knowledge sharing in downward as well as upward supply chain management practices so as to achieve their objectives (Belhasi *et al.,* 2020). The combination of knowledge and information leads to valued capabilities and inevitably encourages performance excellence. Thus, from the supply chain process perspective, incorporating the activities and processes of the entire supply chain helps in building value and efficiency; thereby, allowing for improvements to be made to the total chain of supply performance (Novais *et al.,* 2019). The supply chain integration process makes

knowledge available in the most appropriate places amid partners in the supply chain. Thus, encouraging partners to become deeply valuable and rooted associates of various supply chain networks.

The way in which organizations compete has not changed much since the start of the industrial revolution. Maintaining the loyalty of customers is still a prominent part of strategy for every organization. However, in recent times, organizations are finding ways to make efforts and production in alignment to their customer focus (Khan *et al.,* 2022). A boom in high-quality production at lowest cost is being observed, not only to provide customers with more options but also gain competitive advantage over various rivals (Lieberman, 2021). This can be seen commonly in fast-fashion and lifestyle products. Hence, the primary focus of organizations has become the optimization of supply chain so they can reach more customers and make products faster. The optimization of supply chain by using technology is nothing new; nonetheless, with Industry 4.0, digital supply chain has become the backbone of all manufacturing production (Sobb *et al.,*2020).

A digital supply chain allows organizations to completely automate production and eliminate all kinds of lag that are previously there due to human errors. It has made the process more accurate and precise (Patrucco *et al.,* 2020). However, to achieve this, an organization must first adopt some information technology capabilities necessary for the integration of digital supply chain. There seems to be a lack of knowledge related to industrial cases of application of digital supply chain specific to the manufacturing industry (Büyüközkan & Göçer, 2018). It is emphasized that organizations from various industries have different practices, policies and approaches for Digital Supply Chain.

As, the technology is evolving and changing, it is important to understand the impact of digital supply chain on each specific industry and where it works best (Lehtisalo, 2018). Thus, in future research, a framework within the industry of manufacturing is required to enhance the trends related to Digital Supply Chain. This research is based on the typology of IT use introduced by Zuboff as automate, informate, and transform, which explains the importance of digital supply chain on organizational performance in the manufacturing industry. According to Zuboff (1988), the role of information technology in organizations can be divided into three different functions namely automation, which entails the utilization of technology to carry out its functions more effectively by taking the place of manual procedures; informing, which implies the creation and utilization of information created by the digital processes in order to make decisions and finally transformation, which is the redesigning of business processes and structures by the digital advanced technology. This framework offers a good perspective to study how digital supply chains, with the help of IT capabilities, could reform organizational strategies and results.

1.1. Problem Statement

This research aims to identify the impact of digital supply chain on performance of an organization and the mediating role of information technology capabilities. It is of considerable importance to investigate supply chain from the process integration perspective to improve supply chain performance. Prior research conducted on supply chain and logistics management has effectively showcased the impact supply chain association can have on the performance of the supply chain, operations, and logistics (Asnordin *et al.,* 2021). Besides, research on supply chain integration process factors, which impacts the performance of the organization through supply chain capability. But, it has received very little attention.

Although other researchers have already investigated the overall advantages of digital transformation and supply chain digitization, few studies have focused specifically on the mediating nature of IT capabilities between digital supply chains and organizational performance in manufacturing industry especially in high-stakes industries such as oil and gas. Also, current literature tends to ignore the application of such integrated frameworks as typology provided by Zuboff in terms of reaching the strategic and operational consequences of digital supply chains. The present study covers this gap by studying not just the immediate impacts of digital supply chains but also the role of IT capabilities as a key facilitator of organizational performance. This study is particularly relevant to information systems scholars, management theorists, and strategy researchers who are examining the evolving role of digital technologies in organizational performance.

Particularly, some academics have argued for the need for detailed empirical investigations on the manner in which various supply chain process integration dimensions influence business performance and are interrelated (Birasnav & Bienstock, 2019). Accordingly, various works have also illustrated that business performance and competitive advantage can be achieved by coordinating activities and processes of the supply chain whilst others have assessed the factors that lead to supply chain process integration (Yeniyurt *et al.,* 2019). The integration and development of information technology has a crucial part to play in terms of contributing to and offering a new path for every aspect of the organization, which includes business performance and supply chain management (Birasnav & Bienstock, 2019; Yeniyurt *et al.,* 2019).

1.2. Research Questions

- How digital supply chain impacts the organizational performance?
- How does digital supply chain impacts information technology capabilities?
- What is the impact of information technology capabilities on organizational performance?
- What is the relationship and impact of digital supply chain on organizational performance and what is the role of information technology capabilities as mediator?

1.3. Research Objectives

- To examine the impact of digital supply chain on organizational performance.
- To examine the impact of digital supply chain on information technology capabilities.
- To examine the impact of information technology capabilities on organizational performance.
- To investigate the impact and relationship of digital supply chain, organizational performance as well as information technology capabilities in manufacturing industry.

2. THEORETICAL FRAMEWORK

Digital threads, which allow a smooth flow of data throughout the product lifecycle, are the next example of the informate and transform dimensions of Zuboff, as they do not only facilitate the improvement of the visibility and decision-making but also transform the integration processes of operations, strategy, and innovation. This renders the typology an appropriate instrument to examine the ways in which digital supply chains have an impact on the performance of organizations using the IT capabilities. The concept of digital threads is very well applicable to the framework of Zuboff since it encompasses the gradual advancement of technology on the organizational processes ranging to the transformation (Roumeliotis et al., 2024).

The paper provides a conceptual contribution in that it uses the typology of automate, informate, and transform by Zuboff in relation to digital supply chains and offers a stratified insight into the mediation of the process between digital technologies and organizational performance done through IT capabilities (Liu et al., 2021). In contrast to the previous models where the concept of digital transformation is usually viewed as linear or one-dimensional, the structure advanced by Zuboff reflects the evolutionary quality of the impact on digital transformation in which the digital threads proceed through the levels of efficiency of tasks (automation) to improved decision-making (informating) and finally to business model innovation (transformation) (Ivanov & Dolgui, 2021). This theoretical development allows a more detailed discussion of digital supply chains as strategic resources and not operational ones. In practice, the framework assists managers to determine.

2.1. Digital Supply Chain

A chain of supply that is digital can be defined in various ways in accordance with the literature available. Industry 4.0 provides Digital Chain of Supply with a huge potential which makes it capable of automation and production by the utilization of alpha numeric and digital data (Schruaf & Berttram, 2016). DSC can also be explained in terms of an organization process alignment to its satisfaction of consumers via digital marketing, customer experience, social media and e-commerce. The use of DSC is the aspiration of any business to supply and deliver the products to its consumers at an appropriate time. Many of the digital technologies aid in the improving the chain of supply in many industries which include AI, ML, IoT, Blockchain, Cloud Computing, among others. These are classified as part of digital supply chain as they support

organizations in obtaining a change in their supply chain operations and improve its performance. A digital supply chain is a supply chain that is constructed in alignment with core competencies related to the internet and information technology (Tahiduzzaman et al., 2017). Hence, information technology competencies are an important part of Digital Supply Chain (Bughin *et al.,* 2018).

Supply Chain Optimization influences the value of supply chain by maximizing performance, ensuring timely delivery and minimizing costs (Unhelkar *et al.,* 2022); through strategic planning, process improvements and resource allocation for enhanced productivity and satisfactory customer service (Tarigan & Siagian, 2021). Digital Procurement on the other hand, leverages technology to automate and streamline procurement processes by utilizing digital platforms for purchasing, sourcing and supplier management (Rejeb *et al.,* 2018).

2.2. Organizational Performance

Organizational performance consists of the actual results or outputs of an organization in terms of its intended outputs (Anwar & Abdullah, 2021). The measurement of organizational performance ensures the fulfillment or success of organization at the end of a project as intended by the project goals (Kaydos, 2020). Organizational performance is enhanced by integrating advanced digital technologies into supply chain management. Tools such as the Internet of Things, big data analytics and Artificial Intelligence boost efficiency and streamline operations, optimizing procurement, logistics and inventory management. Real-time data access and automation facilitates superior decision-making, accelerate response times, and minimize errors with improved profitability (Sallam *et al.,* 2023). According to observation, AI-driven predictive analytics accurately forecast demand, optimizes inventory levels and reduces associated costs (Joel *et al.,* 2024). In addition, digital technologies strengthens sustainability by minimizing waste and optimizing resource usage (Javaid *et al.,* 2023; Kurniawan *et al.,* 2022). Internet of Things identifies inefficiencies, enables implementation of more sustainable practices as well as sensors monitor energy emissions and consumption.

Stakeholder satisfaction is also significantly improved through digital supply chains (Baah *et al.,* 2022). Enhanced communication, adaptability and transparency nurture stronger relationships with customers, suppliers and other stakeholders (Emeka-Okoli *et al.,* 2024). Real-time visibility allows organizations to swiftly address issues and track orders efficiently leading to higher customer satisfaction (Obinna, 2024). The suppleness provided by digital technologies allows organizations to adapt quickly to environmental shifts, while maintaining operational continuity during disruptions such as natural disasters or pandemics. Human resource management is crucial for digital supply chain success, as it ensures employees proficiency in new processes and technologies (Haq *et al.,* 2024; Setyaningrum & Muafi, 2023). Training and development programs concentrated on digital skills are critical. It is noteworthy that digital tools provide valuable insights into employee engagement and productivity.

Operational efficiency within organizations help ensures high quality while delivering services and products in a cost-effective way (Anderson, 2020). It leads to reduced waste, improved productivity, and effectively utilization of resources so as to minimized input and maximize output (Goshime *et al.,* 2019). Quality enhancement continuously improves process, product and service quality within an organization adopting best practices, and implementing quality management systems (Alzoubi *et al.,* 2022). In this way, organizations involves in continuous improvement to exceed customer expectations, through effective performance and customer satisfaction.

2.3. Information Technology Capabilities

Capabilities are skills, organizational processes, knowledge and attributes of an organization which enables it to sustain its competitive advantage in comparison to its competitors as well as achieve good performance (Ferreira *et al.,* 2021). Information technology capabilities encompass competencies, skills and tools that an organization utilize so as to harness technology so as to achieve their business objectives (Antoni *et al.,* 2020). These capabilities are critical for enhancing productivity, innovation and efficiency within an organization. A vigorous IT infrastructure forms the backbone of such capabilities (Momodou, 2023). While, the incorporation of software and hardware components such as servers, cloud services, databases and networking equipment helps in effective data management. As, it ensures

the storage, analysis, utilization and collection of data to maintain security, accessibility as well as integrity. This in return drives strategic initiatives and enables informed business decisions.

Cybersecurity is a critical IT capability which involves the implementation of security measures such as encryption, intrusion detection systems and firewalls so as ensure regulatory compliance and protect digital assets (Mishra *et al.,* 2022; Bhat, 2022). Technical maintenance and support services ensure smooth IT systems operation. Addressing disputes and concerns at the appointed time through system monitoring, helpdesk services, routine maintenance and troubleshooting. Integration and innovation capabilities are also pivotal, as it enables organizations to adopt new technologies (Mao *et al.,* 2021). The advanced technologies can then be integrated with existing systems, thus staying modernized with latest trends. Operational IT governance guarantees that IT resources are linked with business goals (Chi *et al.,* 2020). The IT resources are also required to be used efficiently, by establishing standards, procedures and policies for IT management while ensuring performance measurement and accountability.

Cloud Computing Utilization uses cloud-based infrastructure to manage, process and store data to access computing resources, reduce IT costs, improve collaboration, and enhance data security, as well as support business continuity and remote work (Attaran & Woods, 2019; Alashhab *et al.,* 2021). Digital Innovation Capability leverages digital technologies to develop enhanced services, advanced products, and cutting-edge business models by adopting advanced technologies and digital skills to drive efficiency and growth (Nousopoulou *et al.,* 2022).

2.4. Operational Definitions

Dimensions & Variables	**Definitions**	**References**
Digital Supply Chain	The integration of digital technology so as to improve supply chain operations.	(Attaran, 2020).
Supply Chain Optimization	Streamlining supply chain processes for maximum efficiency and effectiveness.	(Lele, 2023).
Inventory Management	Systematic control of inventory levels to meet demand without excess.	(Kourentzes *et al.,* 2023).
Digital Procurement	Using digital tools and platforms for efficient purchasing processes.	(Hallikas *et al.,* 2023).
Organizational Performance	Measurement of an organization's efficiency and effectiveness in achieving goals.	Al Aina & Atan, 2020).
Operational Efficiency	Optimal utilization of resources to maximize output with minimal waste.	(Robaina *et al.,* 2020).
Quality Enhancement	Continuous improvement of products or services to meet or exceed customer expectations.	(Vinodh *et al.,* 2021).
Cost Reduction	Strategies and actions aimed at lowering expenses while maintaining quality.	(Alzoubi *et al.,* 2022).
Information Technology Capabilities	Skills and technologies an organization possesses to manage and leverage IT effectively.	(Panda & Rath, 2021).
Cloud Computing Utilization	Leveraging cloud services to enhance scalability,	(Adedugbe *et al.,* 2020).

	flexibility, and collaboration.	
Data Management	Effective handling, storage, and processing of data to ensure accuracy and accessibility.	(Yaqoob *et al.,* 2022).
Digital Innovation Capability	Ability to develop and implement new digital solutions to drive business growth.	(Benitez *et al.,* 2022).

3. LITERATURE REVIEW

Digital threads, which refer to a smooth transfer of data throughout the product lifecycle, is one of the fundamental technological developments that can reflect the increasing strategic capacity of IT in organizations. These threads facilitate real-time connectivity, traceability, and cross-functional integration, and the multidimensional impact of IT on the functions other than operational efficiency (Jesus et al., 2024). This is in line with the power aspects of IT as both an automation device and a force of information disclosure (informating) and change in the organization. The typology presented by Zuboff provides a useful mechanism with the help of which it is possible to view these dynamics, as the typology describes the cumulative effects that IT has on organizational processes and strategy (Tan et al., 2023). Connecting digital threads and this typology, the present study expands the conceptual knowledge of the impact of IT capabilities on digital performance of supply chains.

3.1. Digital Supply Chain Impact on Organizational Performance

The transformative potential of digital technologies and expertise in optimizing supply chain processes is undeniable. As, it enhances the overall performance of an organization (Lee *et al.,* 2022; Hallikas *et al.,* 2021). Digital supply chains leverages advanced technologies such as Artificial Intelligence, Blockchain, and Internet of Things etc. so as to create more transparent, responsive and efficient supply chain systems (Wang *et al.,* 2022). Such digital transformation is expected to yield major benefits in terms of cost reduction, strategic agility as well as operational efficiency (Ebinger & Omondi, 2020). Internet of Things; for example, enables better inventory management, reduces incidence of overstock situations and provides real-time tracing of goods (Sallam *et al.,* 2023). AI as well as machine learning algorithms helps analyze vast amounts of data so as to predict demand accurately, while minimizing waste (Awan *et al.,* 2021; Muthuswamy & Ali, 2023). Cost reduction is another benefit linked with digital supply chains (Roeck *et al.,* 2023).

By enhancing transparency across supply chain, digital technologies enable organizations to recognize inadequacies for cost savings. Blockchain technology, for example, provides an inviolable record of transactions, which reduces the need for intermediaries and lowers transaction costs (Wang *et al.,* 2022). Whereas, predictive analytics helps organizations mitigate risks, avoiding costly delays and anticipate disruptions (Brintrup *et al.,* 2020). These cost savings are substantial, which directly contributes to improved financial performance. Digital supply chains also impacts organization's strategic agility, which allows them to respond swiftly to customer demands and market changes. The capability to rapidly gather data and analyze it from various points in the supply chain provides organizations with an insight needed to make informed decisions (Shukor *et al.,* 2021). This agility and swiftness is central in today's fast-paced market environment. Competitive dynamics and consumer preferences can rapidly shift; thus, it is essential to utilize digital supply chain for enhanced organizational performance.

Digital supply chain optimization positively impacts the efficiency of an organization by ensuring on time delivery through process improvements (Lee *et al.,* 2022; Sharma & Joshi, 2023). Besides, digital procurement is said to enhance data-driven decision-making by reducing costs, refining transparency, and furthering resilience (Ivanov *et al.,* 2019; Langseth, 2024). Operational efficiency; in contrast, reduces waste, optimizes processes, as well as improves productivity, while delivering and maintaining high quality (Jimenez *et al.,* 2019). Quality enhancement also promotes customer satisfaction by adopting best practices and reliability (Famiyeh *et al.,* 2018).

Thus, the research hypotheses established is as follows:
H1: Digital Supply Chain has a positive impact on Organizational Performance.

3.2. Digital Supply Chain Impact on Information Technology Capabilities

Previous research highlights the synergistic relationship between the enhancement of IT capabilities and digital supply chain initiatives within an organization. Digital supply chains incorporates advanced technologies which require robust IT expertise and infrastructure (Attaran, 2020). When organizations adopt such advanced technologies, supply chain processes are optimized simultaneously to bolster their IT capabilities in numerous key areas (Sobb *et al.,*2020; Akbari & Hopkins, 2022). The integration of digital tools necessitates the maintenance and development of sophisticated IT systems that ensure cybersecurity, facilitate seamless communication across various platforms as well as handles large volumes of data (Oliveira-Dias *et al.,* 2022). It drives an organization to up skill their IT workforce and invest in cutting-edge IT infrastructure; thereby, enhancing the overall IT capabilities.
Digital supply chains promotes and pushing organizations to adopt innovative IT solutions so as to stay at the forefront of technological advancements (Weerabahu *et al.,* 2023). The continuous evolution helps organizations improve supply chain efficiency and strengthens its IT capabilities by adopting adaptability and culture of innovation. The use of Blockchain technology for supply chain traceability requires the establishment of decentralized databases; thereby, improving organization's proficiency in these areas (Dutta *et al.,* 2020; Gligor *et al.,* 2020). Besides, Machine Learning applications and Artificial Intelligence in predictive maintenance and demand forecasting necessitates algorithm development skills and advanced data processing, further enhancing IT capabilities. When organizations become proficient in leveraging such technologies, they gain competitive edge in supply chain management. The positive impact of digital supply chain on IT capabilities extends to improve strategic planning and decision-making leading to elevated business strategy (Alabdali & Salam, 2022).
Digital procurement streamlines and rationalizes procurement through technology by improving data-driven decision-making (Vehviläinen, 2019). Whereby, Cloud Computing Utilization enhances collaboration and communication that supports remote work and data security (Alreshidi *et al.,* 2018). Besides, digital innovation capability leads to creativeness by adopting advanced technologies (Jun *et al.,* 2022).
Thus, the research hypotheses established is as follows:
H2: Digital Supply Chain has a positive impact on Information Technology Capabilities.

3.3. Information Technology Capabilities Impact on Organizational Performance

There is a significant role of information technology capabilities in improving numerous aspects of organization's overall success (Tariq *et al.,* 2022). In a technology-driven business environment, vigorous IT capabilities provide organizations a foundation for enhanced competence (Ekman *et al.,* 2022). Advanced organizations with IT proficiencies streamline their operations by optimizing resource allocation, enhancing collaboration and communication as well as automating routine tasks (Hassan & Mhmood, 2021). Enterprise resource planning systems integrate several business processes, which enables decision-making and real-time data sharing across departments (Nyathani *et al.,* 2023). Such integration leads to reduced operational costs, faster response times to market changes and increased productivity (Faccia & Petratos, 2021). In addition, information technology capabilities enable organizations to implement unconventional data analytics to provide insights into market trends, operational performance as well as customer behavior (Ouiddad *et al.,* 2021). These insights eventually facilitates better strategic planning, allowing organizations to make opt and effective decision, identify new opportunities, drive growth and mitigate risks.
Information technology capabilities nurtures innovation by enabling organizations to deploy new business models. With the support of IT, organizations leverage emerging technologies to produce innovative solutions which meets ever evolving customer needs (Randhawa *et al.,* 2021). Predictive analytics poared by Artificial Intelligence help organizations tailor and anticipate customer preferences accordingly

(Reddy, 2021), which enhances customer loyalty and satisfaction (Haleem *et al.,* 2022). Besides, information technology capabilities support the implementation of digital transformation initiatives and agile methodologies, which allows organizations to adapt technological advancements and changing market conditions promptly. Such adaptability is essential to maintain a competitive edge over competitors and also to achieve long-term success.

Information technology capabilities also contribute to enhanced organizational performance by improving the speed and quality of decision-making (Nisar *et al.,* 2021). Advanced IT organizations provide managers with comprehensive and accurate data, enabling them to develop informed decisions which align with organization's strategic objectives. Such data-driven approach reduces reliance on guesswork and intuition, leading to efficient and effective management practices (Ganbold *et al.,* 2021). Besides, IT capabilities impacts organizational performance by supporting better Customer Relationship Management. CRM systems driven by IT allows organizations to track customer preferences, interactions as well as feedback (Shahbaz *et al.,* 2021). This provides valuable insights which can be used to develop targeted marketing strategies and enhance customer service. Building strong relationships with customers helps organizations to drive sales growth, enhance brand reputation and increase customer retention (Khan *et al.,* 2022; Ullah *et al.,* 2020; Cavaliere *et al.,* 2021). IT capabilities support virtual collaboration and remote work, which has gained importance in the modern business environment.

Information technology capabilities optimizes organizational performance by leading greater operational efficiency (Gupta *et al.,* 2020; Li *et al.,* 2021). Cloud computing allows organizations to improve collaboration, reduce IT costs, and enhance data security to improve organizational performance inclusive (Wang *et al.,* 2020). In addition, quality enhancement is achieved by organization by utilizing Information Technology so as to ensure reliability and continuous improvement (Johnson & Sollecito, 2018). While, digital innovation fosters ingenuity, drives growth and stability as well as influences advanced technologies (Si *et al.,* 2023).

Basically, providing employees with tools and technologies required for efficient performance from anywhere helps organizations retain top talent, as well as increase employee satisfaction, leading to overall productivity.

Thus, the research hypotheses established is as follows:

H3: Information Technology Capabilities has a positive impact on Organizational Performance.

3.4. Digital Supply Chain Impact on Organizational Performance with mediating role of Information Technology Capabilities

One of the primary role IT capabilities play in harnessing the advantages of digital supply chains is to enhance organizational performance (Asamoah *et al.,* 2021). Though, digital supply chains influence advanced technologies big data analytics and artificial intelligence to optimize supply chain processes (Benzidia *et al.,* 2021). These technologies also necessitate IT capabilities, which acts as a bridge between improved organizational performance and digital supply chain initiatives (Yang *et al.,* 2021). Organizations which implement digital supply chains must simultaneously develop expertise in IT infrastructure to utilize and manage advanced technologies (Zamani *et al.,* 2023). For example, Internet of Things provide monitoring of goods, but in order to leverage such data, organizations need sophisticated IT systems which are capable of analyzing vast amounts of information (Sestino *et al.,* 2020). This type of integration impacts operational efficiency by minimizing errors, optimizing resource allocation, and reducing manual intervention, leading to significant enhancements in organizational performance.

In addition, adoption of digital supply chains necessitates a need for advanced IT solutions, while developing a culture of continuous innovation and improvement within an organization (Ghasge *et al.,* 2020). When organizations integrate technologies such as Machine Learning and Artificial Intelligence into supply chain operations, they improve their predictive analytics capabilities (Modgil *et al.,* 2022). This ultimately enables precise inventory management and forecasting. Sequentially, this reduces the cost associated with stock outs and improves customer satisfaction through reliable and timely delivery of products. The Blockchain

technology used for supply chain transparency requires secure transaction protocols, which reinforces organization's IT capabilities (Benzidia *et al.,* 2021). These IT capabilities support supply chain optimization, risk management and strategic planning by offering real-time insights.

Digital procurement impacts competence and resilience (Alabdali & Salam, 2022; Hallikas *et al.,* 2021); whereby, achieving operational efficiency focusing on quality assurance and effective customer satisfaction (Afthanorhan *et al.,* 2012). Cloud computing encourages teamwork, supports remote operations and proposes scalable resources (Bello *et al.,* 2021). Whereby, digital innovation as well as information technology capabilities promotes competitive advantages and serves as a bridge to informed decision-making and enhanced data management (Sohu *et al.,* 2023; Khan *et al.,*2024; Li *et al.,* 2021; Martínez-Peláez *et al.,* 2023).

In addition to enhancing operational efficiency, the mediating role of IT capabilities in digital supply chains gives competitive advantage and improves strategic agility (Hu *et al.,* 2022). Organizations with IT capabilities rapidly adapt to technological advancements, evolving customer demands and changing market conditions (Khasdam *et al.,* 2020). As, it enables organizations to pivot strategies swiftly, enter new markets efficiently and launch new products faster.

Thus, the research hypotheses established is as follows:

H4: Digital Supply Chain has a positive impact on Organizational Performance with the mediating role of Information Technology Capabilities

3.5. Research Model

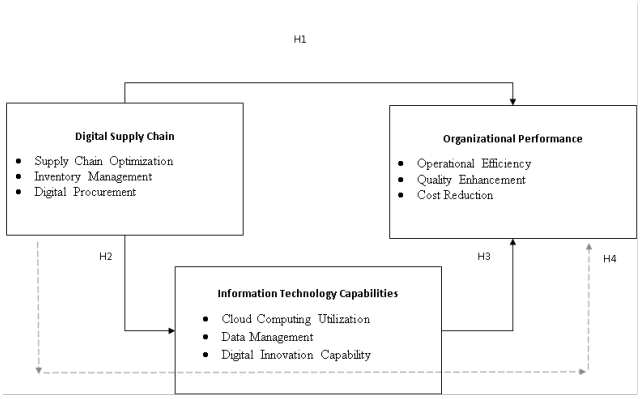

Figure 1: Conceptual Research Model

4. METHODOLOGY

4.1. Research Design & Philosophy

This research adopts quantitative approach to collect numerical data for identifying patterns, exploring relationships and statistically analyzing the relationship among variables in the manufacturing industry. The descriptive and correlational aspects involve detailed descriptions and assessments, while the causal aspect seeks to establish cause-and-effect links. Analytical and empirical, the research utilizes data analysis and measurements for conclusions. Data collection will be facilitated through a survey method, allowing for quantitative analysis of empirical data to test the research's hypotheses. This comprehensive research design ensures a thorough exploration of research questions, providing robust empirical evidence to support the findings.

The case applied in this study is a real one, which deals with actual Digital Supply Chain Managers who work in five manufacturing organizations. It seeks to offer empirical understanding of professionals who are involved in the management of digital supply chains in an active manner thus basing the study on practical application. All the three dimensions of the framework established by Zuboff are well manifested in the real-life example of Digital Supply Chain Managers in the manufacturing industry. The automation is manifested in the computerization of the routine supply chain activities, including order processing and inventory tracking. The element of informing is illustrated by the utilization of real-time data analytics and dashboards where managers will be capable of making informed decisions on the basis of operation insights. We see transformation in the incorporation of AI and IoT to redesign complete workflow of a supply chain to facilitate strategic agility and innovation.

The case presented in this study is based on aggregated fieldwork from actual Digital Supply Chain Managers working in five manufacturing organizations within the oil and gas sector. This fieldwork provides empirical insights into the real-world application of digital supply chains and IT capabilities, as well as their impact on organizational performance. The sample population for this study was drawn from active industry professionals who are directly involved in managing digital supply chains. Therefore, the findings are not hypothetical or merely illustrative

but are grounded in actual industry data.

The research adopts a Realist research philosophy due to its focus on objective measurement and hypothesis testing with statistical methods. It helps understand the causal relationships and underlying mechanisms between the three variables accurately. Methodologically, the approach is deductive, starting with a theoretical framework to develop hypotheses, which are then tested using empirical data so as to validate the theories and relationships among all the variables.

The Artic Manufacturing case illustrates how digital supply chains evolve through Zuboff's automate, informate, and transform dimensions. It begins with automation for efficiency, progresses to data-driven decision-making, and culminates in business model transformation through AI and IoT. While fictional, this case reflects broader industry trends in digital transformation, making it a useful example of how manufacturing companies move from operational optimization to strategic innovation.

4.2. Data Collection Instrument & Procedure

Data collected via a methodically designed survey, crafted based on findings from prior research and validated instruments when applicable. The survey comprises divisions corresponding to different aspects: independent, dependent, mediator, and moderator variables. Participants express their viewpoints and experiences on these variables using a 5-point Likert scale, ranging from strongly disagree to strongly agree. This approach allows for the evaluation of perceptions and experiences relevant to the research's objectives.

Data gathering entailed the dissemination of an internet-based survey for convenient access and extensive reach. Participants are sent email invitations outlining the research's objectives, voluntary involvement, confidentiality assurances, and exclusive use of research data. To maintain response levels, reminders are dispatched two weeks subsequent to the initial invitations.

The current research has made use of a quantitative approach to the subject. In particular, the author conducted an online survey questionnaire of their sample population. This methodology is preferred over that of the qualitative as the current research has sought to evaluate the relationship between two variables and the mediating role played by a third. Accordingly, the use of a quantitative design allowed the author to conduct an online survey questionnaire to ensure that they attain real-world perspectives from various individuals.

4.3. Population & Sample

The sample consists of Digital Supply Chain Managers from a specific business sector relevant to the research. The population includes five organizations from manufacturing industry. Stratified random sampling is applied for this research as it ensures representativeness, with strata based on demographic factors like age, role within the organization, and years of experience. Statistical power analysis determines the target sample size, aiming for at least seventy participants to ensure robust statistical conclusions.

- The sample population used for the current research is inclusive of those working within the manufacturing industry.
- In total, a sample of seventy Digital Supply Chain Managers is gathered for this research predominantly from the manufacturing industry.
- Digital Supply Chain Managers are selected because of their expertise in digital supply chain management, ensuring informed responses to the questionnaire.
- To attain this sample, snowball sampling approach is utilized. It ensure sufficient gathering of large sample of population efficiently.
- Primary data collection instrument is an empirical survey (or questionnaire).

4.4. Unit of Analysis

Questionnaire disseminated among Digital Supply Chain Managers of manufacturing organizations. Digital Supply Chain Managers are nominated as target group as they possess requisite understanding and expertise of the research variables, making them well-resourced for informed responses to the questionnaire.

4.5. Future Research and Empirical Validation Instructions

Future research can be directed by the analytical framework, which is focused on the relationship between the digital supply chains, IT capabilities, and organizational performance as a tested model of understanding the effects of digital transformation. The application of empirical verification in the future can be a longitudinal study of industries or geographic locations to investigate the changes in the framework and a

comparative study to determine the applicability of the framework in various industrial settings. Moreover, structural equation modeling (SEM) might be used to further confirm the fact of causality and increase the predictive potential of the model.

Moreover, in a mixed-method study, the qualitative data may be employed to put the quantitative results into context and to complement them. An example of this is, qualitative interviews may be conducted on the impact of particular cases or difficulties encountered by organizations in adopting digital supply chains, which can be later correlated with quantitative data on the performance of organizations and IT capacity. The mixed methods approach would give a more comprehensive picture of the implications of the digital supply chain on organizational performance but the breadth (with surveys) and depth (with interviews or case studies). Also, longitudinal research might follow the process of change in organizations under the typology of Zuboff over time, which qualitative interviews might reveal the difficulties and opportunities of every phase of the digital transformation.

5. DATA ANALYSIS

For the purposes of the current research, online survey questionnaire is used. This survey constituted a total of 27 items. Accordingly, the survey is published online by means of Google Forums with focus on ensuring that their survey could reach the highest possible audience in the shortest amount of time. Although, it is expected that the survey will be inclusive of hundreds of respondents, the overall response rate; nonetheless, is 170 individuals (minimum level required for creating generalizable results) regarding a given matter. In this regard, the data analysis offers segmented findings into sections. The analysis discusses demographics of the participants, and offers both graphical depictions of the survey results based on the variables of the research alongside quantitative data analysis results.

5.1. Demographics of Participants

Below figure illustrates the age distribution of the participants. Herein, it can be seen that the participants are predominantly between the ages of 28 and 37 with them comprising 41% of the population. Those between the ages of 18 and 27 and those between 38 and 47 has almost equally comprised two segments constituting 24% of the sample with the remaining constituting the rest.

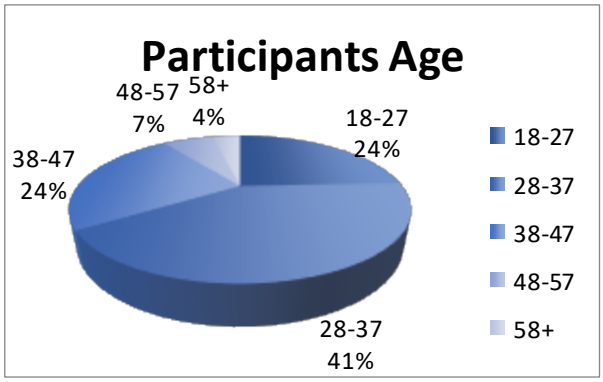

Figure 1: Participants Age

Accordingly, the below figure 2, shows that the participants are predominantly female individuals. Almost 57% of the participants are female whereas forty-three per cent are males. Moreover, figure 3 illustrates the work experience of the participants. Herein, it can be seen that the majority has between eight to sixteen years of work experience with those who has between eight and twelve years constituting nearly twenty-three per cent of the sample and those with twelve and sixteen years of work experience constituting twenty-one per cent of the sample. Figure 3, in this regard, shows that the participants, overall, has a considerable amount of work experience and are thus highly experienced professionals within their fields. These three figures, figure 1, 2, and 3 show that the participants are adult females with a considerable amount of work experience.

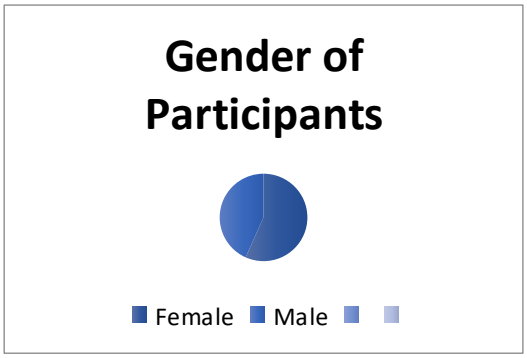

Figure 2: Gender of Participants

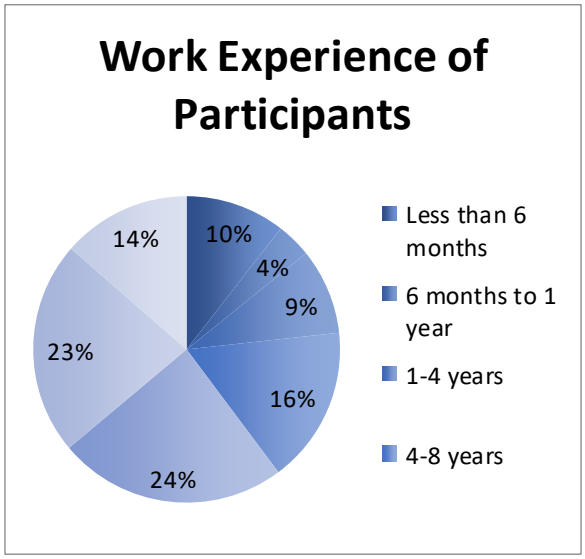

Figure 3: Work Experience of Participants

5.2. Model Measurement and validation

In assessing the reliability and validity of the data with the help of SmartPLS, one of the most important criterion is convergent validity which validates the measurement of the constructs. This is demonstrated through several key indicators: According to Hair et al . (2010), three types of reliability are Cronbach's alpha coefficient, composite reliability (CR), and average variance extracted (AVE). Cronbach's alpha is an assessment of internal consistencies with results greater than 070 being considered satisfactory for the construct under consideration. Thus, the composite reliability should be higher than 0.70 in order to make sure that the indicators adequately measure the respective construct. Besides, AVE calculates the proportion of the total variance explained by the construct as compared to the measurement errors; it's suggested that values greater than 050 can indicate acceptable level of convergent validity. For instance, if the Cronbach's alpha values are 085, composite reliability rates are 088, and AVE values are 060, all these values contribute to proving that the employed constructs provide a strong signal that convergent validity is present which further goes to illustrate and state that the measurement model is quite sound see (Table 1).

Table 1: Cronbach's Alpha, Composite Reliability, Average Variance Extracted

	Mean	*SD*	*Cronbach's Alpha*	*Composite Reliability*	*Average Variance Extracted*
Digital Supply Chain	3.0	0.784	0.881	0.893	0.621
Information Technology Capabilities	3.0	0.669	0.856	0.840	0.548
Organizational Performance	4.0	0.742	0.904	0.821	0.622

5.3. Discriminant Validity

In Table 2 the discriminant validity is meant to ascertain that a measure in a measurement model has uniqueness that is not in any way correlated to other measures. It decides whether a construct is well different from other constructs and captures aspects of the phenomena that are not covered by other constructs. The heterotrait-monotrait ratio (HTMT) can be used, and the acceptable values should be below 0.85 which can be considered adequate discriminant validity as a general rule.

Table 2: Discriminant Validity

Heterotrait-Monotrait Ratio (HTMT)

	Construct	1	2	3
1	Digital Supply Chain	---		
2	Information Technology Capabilities	0.548	---	
3	Organizational Performance	0.610	0.684	---

Such measures ensure that each of the constructs gives unique information that does not in any way replicate the information given by the other constructs, which in turn increases the overall validity and interpretability of the measurement model. Table 2 demonstrate the acceptable positive correlation among the study variables.

5.4. Structured Model Assessment

Structural Equation Modeling (SEM) therefore appears as a detailed statistical procedure as far as assessing inter-variable correlations are considered. SEM uses factor analysis and multiple regression analysis in least 2 ways; to evaluate the measurement model which evaluates the level in which the observed variables define the latent constructs and the structural model which

evaluates the relation between several latent causes. This method helps research to establish theoretical models that directly and indirectly determining the effects within a system thereby enabling researchers to understand the interplay of the pathways within the system see (Figure 4).

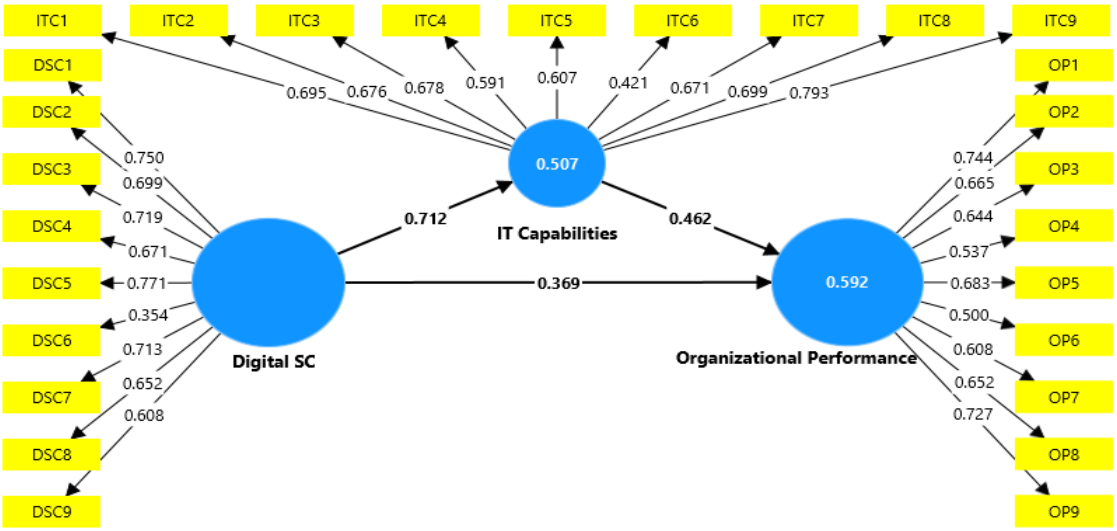

Figure 4: Structured Model

Table 3: Hypothesis Assessment

	Relationship	*Beta Coefficient*	*t-value*	*p-value*	*Decision*
H1	Digital SC→OP	0.369	2.54	0.000	Sig
H2	Digital SC→ITC	0.712	3.87	0.000	Sig
H3	ITC→ OP	0.462	2.99	0.000	Sig

Indirect Effect (Mediation)

Table 4: Mediating effect

		Beta Coefficient	*SE*	*p-value*	*Upper Confidence Interval*	*Lower Confidence Interval*	*Decision*
H4	Digital SC→ITC→OP	0.402	0.195	0.001	0.711	0.241	PM

PM=Partially Mediation, SE=Standard Error

As highlighted above in the Table 3 and 4 and figure 4, the findings from the analysis provide a clear understand of the interactions and the moderating roles of the variables within the suggested model. The direct relations point towards the fact that the Digital SC to OP and Digital SC to ITC are manageable as both have beta coefficients of 0.369 and 0.712 respectively holding p values of 0.000 and 't' values that are more than 2.50 proving the hypothesis significance. Also, the influence of factors that define IT Capability (ITC) and Operational Performance (OP) is also realized as having an influence with a beta coefficient analyzing the two samples of words yielded a t-test and a p-value of 0.000. In regard to moderation, the indirect effect of one mediator, ITC on the relationship of Digital SC and OP is statically significant having a value of 0.402 for the beta coefficient, 0.001 for the p-value and the 95% C.I estimates of 0.241 and 0.711. This independently implies that ITC, at least to some extent, moderates the Digital SC – OP relationship, while at the same time revealing a direct link between Digital SC and OP. In summary, these findings reveal a mediated model where IT Capability fully mediates the association between Digital Supply Chain and Organizational Performance, and at the same time, stress the direct impact of the Digital SC on IT Capability and OP.

Table 4: Zuboff's IT Power Typology in the Context of Digital Supply Chains

Power Type	*Description*	*Digital Supply Chain Example*	*Organizational Outcome*
Automate	Use of IT to digitize and streamline manual or repetitive tasks.	Automated inventory tracking, order processing, warehouse systems	Increased efficiency and cost savings
Informate	Generation and use of data to support decision-making and improve visibility.	Real-time dashboards, performance metrics, predictive analytics	Enhanced transparency and insight
Transform	Fundamental redesign of processes enabled by advanced digital technologies.	AI-based demand forecasting, IoT-enabled supply networks	Strategic agility and innovation

Table 4 shows the way in which the IT power typology of Zuboff is used in the digital supply chain context, where the typology focuses on strategic change as progressed to operational efficiency. Automate is the dimension that characterizes the background of IT involvement in the facilitation of regular workflows and Informate represents the capacity of digital processes to produce action-oriented knowledge with the help of data visibility. The stage of Transform is the highest level of IT application, at which organizations restructure processes and strategy with the help of such technologies as AI and IoT. Such typology is not only used to classify the different degrees of digital maturity of the firms but also as a diagnostic tool to determine the necessary level of extra investment or capabilities development to move the organization towards its performance.

6. DISCUSSION OF RESULTS

- H1: Digital Supply Chain has a positive impact on Organizational Performance

There is metamorphic potential of digital technologies in augmenting supply chain processes. As, it has a major role in enhancing organizational performance. By integrating the transformative technologies such as Artificial Intelligence, etc., digital supply chains can achieve increased transparency and efficiency. This revolution promises substantial benefits in strategic agility, operational efficiency as well as cost reduction. Empirical evidence from participant analysis reinforces literature's assertions. Majority of the participants reported substantial improvements in organizational performance due to the adoption of digital supply chain, verifying the transformative potential of these advanced technologies. Alignment between practical experiences and theoretical insights highlights critical role of digital supply chain in driving the organizational success in contemporary business.

- H2: Digital Supply Chain has a positive impact on Information Technology Capabilities

A synergistic relationship between digital supply chain initiatives and enhancement of IT capabilities within organizations is observed during the research. Advanced technologies necessitate robust IT infrastructure and expertise, driving organizations to invest in up-skilling their IT workforce to develop a sophisticated IT system. This integration optimizes supply chain developments. Besides, it enhances IT capabilities, to create a culture of adaptability and innovation. H2 is supported by the survey data because significant portion of participants agreed that their organizations applied contemporary IT capabilities. This indicates that advanced digital tools are placed in their organizations. It is further confirmed by the responses where around fifty percent participants acknowledged their proficiency in IT capabilities.

However, mixed sentiments are revealed about the integration of advanced IT capabilities. Nonetheless, a notable proportion disagreed with the lack of integration, a significant minority

disagreed, signifying areas for enhancement. Although, participants viewed their IT systems as facilitating, there are concerns regarding the limitations of these systems to particular job roles. Overall, positive impact of digital supply chains on IT capabilities is observed through findings. Basically, continuous investment in IT workforce programs and infrastructure is key to maximizing the benefits of digital supply chain.

- H3: Information Technology Capabilities has a positive impact on Organizational Performance

The hypothesis is braced by the survey data analysis as well as literature review. The literature review has demonstrated the crucial role of IT capabilities in improving diverse facets of organizational success. The advanced IT systems streamline operations by improving communication, augmenting resource allocation and automating routine tasks. Enterprise Resource Planning systems helps in taking decision-making across departments, enables real-time data sharing, reduces operational costs with fast response time to market changes. IT capabilities facilitates use of data analytics so as to offer an insight into market trends, customer behavior and operational performance. The data-driven approach supports superior strategic planning, identifies new opportunities, supports effective decision-making, mitigating risks and drives growth. Correspondingly, IT capabilities cultivate innovation by leveraging emerging technologies and deploying new business models in organizations. It enhances customer satisfaction and it also helps meet the evolving customer needs. Survey data verifies these findings as, majority of the participants agreed with the fact that outmoded IT mired organizational performance, while underscoring the significance of maintaining modern IT systems. The survey also revealed that organizations with vigorous IT capabilities minimizes wastage, provides regular training and fosters innovation and enhances professional development.

- H4: Digital Supply Chain has a positive impact on Organizational Performance with the mediating role of Information Technology Capabilities'

Digital Supply Chain positively impacts organizational performance with mediating role of IT capabilities is supported by previous literature as well as empirical data. It is established that IT capabilities are key factors in harnessing the full potential of digital supply chain. Digital supply chains influence advanced technologies; however, they require effective IT capabilities to monitor goods, enhance operational efficiency and evaluate vast amounts of data by optimizing resource allocation, reducing manual intervention and minimizing errors. Also, adoption of digital supply chains focuses on a culture of constant improvement by integrating artificial intelligence and other advanced technologies into supply chain processes and operations. Such IT capabilities manages risk, plans strategically and support supply chain optimization by offering a real-time insight. As a consequence, IT capabilities develops a link between digital supply chain initiatives and improved organizational performance. Empirical data and analysis also supports the mentioned hypothesis because the survey showed a strong positive relationship between IT capabilities, organizational performance and digital supply chains.

The typology is diagnostic, as it helps assess the stages of digital transformation in organizations. It highlights the ethical and political implications of strategic IT visibility, such as concerns over data privacy, surveillance, and control by leadership. Power asymmetries may arise, as organizations with more advanced IT capabilities could dominate decision-making, while resistance may occur from employees fearing job displacement or loss of autonomy in an increasingly digital environment.

The implementation of digital supply chain systems would increase the power disparity within organizations, where the decision-making and control would go to individuals who have expertise in IT and data analytics. Automation and data-based decision-making may also mean that the leadership and/or the IT department gain more power and frontline workers lose their autonomy. Employees might develop resistance based on the fact that they feel estranged by overreliance on technology and are fearful of losing their jobs or decreased power to make decisions. Also, workers with low skills can find themselves powerless, unless they are part of the digital transformation process.

7. CONCLUSION AND RECOMMENDATIONS

Through the present research, fundamental role of

digital supply chains in improving organizational performance, predominantly within the manufacturing industry is observed. The research emphasized that robust IT capabilities are pivotal for leveraging the benefits of digital supply chains. IT capabilities permit organizations to optimize resource allocation, automate routine tasks and streamline operations. Thereby, increasing productivity and reducing operational costs. Through, advanced technologies like IoT, AI and big data analytics, predictive analytics can be provided, leading to significant improvement in inventory management.

In conclusion, the incorporation of IT capabilities and digital supply chains leads to swift adaption to market changes and enhanced strategic agility. This strategic swiftness is key to achieving long-term success and maintaining a competitive advantage in a highly dynamic manufacturing industry. It is observed that the variables of digital supply chain and organizational performance share a close and strong relationship through correlation. Accordingly, IT capabilities is found to share a similar relationship with both variables and thus allowed the author to accept both of their hypotheses, that these variables shared a strong and close relationship with IT capabilities playing a potential mediating role. Further research would be however necessary not only to reinforce the findings of the current research but also add further insight into the matter.

This research is also able to provide various recommendations. Most primarily, the manufacturing industries of the nation should focus more so on integrating digital technologies into their supply chains and operations as well as on attempting to improve the communication technologies and systems at play within their operations. As organizational performance is seen to falter and employees lacked sufficient trust in leadership decisions, it can be recommended that manufacturing organizations focus on improving the trust that employees have as well as on assessing and improving performance by means of performance standards. Basically, by embracing digital supply chain and financing in IT capabilities, manufacturing organizations can gain recognition and achievement through significant improvements in operational efficiency and performance. Such efforts eventually position them in a technology-driven business environment.

Future studies might include sector-based implementations of the digital supply chain concept, investigating how the typology developed by Zuboff (automate, informate, transform) is used by different sectors of logistics, such as healthcare, retail, and logistics. Longitudinal studies would be useful to follow the evolution of organizations through such stages overtime and their influence on the organizational performance. Also, the exploration of ethical aspects of digital transformation like privacy issues and employee autonomy may provide more insight into the socio-political implications. Mixed method research using both qualitative data in the form of interviews and quantitative data would also assist in appreciating the human factor in technology adoption such as resistance and change in organizational culture.

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