THE IMPACT OF DIGITAL TRANSFORMATION ON SUPPLY CHAIN PERFORMANCE IN OIL AND GAS INDUSTRY

By

SYAKILLA BAHARIM

Thesis Submitted to
College of Business
Universiti Utara Malaysia,
in Partial Fulfillment of the Requirement for the Master of Sceince (Management)

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ABSTRACT

This study investigates the impact of digital transformation on supply chain performance in the oil and gas industry. With the rapid advancement of technologies such as Artificial Intelligence (AI), Internet of Things (IoT), Blockchain Technology (BT), and Cloud Computing (CC), understanding their effects on supply chain efficiency, responsiveness, and transparency has become increasingly critical. Employing a quantitative research design, the study utilized a cross-sectional survey distributed to 150 professionals within the oil and gas sector. The survey, consisting of validated measurement scales, gathered data on perceptions of digital transformation technologies and their influence on supply chain performance. Statistical analysis, including correlation and regression techniques, was conducted using SPSS to explore the relationships between the technologies and performance outcomes. The results reveal that all four digital transformation technologies—AI, IoT, BT, and CC—positively impact supply chain performance. The findings underscore the importance of integrating these technologies into supply chain strategies to achieve enhanced efficiency, transparency, and responsiveness. Organizations in the oil and gas industry are encouraged to invest in and adopt these digital solutions to maintain a competitive edge and optimize their supply chain operations. This study contributes to the existing body of knowledge by providing empirical evidence on the specific impacts of digital transformation technologies on supply chain performance within the oil and gas industry. It offers actionable insights for industry practitioners and policymakers aiming to leverage digital advancements for improved supply chain management.

Keywords: Digital Transformation, Supply Chain Performance, Artificial Intelligence, Internet of Things, Blockchain Technology, Cloud Computing, Oil and Gas Industry

ABSTRAK

Kajian ini menyelidik kesan transformasi digital terhadap prestasi rantaian bekalan dalam industri minyak dan gas. Dengan kemajuan pesat dalam teknologi seperti Kecerdasan Buatan (AI), Internet Benda (IoT), Teknologi Rantaian Blok (BT), dan Pengkomputeran Awan (CC), memahami kesannya terhadap kecekapan, kepekaan, dan ketelusan rantaian bekalan menjadi semakin kritikal. Menggunakan reka bentuk penyelidikan kuantitatif, kajian ini menggunakan tinjauan rentas-seksyen yang diedarkan kepada 150 profesional dalam sektor minyak dan gas. Tinjauan tersebut, yang terdiri daripada skala pengukuran yang disahkan, mengumpul data mengenai persepsi terhadap teknologi transformasi digital dan pengaruhnya terhadap prestasi rantaian bekalan. Analisis statistik, termasuk teknik korelasi dan regresi, telah dilakukan menggunakan SPSS untuk meneroka hubungan antara teknologi dan hasil prestasi. Hasil kajian menunjukkan bahawa keempat-empat teknologi transformasi digital—AI, IoT, BT, dan CC—memberi kesan positif terhadap prestasi rantaian bekalan. Penemuan ini menekankan kepentingan mengintegrasikan teknologi-teknologi ini dalam strategi rantaian bekalan untuk mencapai kecekapan, ketelusan, dan kepekaan yang lebih baik. Organisasi dalam industri minyak dan gas disarankan untuk melabur dalam dan menerapkan penyelesaian digital ini bagi mengekalkan kelebihan kompetitif dan mengoptimumkan operasi rantaian bekalan mereka. Kajian ini menyumbang kepada pengetahuan sedia ada dengan menyediakan bukti empirikal mengenai kesan spesifik teknologi transformasi digital terhadap prestasi rantaian bekalan dalam industri minyak dan gas. Ia menawarkan pandangan yang boleh diambil tindakan oleh pengamal industri dan pembuat dasar yang ingin memanfaatkan kemajuan digital untuk pengurusan rantaian bekalan yang lebih baik.

Kata Kunci: Transformasi Digital, Prestasi Rantaian Bekalan, Kecerdasan Buatan, Internet Benda, Teknologi Rantaian Blok, Pengkomputeran Awan, Industri Minyak dan Gas

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CHAPTER 1

INTRODUCTION

1.0 Introduction

The advent of the digital era has resulted in substantial transformations to the supply chain. Globally, these changes have been accelerated by the COVID-19 pandemic. Accelerating digital transformation has become increasingly crucial in the present times. If an application of technology does not bring about significant changes to the organization model and impact the strategy, system, culture, attitude, and community, then it cannot be considered transformative. Due to the globalization of existing industrial markets and the penetration of international boundaries, the business world today is seeing increased competition. Companies must vigilantly monitor new digital technologies that have the potential to transform their industry in order to remain competitive in the global market.

The supply chain in the oil and gas sector is inherently intricate, involving multiple stakeholders, extended geographical networks, and substantial capital investments. The advent of digital technologies ranging from Artificial Intelligence (AI), Cloud Computing (CC) to Blockchain Technology (BT) and Internet of Things (IoT), promises to enhance efficiency, transparency, and responsiveness within this supply chain. However, the extent to which these digital innovations impact supply chain performance remains a subject of considerable interest and debate.

This thesis aims to explore the impact of digital transformation on supply chain performance specifically within the oil and gas industry. By investigating how digital tools and strategies influence key performance indicators such as operational efficiency, cost management, and risk mitigation, this research seeks to provide a comprehensive understanding of the benefits and challenges associated with digital integration. Through a detailed analysis of current practices, case studies, and industry trends, this study will offer insights into how digital transformation can drive competitive advantage and sustain performance improvements in one of the world's most critical and resource-intensive sectors. In undertaking this exploration, the thesis will address the following research questions: Does digital transformation affect supply chain performance metrics in the oil and gas industry? What are the key drivers and barriers to successful digital integration? And how can companies leverage digital technologies to optimize their supply chain operations? By addressing these questions, this research aspires to contribute valuable knowledge to both academia and industry practitioners, offering strategic recommendations for enhancing supply chain performance through digital transformation in the oil and gas sector.

1.1 Background of Research

The oil and gas industry is a cornerstone of the global economy, providing essential energy resources that drive industrial activities and daily life. However, this sector is characterized by its complex and multifaceted supply chain, which spans upstream exploration and production, midstream transportation and storage, and downstream refining and distribution. Managing such a vast and intricate supply chain involves

coordinating numerous processes, stakeholders, and geographic locations, often under volatile market conditions and regulatory pressures.

The capacity to oversee multiple stakeholders, encompassing extensive quantities of data and information, is a fundamental advantage of digitizing supply chain processes (Golicic & Boerstler, 2018). In recent years, the industry has faced mounting challenges including fluctuating oil prices, environmental regulations, and the need for increased operational efficiency. Concurrently, the rapid advancement of digital technologies offers new avenues for addressing these challenges. Digital transformation encompassing technologies like AI, CC, IoT and BT promise to enhance various aspects of supply chain management. These technologies can provide real-time data, predictive analytics, and automated processes, which can potentially streamline operations, reduce costs, and improve decision-making.

Digitalization will lead to an increase in opportunities for enterprises and supply chain strategy. Management is increasingly endorsing digital transformation initiatives, and numerous companies are keen to participate in the digital revolution due to their recognition of the significance of digital technology for their own expansion and organizational triumph. Prior to the integration of digital technologies into the current supply chain, it is necessary to have a solid understanding of their implications on businesses (Ning & Yao, 2023).

1.2 Problem Statement

Oil and gas firms have made significant technological advancements in recent years, particularly with the implementation of digital transformation initiatives. Despite the increasing adoption of digital technologies in the oil and gas industry, there is a limited understanding of how these technologies specifically affect supply chain performance. Many organizations have yet to fully comprehend the extent to which digital tools such as AI, CC, IoT and BT can enhance operational efficiency, cost management, and overall supply chain effectiveness.

Accurately measuring the impact of digital transformation on supply chain performance presents a significant challenge. Traditional performance metrics may not fully capture the benefits or limitations of digital integration. There is a need for a comprehensive framework that can effectively assess how digital innovations influence key performance indicators such as lead times, inventory levels, and risk management. While digital technologies offer substantial potential, their implementation within the oil and gas supply chain is fraught with obstacles. High costs, integration complexities, and cybersecurity risks pose substantial barriers. Understanding these challenges and identifying strategies to overcome them is crucial for leveraging digital transformation effectively.

Organizations in the oil and gas sector often struggle to align digital transformation initiatives with their strategic objectives. There is a lack of strategic guidance on how to integrate digital solutions with existing processes and how to foster a culture that supports technological change. This gap can hinder the realization of potential benefits and impact overall supply chain performance. The degree of digital transformation adoption varies widely across the oil and gas sector, leading to inconsistent impacts on

supply chain performance. This variability creates a need to investigate how different levels of digital integration affect supply chain efficiency and resilience and to identify best practices for achieving optimal outcomes.

1.3 Research Questions

RQ1: Does AI significantly influence the supply chain performance among oil and gas companies in Malaysia?

RQ2: Does CC significantly influence the supply chain performance among oil and gas companies in Malaysia?

RQ3: Does IoT significantly influence the supply chain performance among oil and gas companies in Malaysia?

RQ4: Does BT significantly influence the supply chain performance among oil and gas companies in Malaysia?

1.4 Research Objectives

RO1: To examine the effect of AI on the supply chain performance among oil and gas companies in Malaysia.

RO2: To examine the effect of CC on the supply chain performance among oil and gas companies in Malaysia.

RO3: To examine the effect of IoT on the on the supply chain performance among oil and gas companies in Malaysia.

RO4: To examine the effect of BT on the on the supply chain performance among oil and gas companies in Malaysia.

1.5 Scope of Research

According to research conducted by British Petroleum, natural gas and oil collectively contribute to 57% of global energy consumption. The study reveals that natural gas consumption has grown by 3% globally, while oil consumption has increased by 1.8%. Such news serves as a catalyst for rapid technological advancement in the oil and gas industry. The research primarily concentrates on Malaysia oil and gas companies, with a specific focus on major players operating across diverse regions. It includes both developed and emerging markets to provide a comprehensive perspective on how digital transformation affects supply chain performance in different geographical contexts.

The study examines a range of digital technologies relevant to the oil and gas supply chain. This includes AI, CC, IoT and BT. The research will assess how these technologies are being utilized, their integration into supply chain operations, and their impact on performance metrics. Key performance indicators (KPIs) that are relevant to supply chain management, including operational efficiency, cost management, inventory levels, lead times, and risk mitigation are discovered in this research. These metrics are critical in evaluating the effectiveness of digital technologies in enhancing supply chain performance.

The research investigates how digital transformation aligns with organizational strategies and objectives within the oil and gas sector. It seeks to understand how companies can effectively integrate digital solutions with existing processes and foster a culture supportive of technological change. The results of the study illustrate the

vitality of digital transformation on supply chain. In order to accomplish this, the following part examines the existing body of literature. Subsequently, an examination of the research methodologies, findings, and their theoretical and practical implications, constraints, recommendations for future investigations, and ultimately, a concluding statement will be presented.

1.6 Significance of Research

Research holds significant importance due to several key reasons:

Enhanced Operational Efficiency: Gaining insight into the impact of digital transformation on the efficiency of supply chains can assist the oil and gas sector in optimising operations, cutting expenses, and enhancing resource allocation. Employing digital technology strategically helps reduce operational risks in the supply chain, enhance visibility, and optimise processes.

Competitive Advantage: Businesses that leverage digital transformation projects can be more effectively adapt to changing consumer demands, government regulations, and market conditions in the current dynamic business landscape**.** Organizations can get advantages from research in this area by acquiring knowledge of innovative methods and technologies that can enhance their competitive edge in the market.

Risk Management and Resilience: Digitalization allows for the timely provision of information on possible disruptions such as geopolitical instability, supplier shortages, or environmental hazards, facilitating proactive risk management and enhancing

supply chain resilience. Oil and gas organisations can improve their preparedness for unforeseen events, maintain operational efficiency in challenging conditions, and mitigate risks by leveraging digital tools and analytics.

Sustainability and Environmental Impact: Implementing digital transformation initiatives across the oil and gas supply chain can enhance energy efficiency, minimise emissions, and mitigate environmental harm, thereby aligning with sustainability goals. Researchers in this subject focus on minimizing waste, maximizing resources, and integrating predictive maintenance using digital technology, all while prioritizing cost-effectiveness and environmental sustainability.

Industry Collaboration and Innovation: Study leads to enhanced communication and collaboration among academic institutions, businesses, and suppliers, benefiting all parties involved. The gas and oil industry may drive innovation, experiment with new business models, and shape future standards by exchanging digital supply chain management strategies, experiences, and upcoming trends.

1.7 Definition of Key Terms

Digital Transformation:

Digital transformation describes the process by which businesses entirely reimagine their operations and the value they deliver to customers by incorporating digital technology into their models, processes, and operations. The supply chain of the oil and gas industry is currently experiencing a process of digital transformation, which

involves utilizing technologies such as the AI, CC, IoT and BT to enhance transparency, efficiency, and decision-making.

Supply Chain Performance:

Supply chain performance is the measure of how effectively the various components of a supply chain work together to accomplish objectives and meet customer needs. Supply chain efficiency, responsiveness, reliability, cycle time, inventory turnover, and sustainability metrics are examples of key performance indicators (KPIs) used to assess performance in the oil and gas industry (Ning & Yao, 2023).

Oil and Gas Industry:

The oil and gas industry encompasses activities such as exploration, extraction, refining, transportation, and distribution. It includes a wide range of businesses, such as those involved in exploring and extracting resources, transporting and storing them, refining and distributing them, as well as companies that supply related services, supplies, and contractors.

Artificial Intelligence (AI):

AI is the study of developing robots capable of learning, reasoning, problem solving, and decision making, all of which are typically associated with human intelligence. AI has a variety of applications in the oil and gas industry, including optimizing supply chain operations, managing risks, forecasting demand, and performing predictive maintenance.

Cloud Computing (CC):

CC refers to the concept in which data storage, processing capacity, and software applications are made available on a pay-as-you-go basis via the internet. The oil and gas business can use CC to enable remote data access, stakeholder cooperation, IT infrastructure scalability, and the cost-effective adoption of digital solutions.

Internet of Things (IoT):

IoT refers to a system of interconnected computing devices, sensors, and networks that autonomously gather and communicate data via the internet. The utilisation of IoT technology in the oil and gas industry facilitates the monitoring of equipment health, optimisation of asset performance, augmentation of safety measures, and enables real-time decision-making throughout the supply chain.

Blockchain Technology (BT):

BT enables safe and transparent data movement and record-keeping. It is a decentralized and distributed ledger. The better traceability, authentication, and compliance management provided by BT can help oil and gas supply chain assets, transactions, and contracts.

1.8 Organization of Research

The introduction sets the stage for the research by outlining the significance of digital transformation in the context of the oil and gas industry. It begins with a brief overview of the oil and gas sector, highlighting its traditional supply chain challenges and the increasing role of digital technologies. This section then defines digital transformation and its potential benefits and challenges. The problem statement follows, detailing

specific issues related to supply chain performance that digital transformation aims to address. The research objectives and questions are presented to guide the study, culminating in an explanation of the research scope and the thesis structure.

Literature review in chapter 2 provides a comprehensive review of existing research on digital transformation and its effects on supply chain performance. It begins with a discussion on the evolution of digital technologies and their applications within the oil and gas sector. Key themes include advancements such as IoT, BT, AI, and CC. The review continues by examining empirical studies and theoretical frameworks that connect digital transformation with improvements in supply chain efficiency, flexibility, and resilience. Gaps in the current literature are identified, which helps justify the need for the current research. This chapter concludes with a summary of key findings from the literature and how they inform the research questions.

The methodology chapter outlines the research design and approach used to investigate the impact of digital transformation on supply chain performance. It describes the research strategy, including whether it is qualitative, quantitative, or mixed-methods. This section details the data collection methods, such as surveys, interviews, or case studies, and explains the sampling techniques and criteria for selecting participants. The chapter also covers the data analysis procedures, including statistical tools or thematic analysis methods used to interpret the findings. Additionally, ethical considerations and limitations of the research are discussed to provide a transparent and robust approach to the study.

In chapter 4, the findings from the research are presented and analyzed. It starts with a detailed account of the data collected, including descriptive statistics or thematic results. The discussion interprets these results in the context of the research questions and objectives, comparing them with the literature reviewed in chapter 2. The impact of digital transformation on various aspects of supply chain performance, such as efficiency, cost reduction, and responsiveness, is critically analyzed. This section also addresses any unexpected findings and their implications for the oil and gas industry. The chapter concludes by linking the results to the broader implications for practice and theory.

The final chapter summarizes the key findings of the research and their contributions to the field of supply chain management and digital transformation. It revisits the research objectives and questions, reflecting on how the study has addressed them. Practical recommendations for industry stakeholders are provided based on the research findings. The chapter also discusses the study's limitations and suggests areas for future research to build upon the current work. Finally, it concludes with a reflection on the overall impact of digital transformation on supply chain performance in the oil and gas industry and its future prospects.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The adoption of digital technology across a corporation, known as digital transformation, causes significant changes in organizational operations and the value they offer to consumers. This adjustment has a substantial influence on the effectiveness of the supply chain (Gebayew et al., 2018). Digital technology has the potential to significantly change supply chain operations by improving efficiency, transparency, and the speed of decision-making. Digital transformation enables organizations to enhance inventory management, streamline transportation and logistics processes, and enhance communication and collaboration across the supply chain. This enables them to more effectively forecast and react to fluctuations in demand, identify cost-saving measures and optimize their operations and enhance customer satisfaction by expediting order fulfillment and delivery.

This chapter reviews the existing literature on digital transformation and its impact on supply chain performance, with a focus on the oil and gas sector. It discusses various frameworks and theories relevant to digital transformation and supply chain management. By examining previous research, this chapter identifies gaps in the current knowledge and sets the context for the study's contributions. The review includes an analysis of technological innovations, industry-specific challenges, and the broader implications of digital advancements.

2.1 Supply Chain Performance

Supply chain performance pertains to a company's ability to effectively discover, use, and integrate data and resources from both internal and external sources in order to support the overall functioning of the supply chain. Ning & Yao (2023) propose classifying this phenomenon into four distinct dimensions: information dissemination, activity synchronisation, corporate amalgamation, and supply chain adaptability. The aforementioned aspects, including information interchange, transaction coordination, process integration, and response to market demands, are essential for ensuring efficient supply chain management. In order to reduce these risks, a study highlights the importance of creating a thorough plan for digital strategy, encouraging innovation and the implementation of technology, and enhancing employees' digital skills. Together, these elements enable the efficient integration of new technology in the oil and gas sector. In the context of the oil and gas industry, "digital transformation" refers to the integration of digital technologies throughout the entire value chain, encompassing activities such as exploration, extraction, processing, and distribution. It involves the implementation of data- driven initiatives, reducing expenses, enhancing effectiveness, and optimizing operations using state-of-the-art digital tools and platforms. Few studies have been discovered for this context.

Performance measurement in supply chains typically involves various metrics and frameworks. Traditionally, supply chain performance was assessed using operational metrics such as cost, quality, and delivery time. However, modern approaches have expanded to include a broader range of performance indicators.

Key Performance Indicators (KPIs): KPIs are essential tools for evaluating supply chain performance. Common KPIs include order fulfillment rates, inventory turnover, and supply chain cycle time (Hazen et al., 2014). Recent studies emphasize the integration of financial metrics such as return on assets (ROA) and return on investment (ROI) to provide a more comprehensive view (Gunasekaran et al., 2001).

Balanced Scorecard: The balanced scorecard framework, introduced by Kaplan and Norton (1992), has been adapted to supply chain management. It incorporates financial and non-financial metrics, including customer satisfaction, internal processes, and learning and growth. This approach provides a holistic view of performance and aligns supply chain activities with organizational strategy (Kaplan & Norton, 1996).

Supply Chain Operations Reference (SCOR) Model: The SCOR model offers a standardized framework for evaluating supply chain performance. It includes five key processes: Plan, Source, Make, Deliver, and Return, and provides benchmarks and best practices for each process (APICS, 2008). This model helps organizations assess performance relative to industry standards and identify areas for improvement.

2.2 Artificial Intelligence (AI)

The technological advance is mostly being fueled by AI-powered statistical analysis, which is altering pre-emptive repair operations and the way equipment efficiency is controlled. The application of AI is most noticeable in maintenance prediction, where sophisticated machines are used to evaluate historical as well as current information to anticipate probable malfunctions of equipment. AI makes proactive interventions

possible by spotting patterns and deviations assuring that maintenance tasks are completed exactly when they are required. In addition to improving equipment performance, this predictive method drastically decreases interruptions which is crucial in the oil and gas sector (Elahi et al., 2023).

Demand forecasting, which is the foundation of effective management of supply chains, is greatly aided by AI. Employing past data, current market patterns, and other pertinent criteria, machine learning techniques provide accurate projections of future demand. With the help of this knowledge, businesses in the oil and gas sector may avoid running out and overstock problems by matching inventory levels to projected demand. As a result, such stock management optimization boosts operational effectiveness and lowers costs. AI-driven decision-support platforms have become essential in improving the overall productivity and preciseness of decisions being made within the petroleum and gas supply chain, in addition to maintenance prediction and demand forecasting. By analyzing large datasets using automated learning methodologies, these systems offer useful knowledge for tactical decision-making (Eugene, 2023).

AI provides decision-makers with data-driven precision to successfully negotiate the intricate and unstable terrain of the oil and gas business. The oil and gas industry's variability mandates a logistics system that's not only responsive and durable but also profitable. AI helps significantly towards achieving these objectives because of its capacity to adapt to changing surroundings and learn from them. By utilizing AI technology, the oil and gas supply chain can be prepared to handle today's as well as tomorrow's risks and to be able to anticipate and reduce them (Ghadban, 2023).

2.3 Cloud Computing (CC)

CC has emerged as a significant facilitator of streamlined supply chains in the oil and gas industry, offering a wide range of capabilities that transform decision-making and operational effectiveness. This revolution revolves around the versatility of cloud-based systems, which provide an excellent foundation for data processing and storage. One of the most significant advantages of CC in the oil and gas supply chain is its ability to facilitate smooth stakeholder cooperation. Stakeholders can access and exchange data in real time across organizational and geographical boundaries via cloud-based platforms, promoting improved communication and cooperation. Increased effectiveness and responsiveness in supply chain procedures result from the simplified operations and processes for making choices brought about by this enhanced interaction (Sharif, 2023).

Cloud technologies facilitate the combination of data from many sources, making a comprehensive supply chain management strategy possible. In the oil and gas industry, operations sprawl over numerous geographic regions and involve a multitude of partners and suppliers, making the capacity to integrate and assess data from disparate sources important. Data gathered from sensors, equipment, modes of transportation, and other sources many of which are made feasible by CC provides a comprehensive picture of how things are made and the capacity to make intelligent choices. Furthermore, real-time data accessibility is enhanced by CC, which is critical for supporting decision-making based on data in the fast-paced and unpredictable oil and gas industry. By posting details to the public internet, stakeholders can obtain relevant information on a variety of components, at all times, from any location. The flexible and resilient characteristics of the supply chain are boosted by decision-makers

capabilities to react quickly to shifting market conditions, operational breakdowns, and other impediments thanks to their real-time access to data (Zhifeng1 et al., 2019).

2.4 Internet of Things (IoT)

The oil and gas industry has experienced an important development due to the IoT, which is bringing about an advancement in the visibility of supply chains and control. A new era of continuous tracking is now underway with the introduction of corresponding instruments on machinery and throughout transportation networks, providing never-before-seen insights into the security and quality of vital infrastructure. IoT-enabled sensors offer constant information sources in the field of asset administration, permitting preventative measures for ensuring asset durability. These sensors recognize and share data indicating the functionality of the equipment, the environment around it, and possible problems. Because of this real-time visibility, inconsistencies can be detected early, enabling operators to take corrective action and avert unplanned failures. Introducing condition-based programming results in significant cost reductions in addition to improvements in reliability (Sallam et al., 2023).

The IoT plays a major role in the oil and gas supply chain by making condition-based maintenance procedures easier to implement. Time-based maintenance schedules in the past have resulted in needless expenses and downtime. Instead of being triggered by preset timetables, IoT-enabled equipment conditions dictate maintenance tasks. With this flexible strategy, resources can be allocated successfully and possible problems are dealt with exactly when they arise. As a result, unplanned breakdowns

are less common and maintenance expenses are lower, all of which improve overall operational effectiveness. IoT has an impact on supply chain operations in a larger context than just operational reduction. Integrated sensors' increased accessibility makes tracking and monitoring commodities meticulously along the entire supply line practicable (Soori et al., 2023).

IoT enables a smooth information flow from resource extraction to conveyance, refining, and distribution. This openness is crucial for risk mitigation, roadblock identification, and overall operational efficiency maximization. Businesses in oil and gas industries can react quickly to interruptions thanks to the real-time data collected by IoT gear. IoT's agility is transformational when it pertains to dealing with equipment malfunctions adapting travel directions, and responding to customer movements. In a sector where operating on time is essential to efficiency, prompt actions not only lessen the effect of diversions but also guarantee that deliveries happen on time (Allioui & Mourdi, 2023).

2.5 Blockchain Technology (BT)

In oil and gas industry, BT emerges as a groundbreaking force that revolutionizes the previous paradigms and enhances the new era of transparency, safety, and also efficiency. BT integration which is an independent variable catalyzes transformative and effective changes across the different types of dimensions of the sector heralding unprecedented advancements in the supply chain management and also assisting the tracking and compliance assurance. BT also enhances the impact that lies in its capabilities for establishing a transparent and traceable supply chain in the oil and gas

area. By immutably recording every transaction and product movement from the distribution of the extraction, also engenders of the BT which has unparalleled visibility across the continuum of the supply chain. Transparency enhances the trust between the shareholders along with the encouragement of accountability, which is why it is necessary for minimizing the risks and facilitating the process of decision-making (Lara et al., 2020).

Moreover, the BT also decentralized facilities regarding the architecture field which further streamlined the management of the asset and tracking of the ownership and also transcending the conventional limitations. Through the tamper-proof ledgers creation, the BT strengthens the shareholders for the right and accurate monitoring of the ownership, managing the history and certification of the facilities and equipment. The recent transparency augments the efficiency related to the operations and enhances the more agile and resilient industry of the ecosystem. Additionally, with the help of asset management, the BT also enables the system for payment and revolutionizes the transactional dynamics in the sectors of oil and gas. With the help of digitizing transactions and leveraging the cryptocurrencies and assets tokenized, the BT also expedites the processes of payment and settlement while bolstering safety and compliance. The example optimizes the liquidity in the supply chain and reduces the risks that are linked with fraud and noncompliance regulation, thereby fostering a more financially sustainable landscape of the industry. Moreover, BT also plays a role as a cornerstone for enhancing the compliance of the regulation and reporting integrity inside the industry of oil and gas. By giving auditable records related to the transactions, emissions of the data, and also ecological impact assessments, the BT encourages the shareholders to adhere to the regulatory standards (Ahmad et al., 2022).

2.6 Theoretical Framework

The following theoretical outline draws upon numerous key theories to clarify the mechanisms through which the integration of AI, CC, IoT and BT affects supply chain performance in the oil and gas sector.

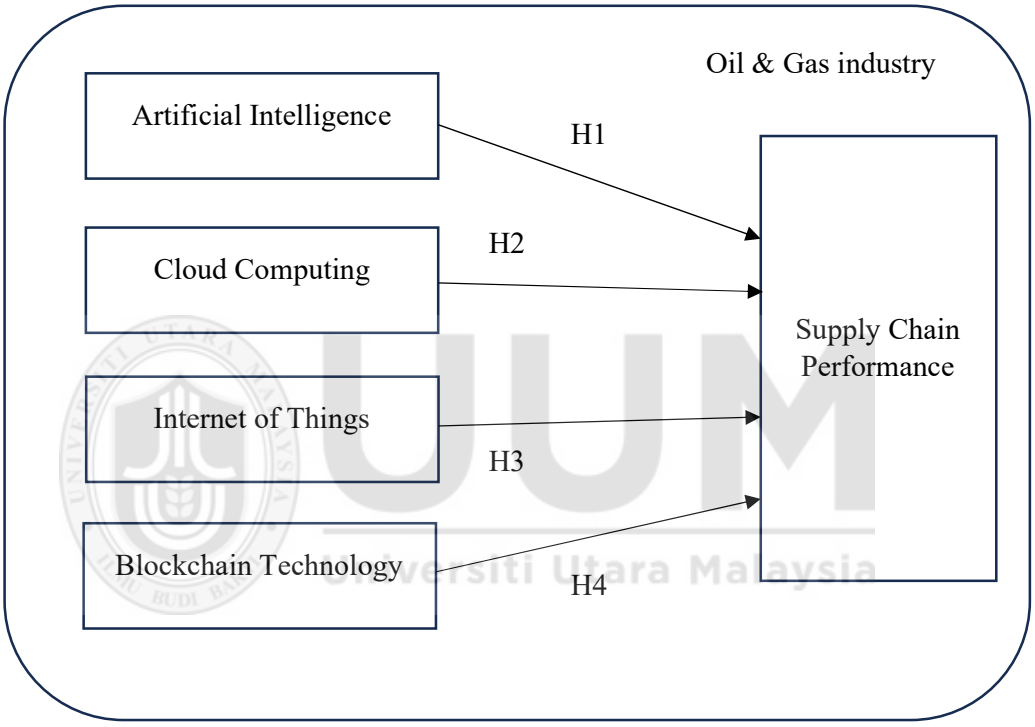


Figure 4.1: Framework

Independent variables (IVs) are variables that are manipulated or categorized by the researcher to observe their effects on other variables. They are the presumed causes or predictors in a study. Independent variables are used to explain changes or differences in dependent variables. They are considered the source of variation that affects the outcome being studied. In experimental studies, the independent variable is actively manipulated to observe its impact. In observational studies, independent variables are

typically measured and analyzed to determine their relationship with dependent variables. In regression or statistical modeling, independent variables are the predictors or explanatory variables used to predict the outcome. In this study, the independent variables are AI, CC, IoT and BT.

Dependent variables (DVs) are the outcomes or responses that are measured in a study. They are affected by changes in independent variables and represent the main focus of the research. Dependent variables are the outcomes researchers are interested in understanding or predicting. They are measured to assess the effects of independent variables. They respond to changes or variations in the independent variables. The relationship between independent and dependent variables helps researchers understand the dynamics and impact of different factors. In this study, the dependant variable is Supply Chain Performance.

2.6.1 Resource-Based View (RBV):

The Resource-Based View (RBV) is a theoretical framework in strategic management that emphasizes the role of internal resources and capabilities in gaining and sustaining competitive advantage. According to RBV, organizations achieve superior performance by leveraging their unique resources and capabilities, which are valuable, rare, inimitable, and non-substitutable. RBV guides organizations to focus on their internal strengths rather than external market conditions (Barney & Hesterly, 2015). It suggests that firms should develop and protect unique resources and capabilities to maintain a competitive edge. In the setting of the oil and gas industry, technical integration signifies a critical reserve that companies can influence to improve supply

chain performance. By integrating AI, CC, IoT, and BT into their processes, organizations can grow competencies such as real-time data analysis, prognostic conservation, and claim to estimate, thereby gaining an inexpensive edge in supply chain competence, receptiveness, and cost-effectiveness.

2.6.2 Technology Acceptance Model (TAM):

The Technology Acceptance Model (TAM) is a theoretical framework used to understand and predict how users come to accept and use new technologies. Developed by Fred Davis in 1989, TAM is grounded in the Theory of Reasoned Action (TRA) and focuses on two primary factors that influence technology adoption: Perceived Usefulness and Perceived Ease of Use. It suggests that a person's intention to use technology is influenced by the apparent practicality and comfort of usage. By representing the palpable aids of technical integration, such as improved visibility, risk management, and decision-making competencies, organizations can stimulate greater acceptance and acceptance of these technologies amongst supply chain investors (Lu et al., 2019).

2.7 Hypothesis

Hypothesis 1: Artificial Intelligence enhances Supply Chain Performance

- H1: The implementation of AI technologies in the supply chain processes of the oil and gas industry significantly improves overall supply chain performance by increasing forecasting accuracy, reducing operational costs, improving marketing activities and customer experience.

Hypothesis 2: Cloud Computing enhances Supply Chain Performance

- H2: The adoption of CC solutions in the oil and gas supply chain enhances supply chain performance by improving data accuracy, real-time information sharing, and quick response.

Hypothesis 3: Internet of Things enhances Supply Chain Performance

- H3: The integration of IoT within the supply chain operations of the oil and gas industry leads to better performance outcomes by facilitating asset utilization, enabling collaboration, enhancing information capture and operational decision-making.

Hypothesis 4: Blockchain Technology enhances Supply Chain Performance

- H4: The use of BT in the oil and gas supply chain improves performance by increasing transparency, reducing fraud, and enhancing the traceability of transactions and goods throughout the supply chain.

2.8 Summary

Overall, digital transformation has a significant impact on supply chain performance. The analysis indicates that supply chain management systems globally have experienced significant advantages from digital transformation, particularly in the post-pandemic period. The increased adoption of information and communication technology (ICT) techniques in the supply chain has led to enhanced collaboration between different departments, reduced logistics costs, and an overall increase in productivity. The study demonstrates that the use of digitization in supply chain

management has led to several notable outcomes. These include an expansion of the retail workforce, a reduction in contract-based production, and a narrowing of the gap between demand and supply.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

The research design for this study will utilize a quantitative approach to assess the impact of digital transformation on supply chain performance in the oil and gas industry. The design will focus on structured data collection through questionnaires, statistical analysis, and hypothesis testing to provide empirical evidence on the relationship between digital transformation initiatives and supply chain performance.

Through an extensive review of relevant literature and theoretical frameworks, this research endeavours to identify the fundamental mechanisms by which digital technologies influence supply chain performance. Moreover, by leveraging primary data collection methods such as questionnaire, this study aims to capture real-world insights from practitioners and industry experts, thereby enriching the analysis with practical perspectives.

3.1 Hypothesis Development

In the context of the impact of technology integration on the performance of supply chains in the oil and gas industry, the following hypothesis about the independent variables emerged.

3.1.1 Artificial Intelligence (AI):

The AI inspires prognostic analytics and strains prediction and policymaking in the supply chain. Through the modern machine learning algorithm, AI encourages organizations to analyze the major volume of data, identify different patterns, and make predictions regarding the data. This increases the overall data planning of the supply chain, inventory management, and reduction of the risks which ultimately foster performance and adaptability (Mac Kingsley, 2022). The Flux Resources platform employs a combination of distributed carrier sensor/document flows and supercomputing techniques to enhance the accuracy of global shipping disruption forecasting by 30% (Hong & Xiao, 2024). The utilization of AI technology has demonstrated its potential to enhance resource efficiency in supply chains through the facilitation of more efficient freight management and the application of predictive analytics for proactive decision-making.

3.1.2 Cloud Computing (CC):

The technological integration of CC revolutionizes the operations of the supply chain by offering a flexible and scalable platform for the storage of data, processing, and collaboration. By applying cloud-based explanations, administrations can modernize dissimilar decision-making developments which additionally enhances reserve distribution and upsurges real-time discernibility across the supply chain refining the overall efficiency and receptiveness. The implementation of fully automated SAP processes resulted in a significant enhancement in data quality and a reduction in errors

(Vijayaraj et al., 2024). The enhancement of data dependability and precision is thereafter observed.

3.1.3 Internet of Things (IoT):

The IoT initiates the monitoring in real-time, asset tracking, and condition-based maintenance among the sector of BT. By linking different devices, sensors, and equipment the IoT enhances the ability of organizations to collect actionable insights into the operational performance, proactively address the needs for the maintenance, and also identify the inefficiencies. This enhances the reliability of the supply chain, enhances the utilization of assets results in approved performance, and manages the cost (Wanasinghe et al., 2020). The integration of suppliers and customers through the IoT contributes to the improvement of supply chain performance in terms of environmental sustainability (Shafique et al., 2018). Hence, the integration of IoT components is expected to have an impact on supply chain performance.

3.1.4 Blockchain Technology (BT):

BT technology enhances transparency, security, and also traceability inside the supply chain. By creating an unchallengeable ledger of the transactions and contracts, the BT makes sure regarding data integrity, minimizes the risk of fraud, and enhances the trust between the stakeholders (Casado-Vara et al., 2018). This empowers the relations of the supply chain, improves overall risk management, and also streamlines regulatory compliance which leads to improved performance. Blockchain-based smart contracts enable stakeholders to coordinate demand signals, hence facilitating collaborative

forecasting. This coordination can mitigate both overproduction and underproduction, while also enabling precise predictions (Hong & Xiao, 2024).

3.2 Research Design

The primary aim of this research is to describe and quantify the effects of digital transformation on various dimensions of supply chain performance. Descriptive statistics will provide an overview of how different digital transformation practices impact performance metrics within the oil and gas industry. This component will investigate causal relationships between digital transformation variables and supply chain performance outcomes. By employing inferential statistical techniques, the study will determine whether and how specific digital transformation practices influence performance metrics. To initially comprehend the topic on a theoretical level, a narrative literature review was performed. A narrative literature review, often referred to as a traditional review, is an unstructured examination of existing literature that seeks to provide contextual information and theoretical foundations for a certain field of research. The term "impact" in this study refers to the tangible and expected transformation that these technologies bring to the supply chain of the industry. This preliminary research had a significant impact on the survey.

The second phase involved administering a systematic survey comprising a range of quantitative inquiries to collect feedback and data for a more comprehensive analysis. This strategy proved to be effective for gathering data from a certain demography. Consistent with the chosen approach, online surveys offer several benefits, such as

ease, reduced expenses, and enhanced precision in findings, while also expanding the pool of potential participants.

3.3 Research Instrument

For this study, a closed-ended questionnaire was used as the primary research instrument to collect data. The questionnaire was developed based on established research frameworks and past studies to ensure it effectively addresses the research objectives and provides reliable data. The instruments employed for the purpose of gathering, examining, or analysing the matter under consideration must possess a high level of quality, ensuring their legitimacy and reliability. This is crucial in order to ensure that the information obtained aligns with the previously revealed facts or situations (Salmia, 2023). The survey questions were premeditated using a predetermined question schedule or guide. A question guide refers to a predetermined compilation of inquiries designed to assist in collecting of pertinent data. A question guide, particularly a semi-structured one, is widely regarded as the most user-friendly instrument for data collection. This type of guide incorporates questions that are not excessively rigidly structured, allowing respondents ample space to provide detailed explanations.

3.4 Sample Selection

The study's data collection focused on a few of oil and gas corporations located in Kuala Lumpur for two main reasons. For starters, the Malaysian economy relies heavily on the oil and gas industry. This nation has a population above 23 million and

is ranked second in Southeast Asia in terms of hydrocarbon output. It also holds the fifth position worldwide for its exports of liquefied natural gas (LNG) (Foggie, 2023). Secondly, a survey conducted by Linkedin revealed that Malaysia is one of the most swiftly growing digital economies among Southeast Asian nations. Malaysia's GDP is expected to see a rise in the digital economy's contribution, reaching 25.5% by 2025 compared to 22.6% in 2023. The Malaysian government invests a substantial amount of funds in the advancement of digital skills through educational initiatives. In 2019, the Malaysian government implemented the National Digital Skills Strategy, aiming to equip one million individuals with digital skills by 2023. In Malaysia, the public sector also contributes to the development of digital talent, alongside the commercial sector. The expansion of IT start-ups and global enterprises in Malaysia is creating new avenues for digital workers to explore. A sample size of 150-200 respondents targeted to achieve statistical significance. This size has provided a reliable basis for analyzing relationships between digital transformation practices and supply chain performance metrics.

3.5 Sampling Technique

In this study, convenience sampling was employed as the sampling technique. Convenience sampling involves selecting participants who are easiest to reach or most readily available, rather than using a randomized approach. This method is particularly useful when dealing with constraints related to time, budget, or access to the target population. Convenience sampling was chosen for several reasons. Given the constraints of time and resources, convenience sampling allowed for the efficient collection of data without requiring extensive logistical planning or access to a

comprehensive list of the entire population. The target population was readily accessible through specific channels or locations, making it feasible to collect data from participants who were conveniently available. This approach is well-suited for exploratory research where the primary goal is to gain initial insights or identify trends before potentially conducting more rigorous studies.

Participants were approached by online post with a link to the questionnaire. Inclusion criteria were based on, having experience in the oil and gas industry and supply chain department. The participation was voluntary. A total of 150 participants were included in the sample. This number was determined based on feasibility within the available time frame. As convenience sampling does not ensure a random selection, the findings may not be generalizable to the entire population. This limitation should be considered when interpreting the results. The sample may be biased toward individuals who are more accessible or willing to participate, which could impact the diversity and representativeness of the data. Participants were provided with information about the study's purpose, procedures, and any potential risks. Informed consent was obtained before participation. Data collected from participants was kept confidential and used solely for the purposes of this research.

3.6 Data Collection

The collection of research data can be approached using either quantitative or qualitative methods, employing a range of processes and equipment (Salmia, 2023). Given that the primary objective of any research is to acquire information, it is imperative that data collection procedures are given priority. The optimal quantitative

data collection method for obtaining dependable and accurate information is the one that is required in this study. A structured questionnaire is the primary data collection tool. The survey is designed to collect quantitative data on digital transformation practices and their effects on supply chain performance. Surveys are administered electronically using an online survey platform to facilitate data collection and ensure efficiency. All collected data are securely stored and anonymized to maintain respondent confidentiality. Access to the data is restricted to authorized research personnel only. The pilot test was completed prior to the initiation of data gathering. The Google Form survey was disseminated online via WhatsApp. Despite the fact that all employees were provided with the link to complete the survey, only 150 have responded in full. All respondents were granted three days to complete the survey. If the respondent persists in completing the survey, feedback is promptly collected through a Google form.

3.7 Data Analysis Technique

In this technique, the data is meticulously evaluated via a software application known as SPSS. SPSS is commonly utilised by researchers in the social sciences for conducting statistical analysis. Key indicators that are linked to the goals may include sales, quotas, or measurements for everyday activity. An essential component of performance management involves evaluating the feasibility and effectiveness of metric targets (Indeed, 2023).

3.8 Summary

Chapter 3 details the research methodology employed to investigate the impact of digital transformation on supply chain performance. The quantitative design, stratified sampling, structured data collection, and robust analytical methods provide a comprehensive approach to addressing the research questions. By adhering to rigorous standards of validity and reliability, the study aims to contribute valuable insights into how digital technologies influence supply chain outcomes in the oil and gas industry.

CHAPTER 4

RESULT & DISCUSSION

4.0 Introduction

This chapter provides a comprehensive account of the data analysis findings from the study and discussion. The data was analysed with the Statistical Package for the Social Sciences (SPSS) version 29.0. The demographic data collected from the participants is analysed using frequency and percentage analysis. This dataset includes demographic attributes such as age, gender, level of education, job title, and work experience. Statistics enhance understanding of the matter by emphasising patterns and connections. In addition, a comprehensive analysis is performed to evaluate the implications for current theories and to provide direction for future research. This chapter delves deeper into data analysis by exploring the significance of the findings and the underlying rationale behind them. This study enhances the current understanding by doing a comparative analysis of its findings in relation to previous research.

4.1 Exploratory Data Analysis (EDA)

Several analyses are performed to look at the data gathered for this study in this section. To address the research challenges presented by this study, statistical approaches are utilized to examine the features of the variables.

4.1.1 Skewness and Kurtosis Analysis

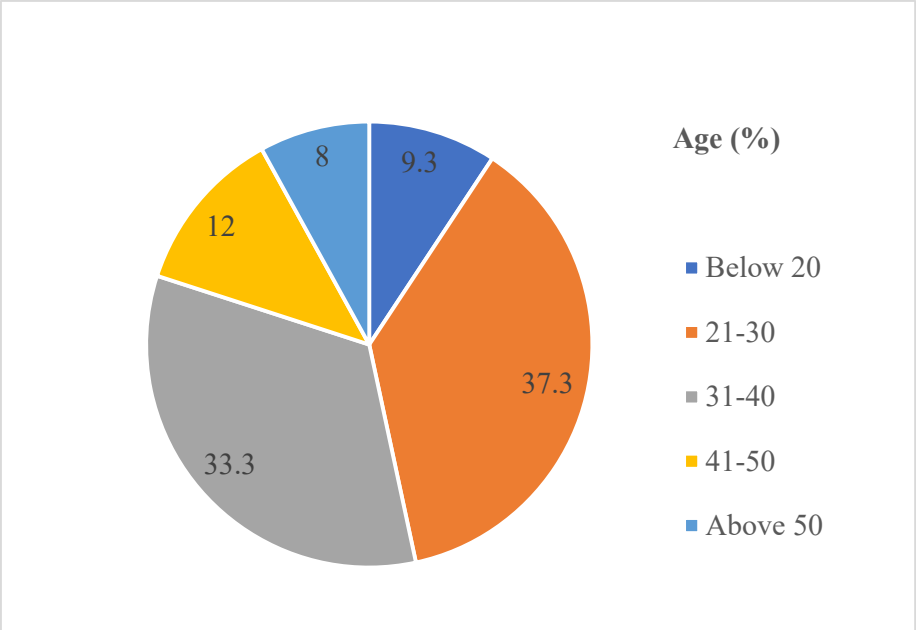
Skewness measures the asymmetry of the distribution of data. It indicates whether the data are skewed to the right (positive skewness) or to the left (negative skewness). Whereas Kurtosis measures the “tailedness” of the distribution. It indicates whether the data have heavy tails or light tails compared to a normal distribution. The results of this examination proved to be within the allowed range. As a result, the total sample size of 150 remains unchanged. The normality of the sample is determined by the Skewness and Kurtosis values of the test. Therefore, the sample's normality is appropriate. In general, the results suggest a standard sample distribution. Consequently, the sample, which was randomly selected from the population, is accepted and can be considered to have a normal distribution. Normality analysis can also be conducted by referencing the values of "Skewness" and "Kurtosis" due to the test conducted on 150 respondent data. If the "Skewness" value is within the range of -0.220 to -7.73, score distribution measurements can be considered as normal. The next test can be conducted if all of the data is normal.

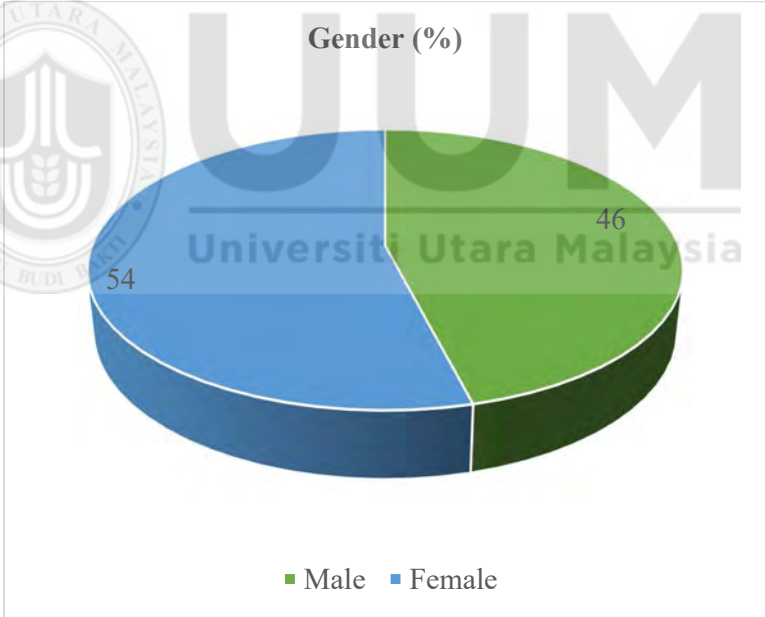
	N	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Std. Error
SP	150	-.531	.198	-1.551	.394
AI	150	-.557	.198	-1.503	.394
IoT	150	-.493	.198	-1.545	.394
BT	150	-.560	.198	-1.444	.394
CC	150	-.567	.198	-1.468	.394
Valid N (listwise)	150				

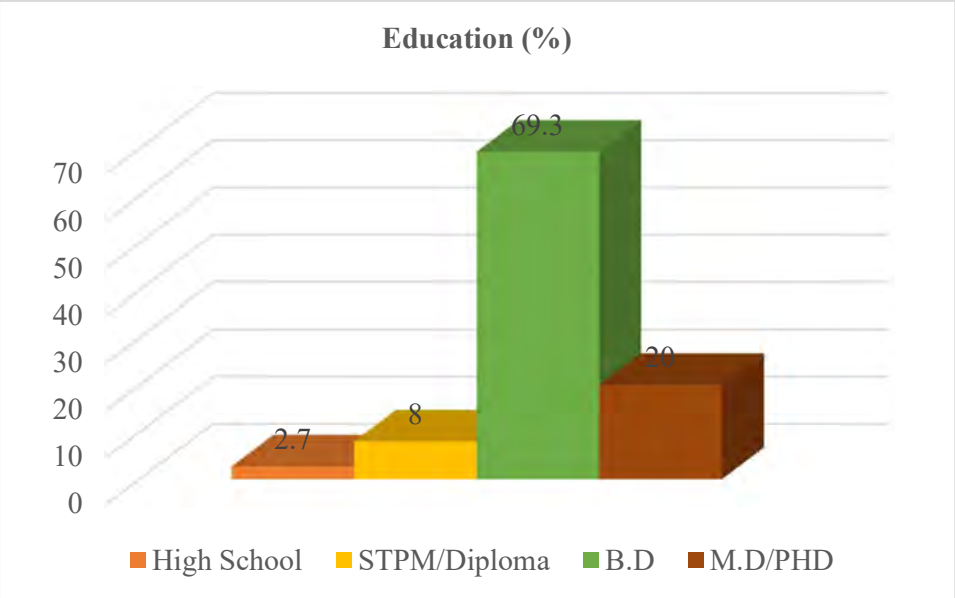
Table 4.1: Skewness & Kurtosis Statistic

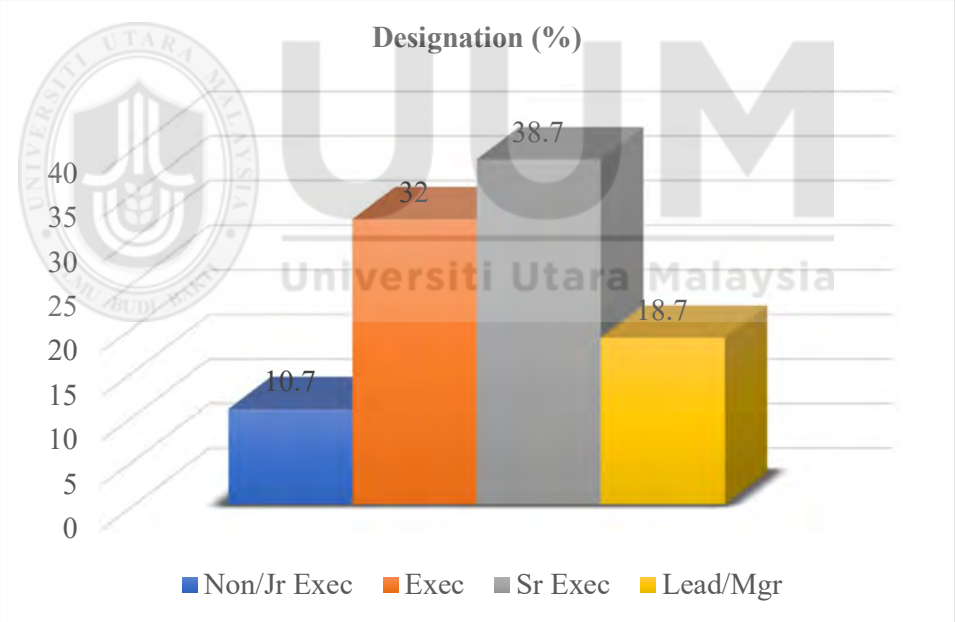
4.1.2 Demographic Analysis

150 responses were recorded. The survey respondents consisted of 46% men and 54% women. Among 150 responses, there are 69 males and 81 females. 37.3% of the respondents belong to the age group of 21-30, which is the largest proportion. Subsequently, the age bracket of those aged 31–40 constituted 33.3% of the total. This demonstrates that the majority of employers in the supply chain are currently in the peak of their professional careers. The majority of them are female, as evidenced by this. The majority of responders (69.3%) graduated with bachelor's degree and 20% of the survey respondents hold master's degrees. Despite the fact that only 8% of survey respondents possess a diploma or STPM qualification and 2.7% high school graduates. Employers in the supply chain possess a robust educational foundation. Out of the entire number of respondents, 38.7% are senior executives, which amounts to 58 individuals. Additionally, 32% of the total respondents, or 48 individuals, are executives. The majority of the participants are clearly in a financially secure position. Out of the respondents that participated in the survey, 60 individuals had served for a duration ranging from 0 to 5 years. The subsequent cohort, with 43 individuals, fulfilled a service period ranging from 6 to 10 years. This suggests that a majority of the players are new in the supply chain industry.









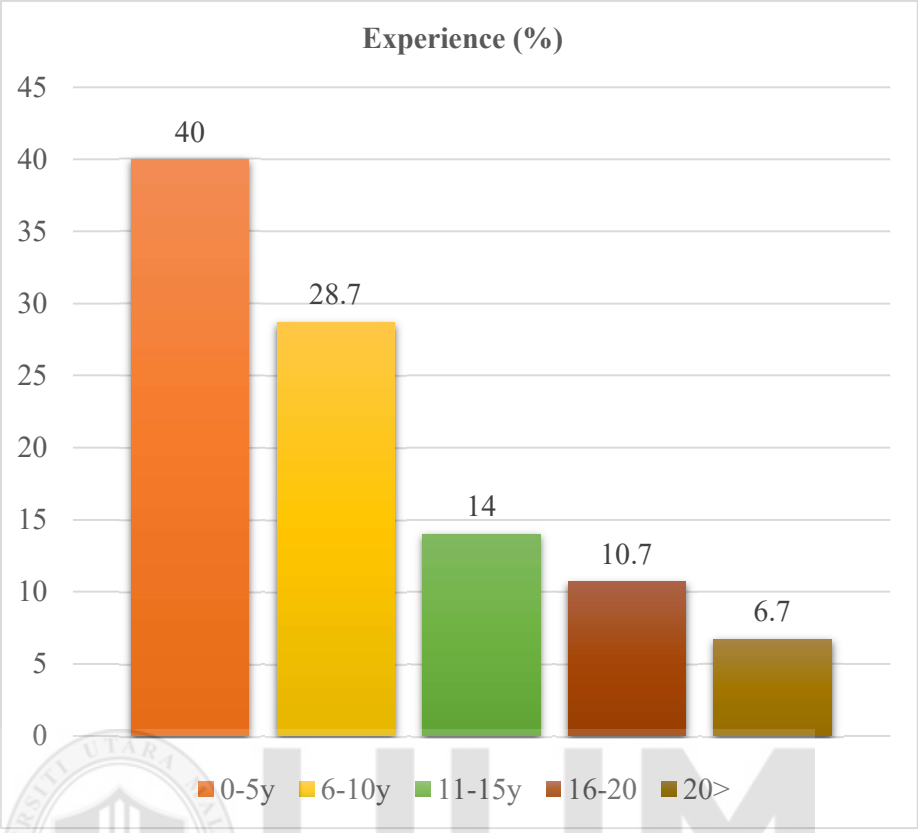


Figure 4.2: Set of Demographic Profile of the Respondents

The data collected indicates that women, who are between the ages of 21 and 30, hold the majority of supply chain positions in the oil and gas sector in comparison to males. Young individuals constitute the preponderance. Additionally, they possess a Bachelor's degree in a variety of disciplines. This demonstrates that employers frequently recruit university graduates to serve as employees. This predilection is based on the assumption that the younger generation is more adept at adapting to digitalization than the older generation, which makes it easier for companies to pursue a digital transformation.

4.1.3 Descriptive Analysis

In this study, descriptive analysis was employed to summarize and present the demographic characteristics of the participants. This approach ensures that the findings of the research accurately reflect the characteristics of the entire population under study. The demographic variables collected include age, gender, level of education, job position, and years of professional experience. This section details the distribution of these variables using frequencies and percentages.

	N	Minimum	Maximum	Mean	Std. Deviation
SP	150	1.50	4.75	3.2767	1.03469
AI	150	1.25	4.75	3.2733	1.08812
IoT	150	1.50	4.75	3.3033	1.02346
BT	150	1.25	4.75	3.2967	1.02706
CC	150	1.50	4.75	3.3450	1.02636
Valid N (listwise)	150				

Table 4.2: Descriptive Statistics

4.1.4 Reliability Analysis

Reliability analysis is a critical component of evaluating the robustness and consistency of measurement tools used in this research. It ensures that the instrument or scale employed produces stable and consistent results across different occasions and conditions. Table 4.3 presents the results of Cronbach's Alpha analysis, where the independent variables are AI, IoT, BT, CC, and the dependent variable is Supply Chain Performance (SP). The AI variable exhibits the highest Cronbach's alpha coefficient, which signifies a significant level of reliability at 0.841. Based on these observations,

the Cronbach's Alpha value is nearing 1. A greater Cronbach's Alpha score signifies enhanced reliability. Greater values of Cronbach's alpha indicate increased internal consistency, implying that the items in the scale are more strongly correlated and therefore more dependable. Generally, a Cronbach's alpha coefficient of 0.70 or above is deemed satisfactory for research purposes, although the acceptable threshold may differ based on the specific circumstances. Table 4.3 displays the dependability coefficients of all variables, which vary from .815 to .841.

Variable	Cronbach's Alpha	N of Items	Interpretation
SP	.827	4	Very Good
AI	.841	4	Very Good
IoT	.823	4	Very Good
BT	.815	4	Very Good
CC	.820	4	Very Good

Table 4.3: Reliability Statistics

4.1.5 Correlation Analysis

In this stage, Pearson's correlation is employed to examine the association between each independent variable (IV) and the dependent variable (DV). The correlation coefficients indicate the degree of strength in the linear relationship between the independent variable (IV) and the dependent variable (DV). The Pearson correlation coefficient (r) ranges from -1 to +1, representing both positive and negative correlation signs. The Pearson correlation coefficient (r) is utilised for examining the association

between variables, and a two-tailed significance criterion is employed to assess null hypotheses.

- 0.0 to 0.1 (or -0.1 to 0.0): No or negligible relationship.
- 0.1 to 0.3 (or -0.3 to -0.1): Weak relationship.
- 0.3 to 0.5 (or -0.5 to -0.3): Moderate relationship.
- 0.5 to 1.0 (or -1.0 to -0.5): Strong relationship.

SP and AI (r = 0.938), SP and IoT (r = 0.937), SP and BT (r = 0.931), SP and CC (r = 0.939). All the independent variables (AI, IoT, BT, CC) have very strong positive correlations with the dependent variable (SP), indicating that increases in these investments are strongly associated with increases in Supply Chain Performance. The correlations among the independent variables themselves are also very strong, suggesting that companies tend to invest in these technologies concurrently. All the p-values (Sig. (2-tailed)) are 0.000, indicating that all the correlations are statistically significant at the 0.01 level. This means there is strong evidence to suggest that these relationships are not due to random chance.

		SP	AI	IoT	BT	CC
SP	Pearson Correlation	1	.938**	.937**	.931**	.939**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	150	150	150	150	150
AI	Pearson Correlation	.838**	1	.944**	.956**	.938**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	150	150	150	150	150
IoT	Pearson Correlation	.937**	.944**	1	.932**	.931**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	150	150	150	150	150
BT	Pearson Correlation	.781**	.956**	.932**	1	.923**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	150	150	150	150	150
CC	Pearson Correlation	.902**	.938**	.931**	.923**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	150	150	150	150	150

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.4: Pearson Correlation Analysis of Variables

4.1.6 Regression Analysis

Regression analysis was conducted to examine the relationship between the dependent variable and several independent variables. This analysis aims to determine the extent to which the independent variables can predict or explain variations in the dependent variable. In this study, a linear regression analysis was performed to explore how supply chain performance is influenced by AI, CC, IoT and BT. Table 4.6 appears to be a summary output from a multiple regression analysis. This table includes the unstandardized coefficients (B), standard errors, standardized coefficients (Beta), t-values, and significance levels (Sig.) for a regression model predicting the dependent variable SP from the four independent variables.

Constant: 0.798 (not significant)

CC: 0.000 (significant)

BT: 0.024 (significant)

IoT: 0.000 (significant)

AI: 0.013 (significant)

Cloud Computing (CC), Blockchain Technology (BT), Internet of Things (IoT), and Artificial Intelligence (AI) are all significant predictors of the dependent variable SP. The highest standardized coefficient is for CC (0.343), indicating that among the predictors, CC has the strongest relationship with the dependent variable SP. The constant (intercept) is not statistically significant, which means the model's baseline prediction (when all predictors are zero) is not significantly different from zero.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.022	.086		.256	.798
	CC	.346	.075	.343	4.623	.000
	BT	.195	.085	.194	2.287	.024
	IoT	.286	.080	.283	3.575	.000
	AI	.156	.092	.164	1.689	.013

a. Dependent Variable: SP

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.960[a]	.921	.919	.29449

a. Predictors: (Constant), AI, CC, IoT, BT

b. Dependent Variable: SP

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	146.943	4	36.736	423.588	.000[b]
	Residual	12.575	145	.087		
	Total	159.518	149			

a. Dependent Variable: SP

b. Predictors: (Constant), AI, CC, IoT, BT

Table 4.5: Regression Statistics

4.2 Results of Hypothesis Testing

Figure 4.2 presents a visual representation of the process of hypothesis testing. Hypotheses 1, 2, 3, and 4 are employed to evaluate the presence of a relationship with the dependent variable via correlation analysis. The findings confirm the acceptance of Hypotheses 1, 2, 3, and 4.

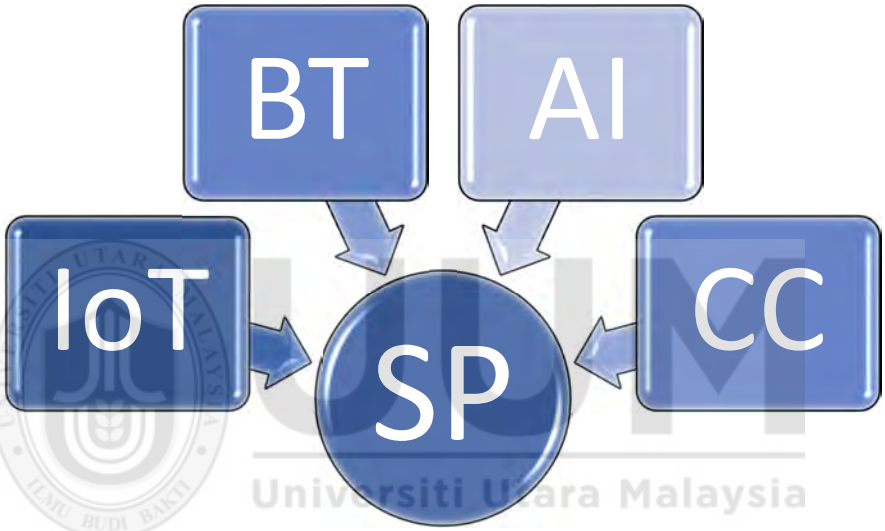


Figure 4.3: Result of Hypothesis Testing

The results demonstrate that investments in modern technologies significantly enhance Supply Chain Performance. The strong positive correlations suggest that companies leveraging AI, IoT, BT, and CC experience notable improvements in their supply chain metrics.

AI: The high correlation with SP highlights the importance of AI in driving SP through increased forecasting accuracy, reducing operational costs, improving marketing activities and customer experience.

IoT: The strong relationship with SP indicates the value of IoT in facilitating asset utilization, enabling collaboration, enhancing information capture and operational decision-making.

BT: The significant correlation with SP underscores the role of BT in ensuring increasing transparency, reducing fraud, and enhancing the traceability of transactions and goods throughout the supply chain.

CC: The leading standardized coefficient suggests that CC is a critical factor for improving data accuracy, real-time information sharing, and quick response in supply chain operations.

4.3 Discussion

The intents of this research are to investigate how technologies such as AI, CC, IoT and BT influences supply chain performance. The study's purpose influenced the selection of these four technologies as independent variables: AI, CC, IoT and BT. The research framework aimed to establish a link between these characteristics and supply chain performance, which served as the dependent variable. The link between dependent and independent variables is mutually dependent, and thus provides the foundation of the research framework's basis. Upon careful examination of the problem statement, it has been determined that a key driving force behind this research is the necessity to close the divide between the conventional workplace and its contemporary digitalized equivalent. Accumulating sufficient data for this study will

enable researchers to address this gap in knowledge and also lay the foundation for future research in this field. It was easily identified the research deficit due to the rising demand for a technologically advanced workforce with key digital skills caused by the COVID-19 epidemic and the shift towards more digitalized work operations. Nevertheless, at that time, numerous employers were still uncertain about the specific nature of those skills. After detecting the gap, the inquiry proceeded to develop a study. However, due to a scarcity of references, it became quite difficult to obtain any relevant material.

Despite being considered adequate, the act of developing a hypothesis and creating a tool to collect further data from the participants was nevertheless regarded satisfactory. Various statistical tests, such as linear regression utilising Pearson's correlation coefficients, were conducted on the data obtained using SPSS to ascertain the nature of the correlations between the independent and dependent variables. The following information was extracted from the research materials:

Artificial Intelligence (AI)

The analysis demonstrates a high correlation between AI and supply chain performance, highlighting AI's pivotal role in enhancing various aspects of the supply chain. AI improves forecasting accuracy, which is crucial for optimizing inventory levels and predicting demand fluctuations. Additionally, AI contributes to reducing operational costs by automating routine tasks and improving operational efficiencies. The technology also enhances marketing activities and customer experiences through advanced data analytics and personalized recommendations. This finding underscores

the importance of integrating AI into supply chain strategies to leverage its capabilities for better decision-making and operational effectiveness.

Internet of Things (IoT)

The strong relationship between IoT and supply chain performance illustrates the value of IoT in modern supply chains. IoT facilitates better asset utilization by providing real-time monitoring and management of equipment and inventory. This connectivity enables improved collaboration among supply chain partners by allowing seamless data sharing and communication. IoT also enhances information capture, providing critical insights into operational conditions and enabling more informed decision-making. The findings suggest that incorporating IoT technologies can significantly improve supply chain operations by enhancing visibility and operational efficiency.

Blockchain Technology (BT)

Blockchain Technology shows a significant correlation with supply chain performance, emphasizing its role in increasing transparency and traceability within the supply chain. By providing a secure and immutable ledger, BT helps reduce fraud and errors in transactions, ensuring the integrity of data and processes. The technology enhances the traceability of goods and transactions throughout the supply chain, which is vital for compliance and quality assurance. The results highlight that adopting blockchain solutions can strengthen supply chain reliability and accountability, which is essential for maintaining trust and reducing risks in the supply chain.

Cloud Computing (CC)

Cloud Computing is identified as a critical factor in improving supply chain performance, as evidenced by its leading standardized coefficient. Cloud solutions facilitate real-time information sharing and collaboration among supply chain partners, which is crucial for timely and accurate decision-making. The technology enhances data accuracy and enables rapid responses to operational challenges. The findings indicate that cloud computing's scalability and flexibility support effective supply chain management by providing robust infrastructure for data storage and processing.

4.4 Summary

The data that was acquired and the preliminary analysis that were conducted on the data prior to any statistical analysis, such as descriptive analysis, correlation analysis, and regression analysis, were discussed in this chapter. The results indicate that each of the independent variables is correlated with supply chain performance. Each technology contributes uniquely to enhancing efficiency, transparency, and responsiveness within the supply chain. The integration of these digital technologies is essential for optimizing supply chain operations and maintaining a competitive edge. The implications, limitations and recommendations that have been derived from this study will be the subject of the subsequent chapter.

CHAPTER 5

CONCLUSION

5.0 Introduction

This final chapter consolidates all the research and analysis from the preceding chapters into a comprehensive assessment of the impact of AI, CC, IoT and BT on the performance of supply chains. This study's meticulous research of supply chain performance has yielded significant new insights and implications for the oil and gas sector. This section gives a brief recap of the findings while offering practical recommendations. It also examines how these findings relate to the broader supply chain context, building upon the empirical data and analysis presented in the preceding chapters. This chapter aims to offer valuable recommendations for both the industry and individuals by examining the implications of the research findings. Additionally, it identifies specific areas that require additional investigation.

Throughout the chapter, there is a transition from summarising the main findings to presenting practical ideas and recommendations that can have an impact on decision-making and practices across other industries, not just confined to oil and gas. Furthermore, this section emphasises the need of addressing and resolving existing issues in supply chain management, as well as benefiting on new opportunities that develop as a result.

5.1 Implication of Findings

5.1.1 Policy Implications

Policymakers should develop and support initiatives that facilitate the adoption of digital technologies within the oil and gas industry. This can include providing financial incentives, grants, or subsidies to companies investing in advanced digital technologies can help offset high initial costs and encourage wider adoption. Establishing clear guidelines and standards for digital technology implementation can help ensure consistency and mitigate risks associated with technology adoption. Policymakers should work with industry stakeholders to develop regulations that promote secure and effective use of digital tools. Supporting educational programs and training initiatives that enhance the digital skills of the workforce is crucial. Government and industry partnerships can facilitate training programs that prepare employees to manage and utilize new technologies effectively.

To address common challenges and promote best practices, policymakers should encourage industry-wide collaboration. Creating platforms for knowledge sharing and collaboration among oil and gas companies can help disseminate best practices and innovative solutions for digital transformation. Dudukalov et al., (2021) conducted a study to assess the influence of online commerce on the supply chain and offer suggestions for using the characteristics of Industry 4.0 in supply chain management (SCM). Establishing partnerships between government agencies, research institutions, and private companies can foster innovation and provide valuable resources for companies undergoing digital transformation.

5.1.2 Practical Implications

Companies in the oil and gas industry should strategically invest in digital technologies to enhance supply chain performance. Focus on technologies that offer the greatest potential for improving efficiency, reducing costs, and enhancing responsiveness. For instance, IoT for real-time monitoring and AI for predictive analytics can provide significant performance benefits. Consider a phased approach to technology implementation to manage costs and integration challenges. Gradual adoption allows companies to evaluate the impact of new technologies and make adjustments as needed.

Organizations should develop strategies to overcome common challenges associated with digital transformation. Implement cost management strategies to address high implementation costs. This could include exploring financing options, leveraging cloud-based solutions, and optimizing technology budgets. Develop comprehensive integration plans to ensure that new technologies work seamlessly with existing systems. This may involve engaging with technology vendors and conducting thorough testing before full-scale deployment. Invest in training programs to equip employees with the skills needed to effectively use and manage new technologies. Training should cover both technical aspects and change management to ensure smooth transitions. Rucker et al., (2021) argue that there is a requirement to augment the workforce involved in knowledge labour to efficiently handle the complex interdependencies between office output and computer systems.

Regular monitoring and evaluation are essential for assessing the effectiveness of digital transformation initiatives. Establish clear performance metrics and KPIs to track the impact of digital technologies on supply chain performance. Metrics may include efficiency improvements, cost savings, and responsiveness. Use performance data to identify areas for improvement and make data-driven decisions to optimize digital transformation efforts. Continuous assessment can help ensure that technologies deliver the expected benefits and provide insights for future investments.

5.1.3 Theoretical Implications

Resource-Based View (RBV)

The findings of this study validate the Resource-Based View (RBV) theory, which posits that a firm's resources and capabilities can be sources of competitive advantage. Digital transformation technologies, such as IoT, AI, CC and BT, are viewed as strategic resources that significantly impact supply chain performance in the oil and gas industry. The study demonstrates that digital technologies enhance operational capabilities, leading to improved efficiency, reduced costs, and better responsiveness. This supports RBV's assertion that valuable, rare, and inimitable resources (in this case, advanced digital technologies) can provide a sustainable competitive advantage (Priem & Butler, 2015). The adoption of digital technologies allows firms to develop new capabilities and improve existing ones. For example, predictive analytics and real-time monitoring improve decision-making and operational efficiency. This aligns with RBV's focus on how resource-based capabilities can drive superior performance and differentiation. The study contributes to the RBV by highlighting the role of dynamic capabilities in the digital transformation process. Firms that effectively integrate

digital technologies into their supply chains demonstrate enhanced dynamic capabilities, such as adaptive problem-solving and agile responses to market changes. This underscores the importance of dynamic capabilities as a mediator between technology adoption and performance outcomes. The findings suggest that the benefits derived from digital technologies can be context-specific. The oil and gas industry's unique operational challenges influence how digital resources are utilized and valued, suggesting that RBV should account for industry-specific contexts when assessing resource advantages.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) provides valuable insights into the adoption of digital technologies, and the study's findings support its core constructs. The study affirms that perceived usefulness and perceived ease of use are crucial determinants of technology adoption in the oil and gas industry. Technologies that are seen as improving supply chain performance and are easy to use are more likely to be accepted and utilized by employees and managers. This aligns with TAM's premise that these perceptions significantly influence technology adoption behavior. The study identifies challenges such as high implementation costs and integration issues that affect perceived ease of use and usefulness. These findings contribute to TAM by illustrating how external factors can influence users' perceptions and adoption decisions. This suggests the need to incorporate contextual and operational challenges into TAM to better understand technology acceptance in specialized environments. The research highlights the importance of contextual factors in shaping technology acceptance. In the oil and gas industry, specific operational and environmental conditions impact how digital technologies are perceived and adopted. This suggests

that TAM could be extended to include industry-specific factors and contextual variables to provide a more nuanced understanding of technology acceptance (Venkatesh & Bala, 2012).

Integrating TAM with RBV offers a comprehensive perspective on technology adoption. While RBV focuses on the strategic value and capability development from resources, TAM provides insights into how these resources are perceived and adopted. Combining these models enhances the understanding of both the strategic importance and the adoption processes of digital technologies within organizations. The integration of RBV and TAM in this study provides a multifaceted understanding of digital transformation's impact on supply chain performance. It underscores the strategic value of digital technologies and highlights the importance of user perceptions in the adoption process. This dual perspective enriches theoretical frameworks and offers a holistic view of how digital transformation can be leveraged for competitive advantage in the oil and gas industry.

5.2 Limitations

Although this work has several imperfections it does present intriguing possibilities for future investigation. According to this paper, digital transformation is beneficial for the supply chain ecosystem as it enhances the significance of supply chain skills and increases their dependence. However, it was a complete failure in accurately estimating the appropriate degree of interdependence. Incorporating the evaluation of incremental costs and benefits should be included in future measurement tests. Utilising a cross-sectional dataset to examine the proposed links also poses challenges

in establishing definitive findings regarding causality. In order to gain a deeper comprehension of the causal linkages proposed by the hypotheses, it is imperative for future studies to collect longitudinal data. Longitudinal study approaches, as suggested by Salamah et al., (2024), can provide a clearer understanding of the connections between digitization activities, supply chain integration, efficiency, and performance. Through the use of visual representations that show the changes and interactions of the components over time, these designs have the potential to effectively communicate the dynamic nature of the components.

To enhance the depth and breadth of studies, future research should collect data from diverse businesses and employ a case study methodology. Furthermore, it is advisable to incorporate targeted technologies that might facilitate a digital revolution in the supply chain. Prior to constructing a conceptual model, it is necessary to fully grasp the background and theories. The study employs a cross-sectional design, capturing data at a single point in time. This design limits the ability to draw conclusions about the long-term effects and causal relationships between digital transformation and supply chain performance. Longitudinal studies could provide deeper insights into how digital transformation impacts supply chain performance over time. The study relies on self-reported data from questionnaires, which can introduce biases such as social desirability bias or inaccuracies in responses. Participants might overstate the benefits of digital technologies or underreport challenges due to various factors, including organizational pressures or personal biases.

5.3 Recommendations

5.3.1 Future Research Recommendations

Future research should consider longitudinal designs to assess the long-term impacts of digital transformation on supply chain performance. Such studies would provide insights into how the effects of digital technologies evolve over time and help establish causal relationships.

Expanding the sample size and including a more diverse range of organizations, including those from other sectors, can enhance the generalizability of the findings. Comparative studies across different industries could provide a broader understanding of digital transformation impacts.

Employing a mixed-methods approach, combining quantitative surveys with qualitative interviews, can offer a more comprehensive view of the challenges and benefits associated with digital transformation. Qualitative data can provide deeper insights into the reasons behind the observed trends and challenges.

Investigating how digital transformation impacts vary across different contexts within the oil and gas industry and in other industries can help refine theoretical models and practical strategies. Exploring industry-specific challenges and solutions will contribute to a more nuanced understanding of technology adoption.

5.3.2 Industry Recommendations

Companies should develop a strategic plan for digital transformation that includes clear goals, resource allocation, and risk management strategies. Understanding the specific benefits and challenges associated with different technologies can help in making informed decisions.

Implement digital technologies in phases to manage costs and minimize disruption. A phased approach allows for evaluation and adjustment based on initial outcomes and feedback, leading to more successful adoption.

Invest in comprehensive training programs to equip employees with the skills needed to effectively use new technologies. Providing ongoing support and addressing user concerns can enhance technology adoption and utilization.

Establish robust mechanisms for monitoring and evaluating the performance of digital transformation initiatives. Regularly review the impact of technologies on supply chain performance and make data-driven adjustments to optimize outcomes.

5.3.3 Policy Recommendations

Policymakers should provide support and incentives for companies adopting digital technologies, including financial assistance and tax benefits. Encouraging industry collaboration and sharing best practices can also facilitate the adoption of digital transformation.

Develop clear regulatory guidelines for digital technology implementation to ensure consistency and security. Collaboration between industry stakeholders and regulatory bodies can help create standards that promote effective and safe technology use.

Foster industry-wide collaboration through forums and networks to share knowledge and best practices. Public-private partnerships can support innovation and address common challenges in digital transformation.

5.4 Conclusion

According to a study, the efficiency of supply chain management (SCM) is influenced by three primary factors: collaboration among supply chain members, the availability of precise information and effective decision-making, and the transparency of supply chain members. These attempts are reliant on the advanced advantages of digital technology (Wang et al., 2022). This study contributes to our understanding of the complex networks created by the integrated supply chains, digitization, efficiency, and performance within the oil and gas industry.

In conclusion, digital transformation is reshaping supply chain management in the oil and gas industry. The integration of AI, IoT, BT, and CC significantly enhances supply chain performance by improving efficiency, responsiveness, transparency, and collaboration. Embracing these technologies is crucial for companies aiming to optimize their supply chain operations and gain a competitive edge in a rapidly evolving industry landscape. The research highlights the importance of strategic technology investments and the need for continued exploration of digital

transformation's impact. As the industry advances, ongoing adaptation and innovation will be essential for sustaining improved supply chain performance and achieving long-term success.

SPSS v.29, a statistical software, facilitated the identification of statistical significance effortlessly. The study's conclusions have had a significant impact on individuals and organisations, leading to extensive discussions. The problem stated was successfully handled. The possible advantages and disadvantages of the study were also conveyed to two distinct groups. The conclusion included recommendations to rectify the shortcomings of the study and guide future inquiries. This study can enhance enterprises' comprehension of digitalized supply networks and provide direction for their future research in supply chain management, particularly in light of the COVID-19 pandemic.

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