Blockchain Values Realisation Assessment in the Oil & Gas Industry

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An Empirical Study Submitted for the Degree of Doctorate in Business Administration by:

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ABSTRACT

The proliferation of Blockchain technology across various industries has garnered significant attention from both academia and industry practitioners. While advocates highlight potential benefits such as cost reduction, time savings, transparency, and security, many Blockchain projects have encountered significant challenges and have yet to materialise, sparking increased interest in understanding this phenomenon. This study seeks to explore the realisation of Blockchain values, beginning with the initial perception-forming phase. It identifies key factors influencing value realisation and provides insights into the potential impact of Blockchain in the oil and gas industry. This empirical study proposes an integrated framework based on ICT adoption theories to assess the holistic realisation of value from Blockchain implementations. A case study approach was employed to collect data from Blockchain projects within the oil and gas sector, followed by an online survey targeting 37 oil and gas firms across various geographical regions. Findings from the interviews and surveys indicate that most Blockchain projects continue to face various challenges and obstacles. The anticipated values, initially based on perceptions, were often not realised in practice. Overly optimistic perceptions, commonly seen as indicators of ICT adoption, were found to be misleading or insufficient in achieving the expected outcomes. Additionally, this study identifies significant factors affecting value realisation, assigning a weight to each and highlighting social factors as the most influential, alongside legal and technological uncertainties. The study also incorporates predictions from subject matter experts in technology and the oil and gas industry based on their experiences and involvement in Blockchain project implementations.

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Keywords: Blockchain, Value Realisation, Perceptions, Predictions, ICT Adoption Theories

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LIST OF ABBREVIATIONS

BC	Blockchain
ICT	Information & Communications Technology
IMS	Information Management Systems
IT	Information Technology
SCM	Supply Chain Management
O&G	Oil & Gas
DOI	Diffusion of Innovation Theory
TAM	Technology Acceptance Model Theory
TOE	Technical, Organisational and Environment Theory
SME	Special Matter Experts
PM	Project Manager
OM	Operations Manager

DECLARATION

I declare that this dissertation, titled ‘Blockchain Value Realisation Assessment in Oil and Gas Industry, is my own original work and has not been submitted, in whole or in part, for any other degree or qualification. All sources of information and data used in the dissertation have been duly acknowledged and referenced in accordance with the standard academic practice. I confirm that I have read and understood the University's policies on academic misconduct and that I have not engaged in any form of academic misconduct in the research and writing of this dissertation. I understand that if any part of this dissertation is found to be in breach of the University's regulations on academic integrity, I may be subject to disciplinary action, which may include the revocation of my degree.

Signed: *Saeed S Alghamdi*

Date: October,2024

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1. INTRODUCTION CHAPTER

1.1. Chapter Introduction

The oil and gas sector is pivotal to global economic growth, serving primarily as a vital source of energy. However, this industry faces significant challenges due to its complex supply chain operations, high infrastructural costs, and stringent regulatory demands. The emergence of digital technologies, including Blockchain, offers promising solutions for enhancing operational efficiency, transparency, and data management within this sector. Despite its potential, the integration of such technologies remains fraught with obstacles, including fragmented data systems, high initial investments, and limited empirical evidence on the realisation of Blockchain values in business enterprises. This chapter provides a comprehensive overview of the oil and gas industry's current landscape and highlights the impact of technological advancements on supply chain management and operational efficiencies. It also explores the potential of Blockchain technology to transform these operations, focusing on the need for strategic planning and effective project management practices to facilitate its adoption. By addressing these issues, this chapter sets the stage for examining the broader implications of ICT integration, particularly Blockchain, within the oil and gas sector.

1.2. Background

In the context of economic expansion, experts recognise the oil and gas sectors as crucial drivers due to their role as fundamental energy sources. These industries manage vast amounts of data from a broad network of buyers and suppliers across various geographical locations. Companies must effectively manage diverse data types, including freight invoices, tax documents, leasing agreements, labour contracts, and the pricing of both indirect and direct materials (Smith, 2012). Such data typically originates from specific supply chain stages, posing significant challenges for organisations in maintaining product quality, which demands increased support and stringent oversight (Johnson & Peters, 2014).

High infrastructural and initial capital investments in the oil and gas industry, including expensive and complex machinery, create significant barriers to entry (Hussain et al., 2006). Historically, this industry has enjoyed high profitability, with companies viewing digitisation as a non-essential but beneficial enhancement (Hussain et al., 2006). However, recent declines in oil prices have increased pressure on operational costs, prompting companies to adopt cost-saving measures (Taylor, 2015).

Operational management within the oil and gas sector faces numerous challenges, particularly in managing operations that span various internal and external entities. These challenges include complexities from globalisation, rapid market changes, and strict quality and compliance requirements (Gilling & Ulmer, 2016). Companies need a comprehensive and adaptable management strategy to navigate this intricate and often convoluted network of relationships and regulatory environments (Evans & Green, 2017). Such strategies should align operations with evolving market demands and regulatory standards, ensuring sustainability and adaptability in a changing economic landscape.

IT and data hubs within the oil and gas industry often suffer from poor connectivity, resulting in limited transparency across supply chain departments. Fragmented data storage and management within different divisions disrupt process flow and hinder overall visibility. Therefore, companies must integrate digitisation strategies into the supply chain process to enhance communication between suppliers, transporters, storage facilities, and customers (Hussain et al., 2006). Over the last decade, technological advancements have improved how consumers receive goods from suppliers, with new supply modes introduced daily. Effective supply chain management involves carefully managing the flow of goods, information, and services to optimise performance and mitigate risks (Tan, 2001). As the economy significantly impacts supply chain performance, companies must collaborate closely to achieve efficiency (Hussain et al., 2006).

Technology use in the oil and gas industry has substantially improved operational efficiency. Companies adopted digitisation in response to declining oil product sales, which fell below $30 in June 2014. Although prices have since risen to $50, they remain below the pre-recession level of over $115 (Mendling et al., 2017). Digitisation helps companies reduce overspending in refining and supply chains by conducting activities electronically, resulting in increased productivity to meet demand. Additionally, digitising the gas production process improves communication between suppliers and consumers. Client feedback allows companies to gauge demand accurately and produce only the necessary quantities. Research shows that approximately 69% of oil companies face cost overruns, and 80% struggle with time management (Mendling et al., 2017). Digitisation reduces production costs, improves workforce productivity, and enhances efficiency in hiring and training employees.

The oil and gas (O&G) industry comprises three segments: upstream, midstream, and downstream. The downstream segment, which involves processing crude oil into consumer products, operates in a highly margin-driven economic model due to its consumer-facing nature (Hernandez, 2017). A significant concern for companies like Saudi Aramco is the lack of visibility into supply chains, which affects liability, regulatory, and environmental aspects. Data often remains siloed within upstream, midstream, and downstream segments and isolated between operations and commercial groups, making retrieval and organisation a manual and incomplete process.

Using a single database for data storage increases security and authorisation risks. As a result, no compelling data management platform ensures that government agencies have access to all supply chain data or that service providers can access only relevant downstream data (Hernandez, 2017). Currently, no scalable method ensures data integrity against malicious actors. Companies that embrace changes in data management gain better control over supply chains, enhancing visibility and customer feedback, positively impacting upstream processes and increasing competitiveness. Many businesses use various software packages for supply chain management but often face challenges integrating these with their Enterprise Resource Planning (ERP) systems. To establish a functional digital ecosystem, oil and gas companies must integrate all their software solutions.

Companies adopting ICT services and emerging technologies in the oil and gas sector require a long-term approach embedded in corporate strategies. These strategies align the organisation's vision, mission, and objectives, providing a blueprint for success (Vernon, Martin, & Thompson, 2017). Robust strategies are essential in dynamic environments, helping businesses navigate challenges, seize opportunities, and maintain competitive advantages (Johnson, Whittington, & Scholes, 2017). Emerging ICT technologies, characterised by their innovation and potential to disrupt existing practices, offer significant benefits for organisations (Laforet, 2019). In today's digital age, delaying the adoption of these technologies can be detrimental (Reeves & Deimler, 2011). Integrating ICT technologies within corporate strategies enables organisations to improve operational efficiency, enhance decision-making, and stimulate innovation (McAfee & Brynjolfsson, 2012). Moreover, adopting emerging ICT technologies fosters creativity, supports new product and service development, and attracts top talent by positioning companies at the forefront of technological advancement (Senyard, Baker, & David, 2018). Technologies such as cloud computing, big data analytics, and the Internet of Things (IoT) allow organisations to gain insights, identify market trends, and respond with agile solutions. Leveraging these advancements helps companies seize new opportunities, meet changing customer demands, and stay competitive (Kim & Mauborgne, 2014).

Incorporating ICT technologies also helps attract and retain top-tier talent, as skilled professionals are drawn to innovative companies (Senyard, Baker, & David, 2018). By prioritising the adoption of emerging ICT, businesses can improve processes, minimise errors, and optimise resource allocation, leading to increased productivity and cost-effectiveness (Porter & Heppelmann, 2015). Furthermore, integrating ICT aligns corporate strategies with the evolving digital landscape, ensuring companies stay current with industry trends and build a foundation for sustainable growth (Eisenhardt & Martin, 2000).

Incorporating project management best practices into strategic planning can significantly facilitate Blockchain adoption in the oil and gas industry. This process starts with defining clear project objectives and scope and aligning efforts across stakeholders to ensure focused delivery of business value. Comprehensive feasibility studies help evaluate potential benefits and challenges, ensuring alignment with the organisation's broader goals (Munim, 2022). This groundwork is crucial to avoid misalignment and inefficiencies (Ahmad, 2022).

Companies must implement effective risk management, identifying potential threats like cybersecurity issues, regulatory compliance challenges, and operational disruptions (Rejeb, 2022). Given the sensitive nature of data in the oil and gas industry, they must develop robust security protocols. Continuous monitoring enables organisations to adapt to unforeseen issues during implementation (Aslam, 2022). Scenario planning and simulations further enhance preparedness, reducing the likelihood of setbacks.

Successful Blockchain implementation relies on meticulous planning and resource allocation, including financial, technological, and human capital. Effective communication and collaboration among project teams and stakeholders maintain a unified approach (Swan, 2022). Cross-functional teams that integrate diverse skills improve problem-solving and drive innovation. Pilot projects provide valuable opportunities to test and refine Blockchain applications on a smaller scale before full-scale deployment, minimising risks and ensuring smoother transitions (Aslam, 2022).

Continuous evaluation and improvement are vital. Establishing key performance indicators (KPIs) provides clear metrics to assess project outcomes and align them with initial objectives (Munim, 2022). Regular feedback from end-users and stakeholders offers insights into practical implications, guiding necessary adjustments and process enhancements over time (Rejeb, 2022). Documenting lessons learned helps build organisational knowledge for future projects, fostering a culture of continuous learning and improvement.

By adhering to project management best practices, the oil and gas industry can enhance Blockchain adoption, ensuring projects are well-structured, risks are managed, and continuous improvement is achieved. The strategic integration of Blockchain technology has the potential to transform operational efficiencies, drive innovation, and offer a competitive advantage in this traditionally conservative sector.

1.3. Blockchain Technology Background

In recent years, many have closely associated Blockchain technology with cryptocurrencies, leading to misconceptions that equate the two. However, recognising Blockchain as a versatile technology with transformative potential beyond digital currencies is crucial. This article aims to dispel these misconceptions by providing a comprehensive exploration of Blockchain technology, including its foundational definitions and concepts, as well as its broader implications and challenges. The objective is to demonstrate Blockchain's transformative power, distinct from its specific application in cryptocurrencies. The frequent conflation of Blockchain with cryptocurrency has impeded a nuanced understanding of the technology's capabilities. Exclusively associating Blockchain with digital currencies like Bitcoin and Ethereum overlooks the extensive range of Blockchain applications across various industries, including supply chain management, healthcare, and government services. This article distinguishes Blockchain from cryptocurrency and examines how the underlying technology functions in contexts where trust, transparency, and decentralisation are critical. At its core, Blockchain functions as a distributed ledger that records transactions across multiple computers in a network. It ensures that data cannot be altered retroactively without modifying all subsequent blocks and obtaining the network's consensus. This immutable and transparent nature of Blockchain grants it a significant degree of trustworthiness, particularly in contexts where data integrity and security are paramount. Blockchain encompasses several key concepts, each contributing to its functionality and distinctiveness.

Blockchain Key Concepts:

Blockchain technology underpins various decentralised systems, offering several critical concepts that enhance the efficiency, security, and transparency of data management across various industries. Understanding these concepts is essential for appreciating how Blockchain supports decentralised, secure, and reliable operations.

- **Programmable**: One of the key concepts of Blockchain is its programmability, which allows blockchains to execute predefined rules and conditions, often through smart contracts. Smart contracts are self-executing contracts with the terms directly embedded in code, facilitating automatic transactions without intermediaries (Buterin, 2014). This programmability enhances the flexibility and functionality of Blockchain networks, enabling applications across finance, supply chain, and more.

- **Secure**: Blockchain ensures that all records are individually encrypted, making data stored on the ledger highly secure against unauthorised access and tampering. The security of Blockchain is primarily maintained through cryptographic algorithms that safeguard data integrity, prevent data breaches, and maintain confidentiality (Narayanan et al., 2016). This security framework is critical in sectors such as healthcare and finance, where data protection is paramount.

- **Anonymous**: Blockchain provides a degree of anonymity by ensuring that the identity of participants is either anonymous or pseudonymous. This aspect protects user privacy and minimises the risk of identity theft, as transactions do not require participants to disclose personal information unless necessary (Zheng et al., 2017). Such anonymity is particularly valued in digital currencies, where privacy concerns are prominent.

- **Distributed**: The distributed nature of Blockchain means that all network participants maintain a copy of the ledger, ensuring complete transparency and reducing the risks associated with centralised data storage (Nakamoto, 2008). This distribution allows for data redundancy, ensuring that even if one node fails, the system remains operational and secure, making Blockchain resilient against data loss and cyber-attacks.

- **Immutable**: Blockchain is characterised by its immutability, meaning that once records are validated and added to the ledger, they cannot be altered or deleted. This concept is achieved through cryptographic hashing, which links each block to its predecessor, creating a tamper-evident chain (Yaga et al., 2018). Immutability is crucial for maintaining trust in systems that require a reliable and permanent record of transactions, such as legal and financial services.
- **Unanimous**: All participants in a Blockchain network agree on the validity of each record through consensus mechanisms such as Proof of Work (PoW) or Proof of Stake (PoS). This unanimous agreement ensures that only valid transactions are added to the ledger, maintaining its integrity and accuracy (Nakamoto, 2008). Consensus is vital for preventing fraudulent activities and maintaining the credibility of the ledger.
- **Time-stamped**: Each transaction on a Blockchain is time-stamped, providing a chronological record that can be traced back and verified. Time-stamping enhances accountability and ensures that all data entries are tracked accurately, making Blockchain suitable for applications where the timing of actions is critical, such as supply chain tracking and regulatory compliance (Pilkington, 2016).

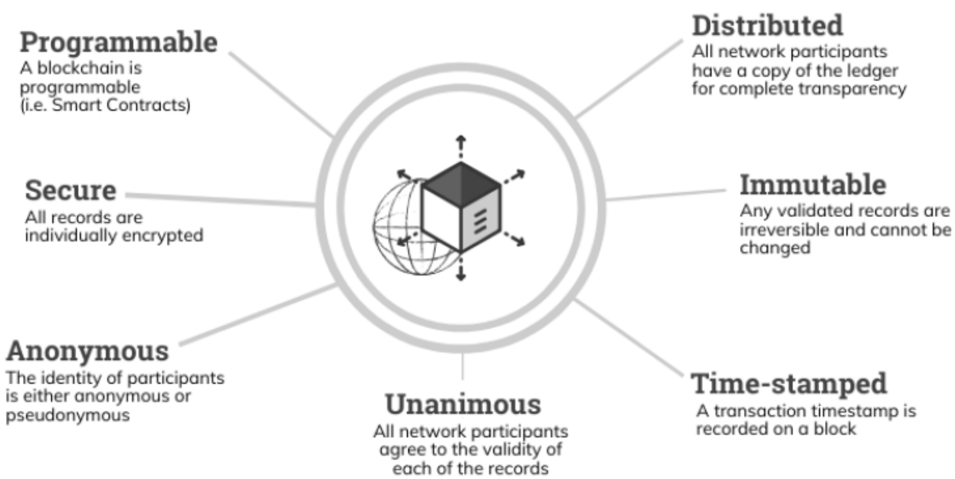


Figure 1.1 Blockchain Concepts

These concepts collectively empower Blockchain as a transformative technology that supports decentralisation, transparency, and trust in digital transactions. As the technology continues to evolve, its core concepts remain pivotal in redefining the future of secure and efficient data management.

Blockchain technology is categorised into several types, each with distinct characteristics suited to different applications and use cases. The primary types of Blockchains are public, private, consortium, and hybrid Blockchains.

Public Blockchains: are entirely decentralised networks with no single authority controlling the data or operations. These networks operate on a permissionless basis, allowing anyone to participate, verify transactions, and maintain the ledger (Nakamoto, 2008). Bitcoin and Ethereum exemplify public Blockchains. Their open and transparent nature promotes trust and security through consensus mechanisms such as Proof of Work (PoW) or Proof of Stake (PoS) (Buterin, 2014). However, public Blockchains can be resource-intensive and slower due to the large number of participants involved in the consensus process (Wood, 2014). Public Blockchains are most suitable for applications requiring high transparency, such as cryptocurrency transactions or open-source projects.

Private Blockchains: in contrast to public Blockchains, are controlled by a single authority that restricts access to the network. Only authorised participants can join, and the central authority oversees the validation of transactions (Pilkington, 2016). This structure provides enhanced privacy and faster transaction speeds but may reduce transparency and increase the risk of centralisation. Organisations typically employ private Blockchains for internal processes where privacy and efficiency are prioritised over transparency (Hughes et al., 2019). Private Blockchains are ideal for enterprise-level applications, such as supply chain management or internal financial transactions, where control and confidentiality are paramount.

Consortium Blockchains: operate under the control of a group rather than a single entity. They combine features of both public and private Blockchains, offering a balance between decentralisation and control (Zheng et al., 2017). Multiple organisations collaborate within the network, sharing decision-making power while still restricting access to approved members. This model enhances security and collaboration among trusted parties, making it suitable for inter-organisational transactions where data integrity and cooperation are critical (Xu et al., 2019). Consortium Blockchains are well-suited for industry-wide initiatives, such as trade finance platforms or joint ventures, where multiple organisations need to cooperate while maintaining some control over the network.

Hybrid Blockchains: merge the characteristics of public and private Blockchains, allowing for a flexible governance model. In a hybrid Blockchain, specific data or processes are kept private under the control of a central authority, while others are made public to all participants (Liang et al., 2017). This dual structure enables the network to benefit from the strengths of both models—maintaining privacy where necessary while ensuring transparency and decentralisation where appropriate. Hybrid Blockchains are ideal for applications requiring a blend of privacy and transparency, such as governmental operations or regulated industries like healthcare, where specific information must remain confidential. In contrast, other data remains accessible to the public (Zheng et al., 2018).

Choosing the appropriate type of Blockchain depends on the specific needs of the use case. Public Blockchains offer maximum transparency and decentralisation, making them suitable for open and trustless environments. In contrast, private and consortium Blockchains provide enhanced control and efficiency, which are vital in enterprise settings. Hybrid Blockchains offer a versatile solution, blending the benefits of both public and private networks. As Blockchain technology continues to evolve, understanding these distinctions will be crucial for selecting the most appropriate architecture for different applications.

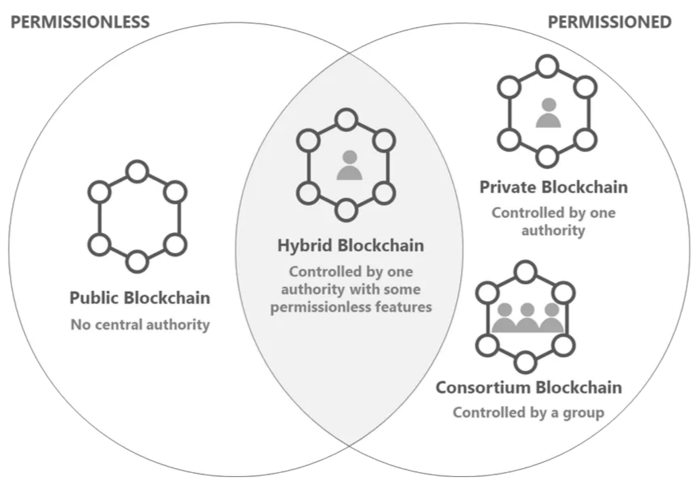


Figure 1.2 Blockchain Types

This analysis clarifies that although Blockchain is often associated with cryptocurrencies, it is a versatile and transformative technology with applications far beyond digital currencies. Understanding its core concepts—decentralisation, consensus mechanisms, immutability, and transparency—is essential for appreciating its potential across various industries. The different types of Blockchains—public, private, consortium, and hybrid—each offer distinct advantages, making them suitable for a wide range of use cases. As Blockchain technology continues to evolve, selecting the appropriate type and structure will be critical to leveraging its full potential in diverse applications.

1.3 Study Justifications and Knowledge Gaps

This study identified knowledge gaps surrounding the emerging ICT technology known as Blockchain, as follows: Firstly, there is a limited number of academic empirical studies that investigate the realisation of Blockchain value in business enterprises. Most of the current literature associated with Blockchain focuses on its application in cryptocurrencies. Secondly, this study found a substantial debate regarding the values of Blockchain and their feasibility within the business enterprise industry. Advocates believe that this technology is promising and will bring desired value to enterprises, while speculators claim that the promised values are exaggerated, considering Blockchain as mere hype. They support their arguments with a high number of failed projects.

Thirdly, this study highlights reports of a considerable number of failed Blockchain implementation projects. Despite the initially positive and promising perceptions regarding the realizability of Blockchain values, this study aims to assess Blockchain projects starting from the perspective of perception development. Fourthly, it is worth noting that many studies have discussed the factors influencing emerging ICT technologies. However, these studies have not sufficiently considered the impact rate of each factor, i.e., the "weight of influence." This omission hinders decision-makers in assessing the feasibility of emerging technologies or identifying significant factors that can mitigate their impacts. Finally, there is a scarcity of comprehensive studies that provide robust predictions about the realisation of Blockchain values. Such studies are essential in assisting decision-makers in determining the optimal timing for the adoption of emerging ICT technologies.

1.4 Research Questions, Objectives and Significance

The research questions are developed to cover the knowledge gaps around Blockchain business value perceptions and realisations. These significant factors impact Blockchain value realisations and the outlook for Blockchain value realisations.

Main question:

What outcomes of value realisation are evident in Blockchain projects within oil and gas firms, based on empirical analysis guided by integrated ICT adoption theories?

Secondary questions:

- **What are significant factors impairing the Value realisation?**
- **What is the prediction of Blockchain Value realisation and recommendation***?*

Significance of the study: This study holds immense importance and contributes to the body of knowledge from both business practice and academic perspectives. From a business practice perspective, this study serves as an eye-opener for O&G firms and other applicable business entities, providing a comprehensive understanding of Blockchain technology and its realisable values. It enables management to make informed decisions regarding the adoption of Blockchain, starting from the initial perceptions. Furthermore, it helps businesses become aware of significant factors that may impede the success of Blockchain implementation projects and guides them in avoiding project failures. Additionally, this study assists enterprise management and specialists in selecting the appropriate timing for adopting emerging technologies by offering predictions and future outlooks gathered from experts involved in Blockchain implementation projects.

From an academic standpoint, this study addresses knowledge gaps regarding arguments surrounding the realisation of Blockchain value (Hype or Real value addition) by providing an empirical and comprehensive assessment applicable not only to Blockchain but also to other emerging ICT technologies. Secondly, this study represents a straightforward extension of the Technology Acceptance Theory (TAM) by emphasising that individual perceptions play a crucial role in determining the success of adopting emerging technologies. It highlights that perceptions can be a misleading construct for such technologies. Thirdly, this study extends existing adoption theories, such as TOE and DOI, by introducing factor weights. This addition aids in identifying the significant factors influencing the adoption of emerging technologies.

Research Synopsis

The study is structured into five chapters, each contributing to a thorough investigation of the challenges, methodologies, and outcomes related to the realisation of Blockchain value in the oil and gas industry:

- Chapter One: Introduction
  This chapter delves into the business challenges within the oil and gas industry and the limitations of existing ICT technologies in meeting business needs. It highlights the main concepts of Blockchain technology and underscores the importance of project management from a corporate strategic perspective. Additionally, it outlines the research components, including knowledge gaps, research questions, objectives, significance, and expected contributions.
- Chapter Two: Literature Review
  This chapter discusses recent developments in Blockchain concepts, ICT business values for enterprises, perceptions of Blockchain values, the process of forming and developing business value perceptions, and the concept of the value chain. It examines the application of Blockchain technology within the oil and gas industry, focusing on its specific technological context. The chapter also explores relevant ICT adoption theories such as the Technology Acceptance Model (TAM), Technology-Organisation-Environment (TOE) framework, and Diffusion of Innovations (DOI). An integrated framework combining these theories is proposed to provide a comprehensive understanding and assessment of Blockchain adoption within enterprises.
- Chapter Three: Research Methodology
  This chapter details the research methodology, including the qualitative techniques and methods used for data collection. It explains the use of purposive sampling to select participants based on their experience with Blockchain projects. The chapter integrates positivist and interpretivist

philosophies, aligning empirical and objective analysis with the recognition of stakeholders' subjective experiences. The research design includes pilot surveys, in-person interviews, and extensive online surveys to gather rich, context-specific data through a case study approach.

- Chapter Four: Findings and Data Analysis
  This chapter presents the findings and data analysis, illustrating the results obtained from interviews and online survey responses. The findings are analysed and presented in tables and charts based on data collected from 37 firms via the online survey and four firms through in-person interviews. The chapter offers a comprehensive analysis of the findings, highlighting key themes and patterns emerging from the data.
- Chapter Five: Discussion
  This chapter provides a thorough interpretation and discussion of the findings in relation to the literature review. It explores the implications of the findings on ICT adoption theories and their relevance to business practice. Additionally, the chapter addresses the study's limitations and offers recommendations for future research.

1.5 Chapter Conclusion

This chapter has highlighted the critical role of the oil and gas industry in driving economic expansion alongside the challenges and opportunities brought about by digitisation and emerging ICT technologies. The complexities of managing extensive supply chains, combined with the high costs and regulatory burdens, underscore the necessity for innovative solutions such as Blockchain. As discussed, Blockchain technology offers a transformative potential that goes beyond cryptocurrency, providing a decentralised, transparent, and secure framework for data management and operational efficiency. However, realising these benefits requires overcoming significant barriers, including data silos, security concerns, and the integration of complex technologies within existing business models. The insights provided in this chapter underscore the importance of strategic planning, robust risk management, and continuous evaluation to leverage Blockchain effectively in the oil and gas sector. Ultimately, the successful adoption of Blockchain could not only enhance operational efficiencies but also drive sustainable growth and competitiveness in this traditionally conservative industry.

2. LITERATURE REVIEW CHAPTER

2.1. Chapter Introduction

This chapter reviews recent literature on the main components of this study and the key concepts surrounding ICT values, including ICT business values for enterprises, perceptions of Blockchain values, the formation and development of business value perceptions, shared value concepts, and Time to Value. The chapter then examines the nature and characteristics of the oil and gas industry related to ICT adoption. These sections serve to establish and integrate the necessary knowledge to achieve the study's objective of investigating Blockchain value realisation, beginning with the development of perceptions. Subsequently, the chapter explores how this understanding can identify potential applications and opportunities in the oil and gas industry. A theoretical discussion follows, encompassing the adoption of relevant ICT theories for Blockchain, including TAM, TOE, and DOI. Finally, the study proposes an integration of these theories to develop a comprehensive understanding of Blockchain adoption within enterprises.

2.2. ICT Emerging Business Values Concepts and Scope

In management, the term "business value" refers to all forms of value that determine a company's health and well-being. It extends the concept of value to include aspects such as employee value, customer value, supplier value, channel partner value, union partner value, managerial value, and business value, alongside economic value, which includes financial profit, economic added value, and shareholder value (Business Value, 2019). Many of these forms of value take time to quantify financially. Business value often includes intangible assets that cannot be directly assigned to a specific stakeholder group, such as intellectual capital and a company's business model. One widely adopted approach to assessing and managing company quality is the balanced approach.

The concept of company value aligns with the hypothesis that a company functions as a network of internal and external relationships. These networks, sometimes called network value or value chains, consist of stakeholder groups, resources, organisations, end users, interest groups, regulators, and the workplace (Abeysekara, 2019). In a value network, creating value involves cooperation, innovation, and synergy rather than simply relying on mechanistic processes or control. When considering the company as a value network, the focus shifts to how each node contributes to overall results and addresses its needs. If the nodes represent autonomous organisations (e.g., suppliers) or agents (e.g., customers), the company seeks cooperative, win-win partnerships in which all parties play essential roles. Even when nodes like employees lack full autonomy, rewards should go beyond financial compensation. Although reducing business value to a single financial measure (e.g., discounted cash flow) is appealing, many experts consider it impractical or impossible. Advocates of business value recommend assessing and managing various types of value for each stakeholder group. At present, there is no clear consensus on how these components of value interrelate or how they contribute to a company's long-term success. While the business model offers promise, it remains underdeveloped.

Several factors influence how information technology (IT) affects business value. The most critical factor is the alignment between IT, business processes, organisational structure, and strategy. Effective integration of business architecture, enterprise system design, organisational structure, and performance metrics achieves this alignment. Additionally, various quality factors limit and define IT capabilities at the level of computing and communication infrastructure, including usability, functionality, reliability, recoverability, and efficiency (e.g., throughput, response time, predictability, and capacity).

The term "business value" remains informal, and scholars and leadership experts disagree on its meaning or relevance to decision-making. Some have even labelled it a "buzzword" used by consultants, analysts, managers, authors, and academics. Critics argue that focusing solely on financial value, profit, or shareholder value is sufficient to guide decision-making (Anderson et al., 2006). They consider other forms of value to be intermediate steps toward financial profit, viewing them as distractions if they do not directly contribute to economic gain.

Other commentators (Kaznacheev, 2018) argue that comprehensive efforts to assess business value may hinder, rather than benefit, decision-making. They express concern that decision-makers might struggle to manage too many objectives and considerations. IT value research originated in studies on information systems performance (Cronk & Fitzgerald, 1999). The term "IT business value" emerged in the 1990s, leading to numerous studies examining the relationship between IT and business outcomes. Many researchers concluded that IT generates competitive advantages, accelerates business processes, enhances customer satisfaction, provides superior value, and increases profitability (Afflerbach, 2015; Barua et al., 2010; Brynjolfsson & Hitt, 2000; Grover & Kohli, 2012; Kohli & Devaraj, 2003; Melville et al., 2004; Schryen, 2013). However, some scholars, such as Strassmann (1997), expressed scepticism, arguing that no correlation exists between IT expenditure and recognised productivity metrics. Nevertheless, later research provided substantial evidence linking IT to organisational performance (Barua et al., 2010).

2.2.1.Business Strategies and ICT Values

In organisational management, business strategies represent a comprehensive set of actions and decisions designed to achieve a company's goals and objectives. These strategies play a crucial role in a company's success by providing a structured approach to setting goals and gaining a competitive edge in the market (Consulterce, 2021). A business strategy outlines the methods an organisation uses to position itself effectively, reach both immediate and long-term objectives, and maintain intense competition in its market (HBS Online, 2021). Critical components of a business strategy include setting clear, measurable, and attainable goals that align with the organisation's mission and vision. This approach is strengthened by conducting an in-depth analysis of the competitive environment to identify opportunities and threats (York University Online, 2021). Strategic allocation of resources, such as capital, personnel, and technology, is critical for the effective execution of the strategy. Developing a detailed action plan further outlines the steps necessary to achieve these goals (Springer, 2021). Moreover, implementing metrics and benchmarks is vital for evaluating the strategy's success and making necessary adjustments, thus ensuring the organisation's growth, sustainability, and relevance in an ever-changing business landscape (Springer, 2021).

Integrating Information and Communication Technology (ICT) into business strategies offers a host of benefits, significantly enhancing operational efficiency, communication, data management, analysis, and decision-making processes. ICT tools have become indispensable for effective business operations in dynamic environments (StudySmarter, n.d.). Dairo (2021) highlights the strategic alignment between business and IT strategies as a complex and dynamic process which allows organisations to maximise ICT benefits. Such alignment is essential for leveraging IT capabilities to support business objectives. Furthermore, Karim (2022) underscores the relationship between ICT use and business performance, especially in the context of national ICT development, providing valuable insights into how ICT boosts organisational outcomes.

Similarly, Pashutan (2022) underscores the critical role of aligning IT resources with business strategies. This alignment fosters technological value creation and ensures both business and IT strategies work toward common goals, a crucial factor in driving business success. ICT's role extends beyond technological assistance; it is integral to the digital transformation of businesses. This transformation enables organisations to swiftly adapt to market changes and customer demands (BAU, n.d.). Moreover, ICT innovations present unique opportunities for business value creation, benefiting both technology creators and adopters (Ebrary, n.d.). In sum, strategically integrating ICT in business is a multifaceted process essential for modern organisational success. It encompasses value creation, strategic alignment, and optimising technological resources, contributing to a robust and dynamic business environment.

2.2.2. Value Creation and Co-creation

In the domain of business, value creation is conceptualised as the process through which companies craft products or services that hold value for customers, thus generating revenue and enhancing profitability. This process encompasses innovation, production, and delivery methodologies that contribute value both to the company and its clientele. Co-creation, as an extension of this notion, involves customers or other key stakeholders in the creation process, fostering a more profound understanding of customer requirements and potentially leading to more innovative and bespoke products or services (Tanev, 2011).

In the sphere of Information and Communication Technology (ICT), value creation assumes an enhanced dimension. The adoption of ICT facilitates businesses in streamlining operations, boosting productivity, and inaugurating novel avenues for customer interaction and service provision. The assimilation of ICT in business operations can effectuate significant operational efficiencies and cost reductions, thereby engendering substantial value for the enterprise (Pathak, 2022).

The concept of co-creation within the ICT realm is particularly influential. The emergence and proliferation of digital platforms have empowered customers to actively participate in the development of products or services. This phenomenon is observable in sectors such as software development, where consumer feedback directly influences product improvements and updates. Moreover, ICT's role in co-creation extends to enabling enhanced communication and collaboration between businesses and their customers, thereby enriching the value-creation process (Badawi, 2023; Nájera-Sánchez, 2020). For example, the application of social media and other digital interfaces allows real-time interaction with customers, offering businesses immediate insights that can be leveraged to refine products and services. Additionally, ICT capabilities like data analytics provide businesses with deeper insights into customer preferences and behaviour, leading to more effective and personalised service offerings (Agrawal, 2015).

In summary, the adoption of ICT not only amplifies traditional value-creation methods within businesses but also paves the way for innovative forms of co-creation. This shift is critical in today's digital era, where customer engagement and technological advancement are fundamental to business success.

2.2.3. Value Proposition Concept

The concept of a value proposition is fundamental in marketing and business strategy. It refers to a business's promise of value to its customers, encapsulating the benefits and advantages of its products or services. A value proposition essentially serves as a clear, concise statement that explains why a customer should choose a particular product or service over others in the market. From an academic perspective, the value proposition represents the unique combination of benefits and values that a company promises to deliver to its customers. This concept is critical for differentiating a brand in a competitive market, highlighting what makes the brand's offering unique and desirable (Hassan, 2012).

In the context of Information and Communication Technology (ICT), the value proposition plays an integral role in modern business strategy. It refers to the value promised by a specific technology, outlining the benefits and solutions it provides to users or businesses. A clear ICT value proposition distinguishes a particular product or service in a competitive market. For example, ICT integration in the educational sector significantly enhances both the learning and teaching experience. Batista (2021) notes that teachers widely support the use of ICT in education, recognising its role in facilitating more efficient and engaging communication. Moreover, studies by Bicalho et al. (2023) suggest that ICT adoption in teaching practices can be effectively integrated into existing systems, offering educators both flexibility and responsiveness.

On a broader scale, adopting ICT technologies such as Blockchain or artificial intelligence in business operations can transform organisational processes. These technologies streamline complex tasks, improve data security, and provide insights through data analytics, ultimately leading to better decision-making and enhanced efficiency. These technologies create a significant competitive advantage, enabling businesses to operate more effectively and respond to market changes with greater agility. In summary, the value proposition of specific ICT technologies lies in their ability to enhance efficiency, productivity, and innovation across various sectors. They offer transformative solutions that redefine traditional practices and open up opportunities for new business models and strategies, making them invaluable in today's rapidly evolving technological landscape.

2.2.4. Value perceptions concept

The concept of value perceptions plays a crucial role in both academic and business contexts. It encompasses the subjective assessments individuals make regarding the worth or importance of products, services, or experiences. In academia, value perceptions influence how students and educators gauge the quality and relevance of educational content and methodologies. According to a systematic review by Sánchez-Fernández et al. (2007), perceived value in education can significantly impact student engagement and learning outcomes. This perceived value is often shaped by personal values, educational service quality, and the epistemic benefits of higher education (ResearchGate, 2023).

In the business realm, perceived value is central to customer satisfaction and loyalty. Kolomoyets (2023) suggests that there are five primary sources of value in business: information, product, interactions, environment, and ownership/possession transfer. Companies must understand and enhance these value sources to meet and exceed customer expectations. Scridon (2019) highlights the role of customer value in business, emphasising that customers' perceptions of products and services are influenced by their personal preferences and evaluations. Moreover, the adoption of technology in business, mainly Information and Communication Technology (ICT), has introduced new dimensions to value creation and perceptions. ICT facilitates enhanced interaction, personalisation, and efficiency in service delivery, thereby influencing customer value perceptions.

2.2.5. Value Realisation Concept

Business value realisation is achieved by showing the actual business benefit resulting from a new product, solution, or service implementation or enhancement. Modern technology initiatives and programs also involve significant structural changes that require an organisation's shift of mind and considerable investment. The ability to measure the use of new capabilities, services and approaches by the company and its clients is a crucial success driver in these transitions. The gains and interest will not be known by lousy adoption. Therefore, the mechanism to achieve business value seeks to calculate and optimise the progress of the transition of a company over time. Only through complementary changes in business–including changes in governance, business and operational models, business processes and practices, people's work, and the skills and abilities needed to get work done successfully, rewards and incentive systems, will an organisation realise business value from our increasingly significant, complex investments in IT-capable transformation. And the most challenging shifts in structure, community, and perhaps human behaviour. The meaning journey begins with the sales cycle, and this is the first location where progress and failure are rooted.

2.3. Emerging ICT Values (Hypes or Real Value Additions) Argument

The discourse surrounding "ICT Emerging Technologies: Hypes or Real Value Additions" remains a central theme in Information and Communication Technology (ICT). This debate critically assesses whether recent technological advancements are genuinely transformative or merely surrounded by exaggerated enthusiasm. Blockchain technology, with its blend of potential and challenges, perfectly encapsulates this dichotomy and serves as a microcosm of the broader ICT discussion. Proponents of emerging ICT technologies argue that these innovations significantly improve efficiency, security, and functionality. They claim that advancements like artificial intelligence (AI), the Internet of Things (IoT), big data analytics, and Blockchain do more than offer incremental upgrades; they are transformative tools that redefine operational processes and service delivery.

Advocates highlight the efficiency gains brought by automation, which reduces manual labour, saving both time and costs. Enhanced security features in these technologies are crucial in a digital world increasingly marked by cyber threats and data breaches. Furthermore, technologies such as AI and big data analytics offer improved decision-making capabilities by providing deep insights and enabling predictive analytics, which are vital for modern businesses (Smith & Johnson, 2020). However, sceptics argue that the hype surrounding emerging ICT technologies exceeds their practical utility. They cite instances where technologies have been marketed based on potential rather than proven performance, leading to unrealistic expectations and subsequent disillusionment. Critics contend that the capabilities of new technologies are frequently overstated, with real-world applications falling short of initial promises. Challenges with integrating these technologies into existing systems often cause operational disruptions and unmet expectations. Moreover, sceptics express concern that investments in these technologies may not deliver the expected return on investment (ROI), particularly when organisations adopt them without a clear strategic purpose (Doe & Clark, 2021).

The literature on Blockchain value realisation also presents a mixed perspective on whether its potential value is real or simply hype. Kshetri (2018) argues that organisations have yet to fully realise Blockchain's potential for business enterprises, as most remain in the experimentation phase. On the other hand, Tapscott and Tapscott (2016) assert that Blockchain has the potential to revolutionise various industries and create new business models. Blockchain's actual value, however, depends heavily on the specific context and use case. For instance, it may be more effective in improving transparency and security in some scenarios, while in others, it could help create new business models and revenue streams. Therefore, it is essential to consider the specific use case before concluding Blockchain's potential value.

Several initiatives aim to address regulatory issues, such as the Global Blockchain Forum and the Blockchain Alliance (Blockchain Alliance, 2018; Global Blockchain Forum, 2018). However, these initiatives are still in their early stages and have yet to establish clear and consistent regulations or guidelines. At the same time, many claim that Blockchain has the potential to revolutionise industries, but a growing body of literature argues that its actual value for business enterprises remains unrealised. Findings from this study support this argument, indicating that, based on empirical research, Blockchain's value cannot be entirely determined until the issues that impair its realisation are resolved. For example, Kshetri (2018) found that while Blockchain technology holds the potential to disrupt various industries, its actual impact on business operations and value creation remains unclear. Similarly, Li, Wang, and Wang (2019) concluded that although Blockchain could improve transparency and efficiency in business operations, it is still in the early stages of development, and its real-world impact has yet to materialise. Shen et al. (2021) further argue that Blockchain adoption is hindered by the technology's limitations and lack of standardisation, which impair value realisation.

Blockchain technology exemplifies the complexities of this debate. While lauded for its revolutionary potential, Blockchain is seen as a game-changer for various industries, particularly for financial transactions and supply chain management, due to its ability to create a secure, decentralised, and immutable ledger (Johnson & White, 2021). However, Blockchain faces significant challenges, as many projects have struggled to progress beyond pilot stages. Issues such as scalability, energy consumption (especially in proof-of-work systems), and integration with existing technological infrastructures hinder its practical use. These challenges raise questions about Blockchain's applicability beyond niche areas like cryptocurrencies (Taylor & Hughes, 2021). The hype surrounding emerging ICT technologies, including Blockchain, often stems from a fascination with their novel capabilities without adequately considering their practical implications. As a result, many promising technologies fail to live up to initial expectations. The gap between theoretical benefits and practical execution underscores the need for a more nuanced approach to evaluating and implementing these technologies.

To fully understand the actual value of emerging ICT technologies, comprehensive empirical research is necessary. Longitudinal studies should focus on the long-term implications and sustainability of these technologies. Moreover, industry-specific analyses are essential, as the applicability and effectiveness of technologies like Blockchain vary significantly across sectors (Wilson & Patel, 2021). The debate over ICT emerging technologies, exemplified by Blockchain, reflects a tension between the excitement generated by technological innovation and the challenges of practical application. Although these technologies hold transformative potential, their successful implementation requires overcoming significant hurdles. A balanced and critical approach is crucial when assessing these technologies, weighing their potential benefits against their limitations before fully adopting them as solutions.

2.4 Blockchain Business Values Perceptions

This section presents the perceptions of Blockchain value that drive firms and individuals to support and advocate for its adoption, drawing from recent literature and proponents' viewpoints. It is followed by a counterargument that highlights the limited reports on the outcomes of Blockchain implementations, offering a sceptical perspective.

One of the critical factors influencing technology adoption is perception. This section discusses the role of perception in technology adoption, supported by relevant references. Perception refers to how individuals interpret and make sense of their surroundings. In the context of technology adoption, perception plays a critical role in determining whether individuals will accept and use an innovative technology. Two important aspects of perception relevant to technology adoption are perceived usefulness and perceived ease of use (Davis et al., 1989). Perceived usefulness describes the extent to which individuals believe that an innovative technology will enhance their performance or productivity, while perceived ease of use refers to how easy they believe the technology is to learn and use. Research consistently shows that perceived usefulness and perceived ease of use are strong predictors of technology adoption. For example, Davis et al. (1989) found that these two factors were the most significant in predicting whether individuals intended to use modern technology. Those who viewed the technology as both valuable and easy to use were more likely to adopt it.

In addition to these factors, social influence significantly shapes individuals' perceptions of modern technology and impacts their decision to adopt it. Venkatesh et al. (2003) found that social influence plays a crucial role in technology adoption. Individuals are more likely to adopt a technology if their colleagues or peers are using it, highlighting the importance of social networks in driving adoption. Media coverage also influences how individuals perceive technology. Lu et al. (2014) demonstrated that positive media coverage significantly correlates with technology adoption. In conclusion, perception is a vital factor in technology adoption. Perceived usefulness, ease of use, social influence, and media coverage all shape how individuals view modern technology and affect their decision to adopt it. Developers and marketers need to account for these factors when promoting their products. Innovators are exploring ways to use Blockchain to disrupt and transform traditional business models across global supply chains, financial services, healthcare, and other sectors. Many industries have already realised significant benefits from Blockchain, including increased transparency, enhanced security, improved traceability, greater transaction efficiency and speed, and reduced costs (Hooper, 2019).

Increased transparency: Blockchain technology enhances transparency by allowing participants in a network to share the same documentation. As a distributed ledger, Blockchain ensures that all participants maintain identical copies of transaction histories. Any changes to this shared version require consensus, ensuring accuracy and transparency. Changing a single transaction would necessitate altering all subsequent records and the entire network, making data more accurate and coherent than traditional paper-based processes (Hooper, 2019).

Despite these advantages, there remains concern over the limited awareness and understanding of Blockchain technology. A Deloitte (2017) survey of senior executives at large US companies found that 39% had little or no knowledge of Blockchain. To address this gap, executives can collaborate with industry thought leaders, review current use cases or engage with industry associations. Additionally, the lack of uniform standards for Blockchain technology continues to pose challenges, although 56% of executives in the same survey indicated that technical standards are crucial for broader adoption.

Improved security: Blockchain increases security by requiring verification of all transactions before they are recorded (Hooper, 2019).

Improved traceability: In industries with complex supply chains, tracing a product's origin is often challenging. Blockchain enables businesses to access an audit trail that records the source and movement of assets. This historical data helps verify authenticity and prevent fraud.

Increased efficiency and speed: Traditional paper-based processes for transactions are slow and prone to human error, often requiring third-party mediation. Blockchain streamlines these processes by automating transactions, enabling faster and more efficient completion. With a shared digital record system, participants no longer need multiple ledgers, simplifying the process.

Immutability: Blockchain's immutability ensures that once records are created, they cannot be altered, which increases trust by reducing the potential for fraud. However, critics argue that immutability is sometimes overstated. While Blockchain provides enhanced security, data integrity may still be compromised under specific conditions (Zyskind et al., 2015). Nevertheless, Blockchain benefits from continuous advances in computing power, storage, and bandwidth, enabling multiple nodes to act together within a unified network (Deloitte & Blockchain, 2017).

Decentralisation: Blockchain's decentralisation offers an alternative to centralised systems, which typically rely on intermediaries. In the sharing economy, decentralised models eliminate the need for central aggregators, allowing more equitable value distribution among participants. However, challenges such as governance and scaling remain unresolved. The division of the Decentralised Autonomous Organisation (DAO) and the surrounding debates exemplify these governance issues (Mehta & Striapunia, 2017).

While Blockchain's potential is significant, its energy consumption raises concerns. Blockchain requires substantial computational power, leading to high electricity and cooling costs (Dufva, 2017). Despite these challenges, companies across sectors—from finance to medicine and aviation—are adopting Blockchain to enhance transparency and traceability in their operations (Mougayar, 2016).

However, supply chains can be resistant to change. Mougayar (2016) argues that businesses spend years refining their supply chains, and integrating innovative technology like Blockchain is not straightforward. The complexity of incorporating new systems into established supply chains presents significant challenges. Percy Venegas (2016) adds that before implementing Blockchain, companies must carefully assess the financial risks of managing an extensive supplier portfolio and enhance their legal expertise. Venegas also notes the shortage of specialists with experience in cryptocurrencies and other crypto assets, emphasising the importance of companies gaining a solid understanding of Blockchain before joining its network. Gartner's Valdes, Furlonger, and Chesini (2016) highlight Blockchain's potential as an emerging technology, advising businesses to evaluate both its benefits and drawbacks critically. Martha Bennett agrees with Mougayar, stating that the successful implementation of Blockchain in a supply chain requires full cooperation from all participants, which can be a highly complex process (Earls, 2016). Other researchers argue that while Blockchain offers strengths such as broad accessibility, there is still much room for improvement. Pat Bakey acknowledges that Blockchain could bring significant benefits but cautions that it cannot fix flawed relationships within supply chains. The complexity of end-to-end processes exceeds what technology alone can resolve (Earls, 2016).

In the oil and gas industry, Blockchain has the potential to address challenges such as high transaction costs, opaque processes, and reliance on intermediaries in crude oil trading. McKinsey & Company (2018) reports that Blockchain could reduce transaction costs by up to 30% and improve trading efficiency by up to 50%. Blockchain-based platforms allow traders to execute transactions directly, bypassing brokers and banks, which reduces fees and complexity (Jaiswal et al., 2018).

Perceptions of emerging technologies: The development of perceptions surrounding emerging technologies in ICT is dynamic and influenced by a range of factors, including prior knowledge, personal experience, peer influence, and media coverage. Individuals' previous knowledge and experience play a critical role in shaping their views on innovative technologies (Chen, 2018; Zhao et al., 2019). For example, someone with a background in computer science will likely perceive a new programming language differently from someone without that expertise (Zhao, 2019). Similarly, positive or negative experiences using a particular technology can shape perceptions accordingly.

Exposure to information about innovative technology is also essential in shaping perceptions. Sources such as academic journals, industry publications, news articles, and social media influence understanding, particularly when they come from reputable experts or well-regarded publications (Chen, 2018). Personal experience using technology further refines perceptions. Hands-on experience allows individuals to understand a technology's capabilities, although factors such as ease of use, user interface quality, and the availability of support can also affect their experience (Chen, 2018; Zhao et al., 2019). Expert opinion and peer influence also shape perceptions of emerging technologies. A respected industry expert's positive view may lead individuals to adopt favourable opinions of the technology (Chen, 2018), while negative opinions from trusted figures may have the opposite effect (Zhao et al., 2019). Media coverage and marketing similarly play crucial roles. Media platforms allow industry leaders to share insights while marketing campaigns generate excitement. However, media and marketing can also manipulate perceptions, creating inflated expectations that technologies may not meet (Chen, 2018; Zhao et al., 2019).

In conclusion, the formation of perceptions about emerging technologies in ICT involves multiple factors. It is crucial for individuals to critically evaluate the information they receive and consider multiple perspectives when assessing the value of an innovative technology. While perceptions can drive technological innovation, they can also mislead if based on misinformation or unrealistic expectations. A critical and open-minded approach is necessary for forming an accurate understanding of emerging technologies.

2.5 Value Realisation challenges in a collaborative ecosystem

In today's interconnected landscape, integrating Information and Communication Technology (ICT) into collaborative environments plays a pivotal role in business operations. However, realising tangible value from ICT investments is often more complex than it seems (Davenport, 1998). The complexity inherent in these frameworks—characterised by multiple stakeholders, systems, and processes—often obscures the origins and distribution of the value generated. Divergent stakeholder objectives further complicate this. For example, while vendors may prioritise sales, users might focus more on usability and efficiency

(Henderson & Venkatraman, 1993). This divergence frequently leads to conflicts in identifying and realising the value of ICT.

Certain benefits, such as enhanced collaboration or innovation, are intangible and difficult to quantify (Brynjolfsson, 1993). In the digital age, ICT is not merely a peripheral component but the central conduit through which collaborative environment's function. Although ICT offers immense potential, understanding and realising its actual value remains a challenge.

Beyond the complexity of collaborative systems, the human element adds unpredictability. Stakeholders, with their varied backgrounds and motivations, are the driving force behind these systems (Freeman, 1984). Their interactions with both the technology and one another significantly influence the value derived. For instance, developers may emphasise system robustness, while end users may prioritise ease of use and functionality. This misalignment, as noted by Henderson and Venkatraman (1993), can hinder the full realisation of ICT's value. This exploration highlights the intricate dynamics of ICT value realisation in collaborative settings and stresses the importance of addressing stakeholder values to harness the full range of benefits. The rapidly evolving technological landscape means that today's cutting-edge solutions can quickly become obsolete. ICT investments often face this harsh reality, with their value dissipating before companies fully extract it (Peppard & Ward, 2004). This transient nature of technology necessitates continuous adaptability and foresight. Evaluating ICT's value is not always a straightforward numeric exercise. Intangible benefits—such as enhanced collaboration, accelerated innovation, or improved stakeholder morale—are difficult to quantify but have a profound impact (Brynjolfsson, 1993). This intangibility creates a paradox: while stakeholders recognise the value, they struggle to measure and articulate it explicitly.

Despite these challenges, ICT-driven collaborative environments offer significant advantages. When stakeholders' values align, the synergies generated can exceed the sum of individual aspirations (Galleries, 1993). As stakeholders see their priorities acknowledged and addressed, their commitment to ICT initiatives strengthens, improving overall efficacy (Donaldson & Preston, 1995).

In essence, while realising optimal value from ICT in collaborative environments poses challenges, it also presents opportunities. By recognising and navigating these challenges—understanding stakeholder dynamics and appreciating both the tangible and intangible facets of value—organisations can unlock unprecedented collaborative potential and innovation. As collaborative frameworks expand, a judicious, adaptive, and inclusive approach becomes crucial for fully realising ICT's value.

The value chain comprises a set of activities performed by a company to deliver a valuable product or service to the market. Michael Porter first introduced the concept in his 1985 book, *Competitive Advantage:*

Creating and Sustaining Superior Performance (Porter et al., 1985). The value chain concept views organisations as systems composed of subsystems, each involving inputs, transformation processes, and outputs. These inputs, processes, and outputs depend on resources such as capital, labour, materials, machinery, property, governance, and administration. The cost and profitability of value chain activities determine an organisation's performance. The value chain framework quickly became a leading tool in strategic management, especially for planning and analysis. In the early 1990s, the more straightforward concept of stream mapping—a cross-functional process—gained traction (Martin, 1995). It applies to entire supply chains and distribution networks. The coordination of local value chains contributes to a broader, often global, value chain. The term "value system" describes this interconnected chain, encompassing suppliers, the company, distribution channels, and buyers. Many strategists now focus on capturing the value generated throughout the chain. For instance, a manufacturer might require suppliers to locate near its assembly plant to reduce transport costs. By using information from both upstream and downstream in the value chain, companies can bypass intermediaries, create new business models, or enhance their existing value systems.

Cooperative Strategy: Forming strategic alliances is a common method for implementing cooperative strategies. In such alliances, partners share resources and activities to gain a competitive advantage (Grant & Baden-Fuller, 2004). According to Johnson et al. (2015), strategic alliances can be either equity-based or non-equity-based. Equity alliances involve creating a new company owned by the partners, such as a joint venture where each participant remains independent. In a consortium, partners establish a new joint venture with shared ownership. Non-equity alliances, like franchising or licensing, rely on contractual agreements, which may lead to weaker commitments due to the lack of ownership (Johnson et al., 2015).

Although strategic alliances offer advantages, they also present challenges. While partners agree to collaborate, they often remain competitors, creating internal dilemmas. A company must contribute to the strategic alliance while prioritising its interests (Porter, 1980). Fonti et al. (2017) describe this as a "classic collective action problem," where actors hesitate to commit resources, creating a free-rider situation that limits the collective potential. Although alliance theory explains why and how companies form alliances, it does not fully address the complexity of these collaborations.

Co-opetition: The complex relationship between competing and cooperating organisations is referred to as co-opetition (Bengtsson & Kock, 2000). As globalisation intensifies, cooperation among competitors has become more common, leading to increased research on co-opetition (Bouncken et al., 2015; Bengtsson & Kock, 2014; Gnyawali & Park, 2011). Brandenburger and Nalebuff (1996) first applied co-opetition in an academic context, advocating for game theory approaches in business decisions. Co-opetition should not be seen as a simple trade-off between cooperation and competition. Bengtsson and Kock (2014) argue that it captures the complexity and paradoxes of organisations cooperating while competing.

Risk: Co-opetition carries inherent risks because the companies involved are also competitors. Although research often focuses on the positive aspects, such as innovation and reduced costs, risks are also present. One significant risk is opportunism, where companies exploit shared information for their gain, potentially undermining competitive advantages (Bouncken & Kraus, 2013). However, information sharing is essential in cooperative relationships, especially when collaborating on new products. Conflicting ideas can pose risks, as disagreements may cause the relationship to break down if no consensus is reached (Lee & Johnson, 2010).

Tension: Managing tension is crucial for successful co-opetition. Fernandez et al. (2014) identify multi-layered challenges at both the inter-organisational and individual levels. Deciding how much information to share is a common source of tension. Sharing too much could harm one party, while withholding too much may hinder the project's success. Bengtsson et al. (2016) distinguish between internal and external tensions in co-opetition. Internal tensions arise at lower levels, where day-to-day work occurs, while external tensions involve managing co-opetition at a strategic level.

Managers must ensure that all parties in a co-opetition align their goals and tasks. Misalignment can erode trust and lead to breakdowns in the relationship, with companies blaming one another for failures. Larger, more powerful companies may exploit smaller ones, creating a dependence that forces smaller companies into unfavourable decisions (Tidström, 2014). Osarenkhoe (2010) warns that larger companies may demand access to smaller firms' core competencies, leading to controlled relationships that harm the smaller businesses. Managing co-opetition projects can be a source of tension, as companies may resist allowing a competitor to lead a joint project. Effective management is crucial for maintaining these relationships and ensuring fair use of shared knowledge (Lee & Johnson, 2010).

2.6 Time to Value Concept and Challenges

The concept of Time to Value (TTV) in Information and Communication Technology (ICT) refers to the period it takes for organisations to fully benefit from implementing a specific technology (Breznik & Hisrich, 2020; Lith, 2017). TTV is a crucial measure for organisations as it influences how effectively they achieve their goals (Perera, Nandasara, & Gunawardena, 2021). Lith (2017) defines TTV as the time required to realise the full benefits and value of implementing a particular technology. It serves as an essential metric for organisations, guiding the effective utilisation of resources and the attainment of objectives (Perera et al., 2021).

TTV can vary significantly across different ICT technologies, depending on factors such as the nature of the technology, organisational preparedness, and industry-specific considerations (Godoy, Mylopoulos, & Yu, 2019). For example, cloud computing often results in a shorter TTV due to its ease of provisioning and scalability benefits (Chen, Preston, & Xu, 2019; Suncu, Aşkın, & Tuna, 2020). Conversely, technologies such as artificial intelligence (AI) may involve complex processes, including model training and data analysis, leading to a longer TTV (Ravishankar, Pan, & Palvia, 2019; Thomé, Scavarda, & Graeml, 2022). The TTV for Internet of Things (IoT) adoption can vary based on the scale and complexity of deployment (Süel & Tenekecioğlu, 2020), while Blockchain technology tends to result in longer TTV due to the need for infrastructure establishment and consensus-building among participants (Ismail, El-Esabey, & Tayel, 2021; Lincoln, Fisher, & De'Arth, 2020).

Comparative TTV analysis across different technologies requires empirical research and a case-specific approach within distinct industry contexts (Bikhchandani, Hirshleifer, & Welch, 2021). In-depth case studies and empirical investigations are essential to identifying factors influencing TTV, such as technology complexity, implementation strategies, and organisational readiness (Corsaro & Meloni, 2021; Koop, Randhawa, & Córcoles, 2020). To fully understand TTV and strive for value realisation in ICT technology adoptions, it is essential to analyse industry-specific challenges and consider theories or frameworks that could aid in reducing TTV and maximising value (Mayernik, Stege, & Tolhurst, 2020; Zeimpekis, Vrontos, & Kavadis, 2022).

Continued qualitative and quantitative research is necessary to gain insights into technology-specific TTV experiences, identify best practices, and formulate guidelines applicable across various ICT domains (Hillières et al., 2022; Sharma, 2019). Comparative analyses, based on empirical data within a specific industry domain, can provide valuable insights into TTV variations across ICT technologies. Such studies enable organisations to make informed decisions regarding technology selection, resource allocation, and implementation strategies, ultimately reducing TTV and maximising value realisation (Bayrasheva & Mayhew, 2021).

TTV Features and Challenge: Considering TTV in ICT adoption offers multiple benefits. Firstly, it helps organisations assess the feasibility and viability of implementing innovative technologies by providing a measure of the time required for the investment to yield tangible returns (Breznik & Hisrich, 2020). This assessment allows organisations to make informed decisions regarding resource allocation, cost management, and potential risks associated with adoption. Secondly, TTV promotes efficiency and resource optimisation. Understanding the timeline for realising value enables organisations to develop strategic plans and take proactive measures to streamline the adoption process. These measures include selecting appropriate technologies, ensuring effective communication and coordination among stakeholders, and implementing necessary infrastructure in a timely manner (Godoy et al., 2019). A TTV-driven approach allows organisations to optimise resource allocation, reduce costs, and minimise potential disruptions during implementation.

Furthermore, organisations that prioritise TTV analysis are better equipped to manage expectations and mitigate risks. By setting realistic timelines for value realisation, they can address challenges related to learning curves, technology complexity, and potential disruptions to existing workflows (Godoy et al., 2019). These anticipatory measures contribute to smoother adoption processes, enhance user acceptance, and reduce resistance to change. However, TTV poses challenges. One critical challenge is accurately predicting the time required for value realisation, given the numerous factors that may be difficult to anticipate. Technology complexity, customisation requirements, integration difficulties, and external dependencies can all significantly impact TTV estimation (Ravishankar et al., 2019). Therefore, organisations must conduct careful assessments and gather empirical data to ensure their predictions adequately reflect implementation realities.

Critics of the TTV approach may argue that focusing solely on the time required to realise value overlooks certain long-term benefits that may accrue gradually. Overemphasis on TTV might encourage organisations to prioritise short-term gains at the expense of potentially more significant long-term advantages (Mayernik et al., 2020). It is crucial to strike a balance between short-term returns and long-term value when evaluating ICT adoptions. Time to Value (TTV) provides a valuable metric for organisations adopting emerging ICT technologies. By incorporating TTV into decision-making processes, organisations can assess feasibility, optimise resource allocation, manage expectations, and address concerns related to technology adoption. Although TTV estimation presents challenges, careful empirical analysis and a balanced approach can ensure informed decision-making. Acknowledging both the benefits and limitations of TTV is essential to maximising value realisation from ICT adoptions (Zeimpekis et al., 2022). Technological advancements have led to the emergence of diverse ICT technologies, each with unique characteristics and complexities. Understanding TTV variations among different ICT technologies is crucial for organisations seeking to maximise the benefits of their technology investments. This discussion explores TTV variations within the context of relevant theories and provides academic references to support the analysis.

When comparing TTV among different ICT technologies, factors such as the nature of the technology, organisational preparedness, and industry-specific considerations contribute to observed variations (Godoy et al., 2019). The Technology-Organisation-Environment (TOE) framework provides a theoretical lens for understanding these variations. According to this framework, technological characteristics, organisational factors, and the external environment interact to determine TTV for each technology (Chen et al., 2019). For example, cloud computing typically exhibits a shorter TTV due to its ease of provisioning and scalability (Chen et al., 2019; Suncu et al., 2020). The Resource-Based View (RBV) theory suggests that cloud computing's inherent characteristics, such as scalability and cost-effectiveness, enable organisations to realise value quickly by efficiently utilising resources (Chen et al., 2019).

Conversely, technologies like artificial intelligence (AI) often involve more complex processes, such as model training and data analysis, leading to longer TTV (Ravishankar et al., 2019; Thomé et al., 2022). The Resource Dependency Theory (RDT) explains this phenomenon by highlighting how the availability and accessibility of critical resources, such as skilled AI professionals and large datasets, influence AI's TTV (Ravishankar et al., 2019). In the context of the Internet of Things (IoT), TTV variations occur based on deployment scale and complexity (Süel & Tenekecioğlu, 2020). The Technology Acceptance Model (TAM) posits that factors such as user acceptance, knowledge transfer, and integration challenges affect IoT's TTV (Süel & Tenekecioğlu, 2020). Technologies within IoT ecosystems, such as sensors, connectivity, and data processing platforms, must work together cohesively, influencing the overall time required to achieve value. By examining these TTV variations through relevant theories, organisations can make informed decisions regarding technology adoption and develop strategies to reduce TTV while maximising value. Further qualitative and quantitative research is required to gain deeper insights into technology-specific TTV variations and their implications for different industries (Hillières et al., 2022; Sharma, 2019). In conclusion, understanding TTV variations among different ICT technologies is vital for organisations. By applying theoretical frameworks such as the TOE framework and TAM, organisations can gain insights into the factors that influence TTV variations. This knowledge allows for informed decision-making, resource allocation, and the development of strategies to reduce TTV while maximising value realisation in ICT technology adoptions.

2.7 Technological Paradigms in the Oil and Gas Industry

The integration of burgeoning Information and Communication Technologies (ICT) within the oil and gas (O&G) industry, in comparison to other sectors, invites extensive analysis through diverse theoretical frameworks. Notably, the perspectives provided by theories such as the diffusion of innovations and the technology acceptance model (TAM) yield significant comparative insights. From an organisational behaviour standpoint, Scott (1998) suggests that the hierarchical and risk-averse nature of the O&G industry results in a cautious approach to technology adoption. This perspective aligns with the industry's preference for technologies that ensure operational efficiency and safety, reflecting a strategic focus on reliability and compliance rather than innovation. In contrast, sectors such as technology and finance, as analysed within the same theoretical framework, display more agile structures, enabling the rapid assimilation of innovative technologies (Daft, 2010). This agility, often driven by competitive pressures and a continual pursuit of innovation, distinguishes these industries from the more conservative O&G sector.

Rogers' (2003) Diffusion of Innovations theory further elucidates these differences. According to this theory, the O&G industry tends to fall into the late majority or laggard categories of technology adoption due to its operational complexity and stringent regulatory environment, which necessitate a more cautious and delayed adoption strategy. In contrast, industries like IT and finance are typically early adopters, as they are less constrained by the heavy regulatory frameworks characteristic of O&G, allowing for a more proactive and risk-taking approach to emerging technologies (Rogers, 2003).

The Technology Acceptance Model (TAM), developed by Davis (1989), provides additional insights into how perceived usefulness and ease of use influence technology adoption across industries. In the O&G sector, ICT adoption is primarily evaluated based on operational efficiency and risk mitigation. The O&G contrasts starkly with industries such as healthcare and banking, where adoption is driven by customer satisfaction, competitive advantage, and regulatory compliance (Davis, 1989).

The O&G sector's intricate relationship with ICT reflects a confluence of tradition and innovation. Hamilton (2011) observes that this critical intersection highlights not only the industry's historical practices but also the challenges it faces due to complex supply chains and stringent regulatory oversight. These factors shape the industry's approach to technological advancement, giving rise to a strategy influenced by both internal and external forces.

Van de Graaf and Bradshaw (2018) highlight the capital-intensive nature of the O&G sector, which grants the industry the financial capability to explore cutting-edge technologies. However, this financial muscle also instils caution, as the high stakes involved in O&G operations demand careful consideration before embracing radical technological shifts. This dual approach underscores the sector's unique position within the technological landscape. While the O&G industry may appear conservative, it is far from immune to external influences. Bazilian and Bradshaw (2018) point out that the industry often turns to technology as a means of enhancing efficiency and complying with evolving environmental and safety regulations. The deliberate integration of technology into core processes is carefully monitored by organisations such as the Energy Information Administration (EIA, 2017).

Stevens (2019) notes the industry's collaborative spirit, demonstrated through strategic alliances with technology firms to develop bespoke solutions. Rather than chasing after the latest technological trends, the sector tends to focus on incremental improvements, aligning with Kilian's (2016) assertion that refining processes are often more strategic than undertaking wholesale overhauls.

In recent years, the global discourse has increasingly shifted towards sustainability and environmental concerns, as noted by Bridge and Le Billon (2017). Technologies that promise enhanced safety, reduced emissions, and sustainable operations have found swift acceptance and integration within the O&G sector.

This swift acceptance highlights the industry's adaptability and proactive alignment with global sustainability imperatives. The UK Government (2019) identifies operational efficiency and cost reduction as the primary drivers for technology adoption in the sector. Technologies such as advanced data analytics, artificial intelligence (AI), and machine learning offer the potential for optimising processes and streamlining complex supply chain management. However, the industry's operations in remote and hazardous environments, such as deep-sea exploration, necessitate innovative ICT tools for remote monitoring, supervision, and risk mitigation, as articulated by Jacobs (2019).

The O&G industry's data-rich nature presents significant opportunities for data-driven decision-making, as emphasised by the Energy Information Administration (EIA, 2019). Technologies such as Blockchain and digital twins are critical in ensuring environmental compliance and facilitating precise tracking and management of environmental risks, as highlighted by Opito (2018). Safety and risk management remain central concerns within the sector, with predictive analytics and virtual reality simulations emerging as transformative tools to enhance safety protocols and operational performance (Perrons, 2014).

The retirement of seasoned professionals poses another challenge, which emerging technologies like AI-powered knowledge bases and augmented reality training solutions aim to address (Radnejad & Vredenburg, 2017). The O&G industry's embrace of emerging ICT and technological advancements reflects its response to a variety of factors, including efficiency, cost reduction, and safety improvements. However, it must also navigate the challenges of regulatory compliance, environmental stewardship, and a changing workforce.

Mendling et al. (2017) explore the complexities of supply chain management in the O&G sector, underscoring the role of digitisation in achieving visibility and control. The downstream sector, in particular, grapples with challenges related to information assimilation, with data often siloed across different segments, as highlighted by Hernandez (2017). Blockchain technology offers a promising solution to enhance transparency and safety within the supply chain (Dickson, 2016). Logistical challenges, including the need for specialised transport equipment and the high stakes involved in transporting oil and gas products, further complicate supply chain management. Partnering with third-party logistics providers can offer valuable solutions to address these challenges (Mendling et al., 2017).

While the O&G sector recognises the necessity and potential of ICT, several barriers complicate its adoption. Firstly, the inherent resistance to change within the sector slows the adoption of innovative ICT solutions, as the industry often relies on proven methodologies (Stevens, 2019). Secondly, the high-risk nature of O&G operations requires rigorous testing and validation of new technologies before implementation. Operating in extreme environments necessitates fail-safe and reliable ICT solutions, given the significant consequences of technological failures (Jacobs, 2019).

Another challenge is the interoperability of new ICT with existing legacy systems. The O&G industry relies on a complex network of technologies, some of which have been in place for decades. Integrating modern ICT with these legacy systems without disrupting ongoing operations is a complex task (EIA, 2017). Furthermore, the vast scale and global spread of O&G operations present logistical challenges for consistent implementation and training across diverse operational contexts, especially in remote areas (Bazilian & Bradshaw, 2018). Cybersecurity is also a critical concern, as the sector's reliance on ICT makes it a prime target for cyber threats. Ensuring robust cybersecurity measures to protect sensitive data and operational integrity remains an ongoing challenge (UK Government, 2019). The high capital investment required for advanced ICT solutions is another consideration. While large enterprises may have the financial capacity to invest in modern technologies, smaller industry players may struggle to allocate the necessary funds (Van de Graaf & Bradshaw, 2018). Environmental and regulatory compliance adds another layer of complexity, as ICT must improve efficiency and safety while adhering to strict environmental standards (Bridge & Le Billon, 2017). The sector also faces a talent gap, particularly concerning newer technologies. The retirement of experienced professionals and the shortage of skilled personnel proficient in modern ICT solutions can hinder effective implementation and management (Radnejad & Vredenburg, 2017).

In conclusion, the O&G industry's adoption of emerging ICT, when viewed through various theoretical frameworks, reveals a more cautious and efficiency-driven approach. This cautious contrasts with the agile and innovation-focused strategies observed in other sectors, shaped by industry-specific factors such as organisational structure, market dynamics, and regulatory landscapes. The O&G sector's journey with emerging technologies exemplifies how a traditional industry carefully balances innovation with its longstanding practices. The sector's strategic and deliberate approach to ICT integration ensures alignment with its long-term vision while maintaining its crucial role in shaping the global energy landscape. As the industry continues to evolve, its ability to navigate the challenges associated with ICT adoption will be critical in leveraging technological advancements to meet the demands of the global energy sector.

2.8 ICT emerging technology adoption theories

This section of the study examines the theories of ICT adoption that have been widely used as frameworks in numerous studies to explore the adoption of emerging ICT technologies within organisations. This study has selected three major theories that are instrumental in assessing Blockchain adoption within organisations, from the initial perceptions to the realisation of the desired value. The discussion begins with an in-depth analysis of Blockchain technology within the context of the selected theories: Diffusion of

Innovations (DOI), Technology Acceptance Model (TAM), and Technology, Organisation, and Environment (TOE). Following this, the research identifies gaps in these theories and proposes a framework that integrates them as a foundation for assessing the value realisation of Blockchain technology.

2.8.1 Blockchain Business Adoption in light of DOI, TAM and TOE Theories

2.8.1.1 Diffusion of Innovation (DOI theory

Blockchain is *Diffusion of Innovation (DOI): Blockchain* is an innovation that can significantly enhance the management of IT infrastructure within businesses. Like other technological advancements, its adoption can be explained through the Diffusion of Innovation (DOI) theory, which outlines how innovations spread through organisations. The dissemination of Blockchain technology across organisations depends on both the innovation itself and the characteristics of the organisations adopting it at various stages. According to DOI, the diffusion process follows five stages: 1) knowledge, 2) persuasion, 3) decision, 4) implementation, and 5) confirmation. Knowledge is the first and most crucial stage in this process, particularly in today's complex global environment (Jamshidi, 2015; Avazzadeh, 2015). Once knowledge is established, persuasive arguments for adoption lead to decision-making.

Previous studies have explored the role and impact of Blockchain (Zhu et al., 2003; Oliveira & Martins, 2008; Pan & Jang, 2008; Ghobakhloo et al., 2011). However, these studies have often focused on the decision-making stage and have not adequately addressed the execution and adoption phases, which are critical for reaping the full benefits of Blockchain. Thus, understanding Blockchain implementation beyond the decision phase is essential for organisations. According to Rogers (1962), the DOI framework is one of the most widely used theoretical models for studying the adoption of innovations. Rogers defines *diffusion* as the process by which an innovation is communicated over time among members of a social system, focusing on how individuals or organisations adopt innovations, and the decision-making processes involved.

Rogers (1962) also identifies several characteristics that influence the diffusion of technological innovations: relative advantage, compatibility, complexity, trialability, and observability. Several Information Systems (IS) studies have successfully applied these characteristics to examine technology adoption, including research by Lee and Kozar (2008), who employed DOI to empirically investigate how central processing unit users in the USA adopted anti-spyware software.

The diffusion of innovation explains how individuals embrace new technologies over time. Blockchain is considered a next-generation technology with potential applications beyond digital currencies. Initially, Bitcoin, a digital currency, was Blockchain's most notable use case, but the technology's potential extends far beyond that (Iansiti & Lakhani, 2017). Radical innovations, such as Blockchain, represent discontinuous changes that disrupt existing business models (Freeman et al., 1988). These innovations require significant organisational adjustments, making them more challenging to adopt than incremental innovations, which typically add functionalities to existing technologies (Betz, 2011). Radical innovations introduce innovative technologies and features, often requiring organisations to develop new capabilities or adapt existing ones (Hill et al., 2003).

According to Rogers (1962), adopters can be classified into five categories: innovators, early adopters, early majority, late majority, and laggards. These categories reflect the stages at which individuals or organisations adopt new technologies. For instance, approximately 2.5% of the population are innovators who are willing to take risks and experiment with new technologies. However, it's the early adopters (13.5%) who play a crucial role in spreading innovations within their social systems (Woodside et al., 2017). Early adopters act as change agents, influencing the broader adoption of new technologies within their organisations (Patnaik, 2017).

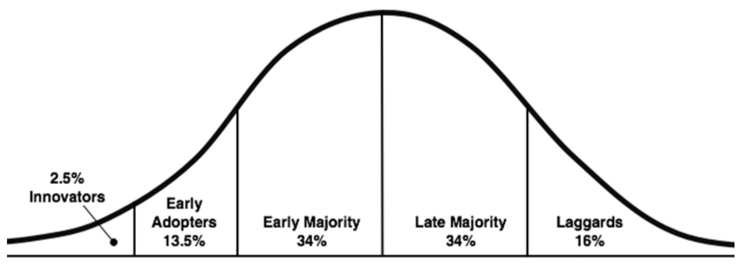


Figure 2.1 DOI Theory Stages

Similarly, early adopters can accelerate the dissemination of innovative technologies by advocating for their adoption (Lember et al., 2014). In contrast, later adopters, including the late majority and laggards, tend to be more cautious, only embracing new technologies after they have been widely tested and accepted (Quitzow et al., 2014). This cautious approach, although slower, is an essential part of the adoption process.

Rausch (2019) suggests that laggards may eventually adopt innovative technologies as they progress through the stages of development. However, defining the precise stages of Blockchain adoption from a theoretical and managerial perspective remains challenging. The diffusion curve is influenced by several factors, including technological compatibility, complexity, network effects, and the relative advantages perceived by organisations (Farahmand & Farahmand, 2019). In many cases, the adoption of innovative technologies is driven by communities of individuals and organisations that have successfully integrated these innovations. Bitcoin serves as a prime example of the practical application of Blockchain technology. The increasing adoption of Bitcoin has had a profound impact on mainstream financial systems. Currently, over 9 million Bitcoins are traded daily, with transaction volumes continuing to grow (Zhang & Wen, 2015). The pace of Blockchain adoption varies between countries, with some nations experiencing faster uptake due to regulatory support and risk mitigation strategies. For example, the UK has been proactive in embracing Blockchain technologies, particularly in the financial sector (Tapscott & Tapscott, 2016).

Governments are also recognising the potential of Blockchain. The UK government recently announced plans to establish six new research centres aimed at enhancing digital infrastructure and supporting start-up businesses (Iansiti & Lakhani, 2017). As Blockchain technology continues to evolve, its integration into business practices is expected to introduce significant developments. Organisations that stay current with these technological trends are likely to gain a competitive advantage over those that delay adoption (Patnaik, 2017).

This study will further explore Blockchain's development and leadership implications, as well as the role of the diffusion curve in shaping its adoption within organisations. The flexibility of the DOI framework has enabled its application across various fields, from Web development to Electronic Data Interchange (EDI) and Venture Reserve Planning (VRP) (Lember et al., 2014). By adopting a triangulation approach, this study will examine Blockchain's adoption through economic, environmental, and textual analyses, contributing to a deeper understanding of its potential impact on organisations (Sapra et al., 2014).

2.8.1.2 Technology Acceptance Model TAM

The Technology Acceptance Model (TAM) is a significant analytical tool widely referenced in the literature for examining the mechanics of technology implementation. Despite varying levels of empirical support, TAM remains a popular and effective conceptual framework for assessing the factors that lead to the adoption or rejection of technology by relevant constituencies. In the context of Blockchain, TAM can be used to evaluate elements of the technology adoption process. Although Blockchain applications beyond cryptocurrency (such as Bitcoin) are still in their early stages of development, several major industry players have shown considerable interest and commitment due to Blockchain's reliable and verifiable record-keeping capabilities. While Blockchain technology complements existing record-keeping systems, it does not entirely replace them. TAM provides a valuable framework for further analysis of this evolving technology.

TAM posits that perceived usefulness (PU) and perceived ease of use (PEOU) are the two main factors influencing a user's intention to adopt technology. PU refers to the extent to which an individual believes that using a particular system will enhance their job performance. At the same time, PEOU relates to the degree to which they perceive the system as being easy to use, with minimal effort. Since its inception, numerous scholars have consistently validated TAM across various settings, making it a widely used model in technological research. However, TAM is a relatively simple model that can be adapted or extended, which has led to several modifications incorporating other models in the literature (Zhang et al., 2008). The model suggests that technology use is determined by the user's behavioural intention (BI), which is influenced by their attitude towards the technology. Ultimately, PU and PEOU directly affect the user's beliefs about the technology. TAM is a foundational theory for predicting and explaining users' cognitive responses to technology, making it a critical framework for this study (Lee et al., 2011). (Lee et al., 2011).

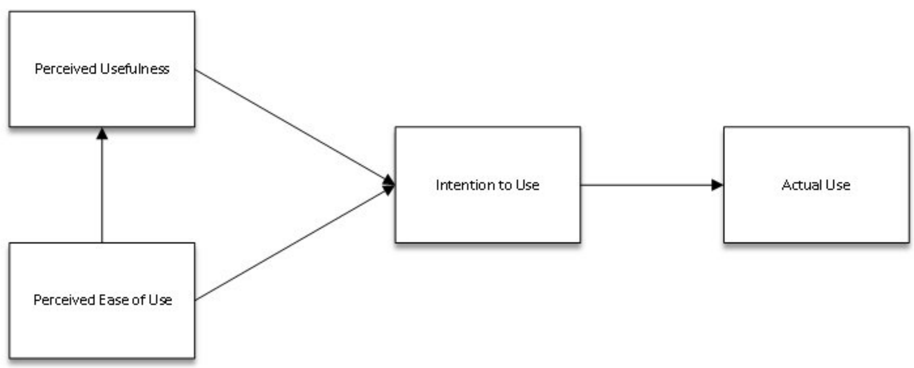


Figure 2.2 TAM Framework

Reputation: Reputation refers to users' perceptions of a particular system or platform, including how well-known the system is, its reputation, and familiarity with the website or service. Unfortunately, because Blockchain serves as the core technology supporting various systems and brands, it struggles to establish a standalone reputation independent of the cryptocurrency or service utilising its capabilities (Gainsbury et al., 2017). This issue is compounded by the general lack of awareness about Blockchain technology compared to cryptocurrencies, despite Blockchain being the underlying technology for many digital currencies.

Risks: Blockchain technology presents various risks, including privacy, security, transactional, and systemic risks. One of Blockchain's key advantages is its enhanced security and privacy features compared to traditional transaction methods. However, focusing on the overall risks associated with Blockchain transactions (BRI) and Blockchain's viability as a business model (BCPRB) is critical (Folkinshteyn, 2016). This is especially important since Blockchain's decentralised nature means there is limited recourse for fraudulent transactions or hacked accounts. Additionally, current concerns surrounding government regulations and energy efficiency issues threaten Blockchain's sustainability as a long-term system. Due to Blockchain's unique features, the risks it presents to users are unconventional and not well-documented in the existing literature. As such, new products and risk assessment frameworks for Blockchain systems have been introduced (Kim et al., 2007).

Perceived Usefulness (PU): There has been limited research on the overall usefulness and application of Blockchain technology. The literature indicates that Blockchain has the potential to impact critical sectors such as energy, the Internet of Things (IoT), finance, government, and healthcare. These sectors benefit from Blockchain's inherent advantages, including improved oversight, reduced reliance on intermediaries, faster information transfer, lower data transmission costs, enhanced security, global reach, and greater trust among stakeholders. While there has been prior research on the perceived usefulness of technological systems, the disintermediation and global effects of Blockchain are unique. As a result, new constructs have been developed based on previous Blockchain and cryptocurrency studies to measure PU (Kim et al., 2007).

Transaction Intentions: Many traditional approaches to studying technology adoption concentrate on analysing user engagement through pre- and post-purchase behaviour or transactions. However, Blockchain technology is inseparable from cryptocurrencies, which are highly regulated and scrutinised. As a result, transactions involving Blockchain cannot be measured in the same way as traditional operations and purchases. This challenge is particularly true because cryptocurrencies and Blockchain-based systems are decentralised and anonymous. Therefore, measuring general transaction intentions is a more appropriate approach (Suh et al., 2003). Previous studies have examined the impact of a range of factors on consumer adoption using TAM. Key constructs such as intention to transact, perceived usefulness, perceived ease of use, and perceived risks form the basis of TAM (Saadé et al., 2007).

Different studies have mapped a range of factors to measure the constructs that influence user interactions with a system. Extensions to the basic TAM model, incorporating factors such as trust, reputation, perceived privacy, and security, have further refined our understanding of user adoption. In earlier research on e-commerce and credit card transactions, the reasons for consumer acceptance were more fully explored, improving both the methodologies for user adoption studies and the systems themselves (Kim et al., 2007).

Blockchain technology was first introduced as the foundational enabler of Bitcoin, the most widely recognised cryptocurrency. This initial association with Bitcoin has provided both advantages and challenges for Blockchain's development and recognition as a standalone technology platform. On the one hand, Bitcoin's prominence in the media and among financial institutions and regulatory bodies has shed light on Blockchain's features, such as authentication, anonymity, and immutability. This visibility has paved the way for further research and development of Blockchain technology. On the other hand, Blockchain's association with Bitcoin has influenced users' perceptions of its reputation and trustworthiness (Anderson, 1972).

Although research on Blockchain technology is growing, much of the focus has been on evaluating its strengths and weaknesses as a solution, as well as proposing ways to address its technological challenges.

However, significantly less research has explored Blockchain's implementation and utilisation across different sectors and applications (Yli-Huumo et al., 2016). It is crucial to investigate how Blockchain is being utilised and embraced by users in order to bridge this gap.

2.8.1.3 Technology, Organisation and Environment (TOE) theory

Tornatzky and Fleischer (1990) describe how organisations recognise novelty by focusing on the hypothesis of unforeseen company occurrences. Their framework identifies three factors—technology, organisation, and environment—that influence organisational adoption, forming the TOE framework. The technological aspect refers to both internal and external resources that an organisation can access. It focuses primarily on affordable tools and achievable innovations rather than inevitable pressures for modern growth.

Four models synthesise theoretical applications of data network security modernisation in businesses. These models represent the customer's acceptance and use of data technology and integrate aspects of the Diffusion of Innovations (DOI), the Technology Acceptance Model (TAM), and the TOE framework. DOI is one of the most widely used models for understanding the innovation process in information networks. However, DOI does not fully capture the adoption process in organisations, as it only explains individual-level adoption and lacks consideration of organisational and contextual factors.

Technological Factors: In this context, "technology" encompasses several variables, including Blockchain technology itself. These variables have been evaluated in relation to other innovations, such as technological capacity, system flexibility, and the technology-organisation gap (Başoğlu et al., 2007). Blockchain is seen as an emerging technology that invites significant excitement due to its potential. In industries such as financial services, the disruptive effect of technology is tied to expected benefits and its application in various scenarios (Nofer et al., 2017; Wörner et al., 2016). Organisations aim to find the best fit between technology and their needs, ensuring it aligns with their requirements (Zhang et al., 2005). This process has been observed in the adoption of other technologies, such as ERP systems, where firms evaluate technological maturity, robustness, accuracy, and timeliness to improve their chances of selecting the right system (Başoğlu et al., 2007). Technological capacity, flexibility (Bradford & Florin, 2003), and system customisation (Bingi et al., 1999) enhance this fit.

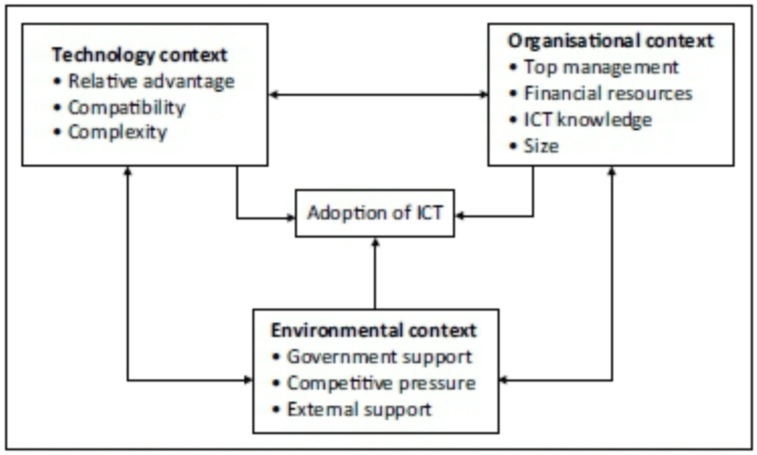


Figure 2.3 TOE Framework

In the case of Blockchain, many IT suppliers provide initial systems, and several major players—such as IBM and Accenture—are now active in the industry. Furthermore, sector-specific and cross-industry consortia, such as Fund Chain (which explores opportunities in asset management) and the China Ledger Alliance (which promotes Blockchain use in various sectors), are advancing Blockchain's adoption. As a result, numerous standards and Blockchain configurations have emerged, complicating the decision-making process for organisations seeking to adopt and adapt these technologies.

From a technical standpoint, Blockchain does not require exceptional innovation but relies on open-source code, much of which is already well-established. In the future, Blockchain technology will likely become more legitimised, and new, creative applications will continue to emerge. Specifications for software, such as speed, processing time, and compatibility with existing systems, will play a crucial role (Harley, 2016). What sets Blockchain apart is that nodes on the network do not need to trust one another. Unlike traditional database systems, which rely on a central server managed by a third party, Blockchain uses a decentralised system in which all network nodes verify and agree on the legitimacy of new transactions (Harley, 2016; Summers, 2016). This feature ensures that fraudulent transactions cannot occur, allowing users to trust the integrity of past transactions. Each block contains the hash of the previous block header, making it challenging to alter individual blocks without also modifying adjacent ones. As more blocks are added, the network's stability increases. This structure makes it nearly impossible to exploit past transactions on a Blockchain network. The distributed nature of the digital ledger, where every node has a complete record of all transactions, further enhances the security of Blockchain (Kiviat, 2015).

Organisational Factors: A lack of understanding of modern technologies and unclear perceptions of their benefits contribute to caution. As a result, when considering modern technology adoption, top management prioritises costs and risks over potential benefits, which decreases the likelihood of Blockchain adoption within enterprises like Saudi Aramco.

According to the Digital Research Company (2017), enterprises in Saudi Arabia display low IT readiness. Many of these companies develop and upgrade their IT systems in-house, leading to unique systems that create data silos. When deciding whether to adopt modern technologies, these organisations must balance the cost of replacing or integrating new technology with existing infrastructure. Organisational readiness for change can be seen as a precursor to supporting change initiatives. It occurs when employees believe in and are committed to change based on a perceived need (Suwaryo et al., 2016). This readiness is also a cognitive assessment that may result in employee resistance or support for change initiatives. Commitment to change can be viewed as a mindset that binds individuals to the activities necessary for successful implementation (Swan, 2015; Wang et al., 2016).

Environmental Factors: This section examines Blockchain adoption in terms of competitive pressure, environmental uncertainty, and industry support. Competitive pressure is exceptionally high for large enterprises due to low profit margins and the limited potential for differentiated services (Toni, 2017). Therefore, reducing operational costs is essential, and investments in cost-saving technologies like Blockchain may help achieve this goal. Environmental uncertainty, which is also high, particularly impacts organisations due to fluctuations in global trade and the regulatory environment. Since environmental uncertainty is positively correlated with the intention to adopt inter-firm technologies (J. & Sweeney, 2011), this factor may increase the likelihood of Blockchain adoption.

Blockchain technology enables individuals and communities to reshape their relationships in politics, business, and society through automated, trustless transactions (Zyskind et al., 2015; Reid & Harrigan, 2012). This process could alter the principles that underpin political systems and governance, challenging the traditional role of the State and central institutions. Governments are beginning to explore Blockchain because of its ability to verify and record the movement of assets, ownership, and identities. For example, Blockchain can store licences, proof of records, and transactional data on a single chain accessible to everyone (Garrod et al., 2016). Several countries, including the UK and Sweden, are investigating Blockchain's potential. The UK is currently exploring the use of Blockchain to manage grants, which are often subject to fraud and misuse. By using Blockchain, all transactional details would be transparent and accessible to all parties involved. Dubai, for instance, aims to have all government documents on Blockchain by 2020 as part of the Dubai Expo 2020 initiative.

Countries like Dubai are already setting goals to have all government documents on Blockchain by 2020, according to the Dubai Expo 2020.

2.8.2 Knowledge gaps elaborations

The following is an elaboration on factors impacting the value realisation of ICT emerging technologies and the challenges of predicting value realisation. Numerous factors influence the adoption of emerging information and communication technology (ICT) and can significantly impact its value realisation. However, there is a gap in knowledge regarding the weight or level of impact of each factor on the successful adoption of emerging ICT technologies. This argumentative essay aims to shed light on this knowledge gap and discuss the potential implications of addressing it.

Weight or Level of Impact of Factors: Understanding the weight or level of impact of factors is crucial in prioritising efforts and resources to enhance the adoption and value realisation of emerging ICT technologies. Although research has identified several factors, their relative importance remains unclear. For instance, technological maturity and scalability are widely recognised as significant factors (Sultan, 2014). However, the specific weight or level of their impact in driving adoption remains unexplored. Quantifying their influence would allow organisations to make informed decisions and allocate resources accordingly.

Similarly, organisational readiness and change management are acknowledged as critical factors (Alshawi et al., 2013). Nevertheless, a knowledge gap exists regarding the relative significance of these factors in the adoption process. Identifying their weights would help organisations develop tailored strategies and allocate resources effectively. Interoperability and integration challenges are recognised barriers to adoption (Chen et al., 2017). However, the relative impact of these challenges compared to other factors remains unclear. Understanding the weight of interoperability in the overall adoption process would enable organisations to prioritise efforts in addressing this critical barrier. Security and privacy concerns are well-documented factors impacting adoption (Lau et al., 2018). However, the level of their impact in relation to other factors remains unexplored. Quantifying their weight would allow organisations to develop robust security measures and privacy frameworks to mitigate risks effectively.

Knowledge Gap Implications: Addressing the knowledge gap related to the weight or level of impact of factors associated with emerging ICT technologies can yield significant implications. First, it enables evidence-based decision-making by providing organisations with a clear understanding of which factors to prioritise. This knowledge empowers organisations to allocate resources efficiently and effectively.

Second, addressing the knowledge gap allows for the development of targeted strategies and interventions. By knowing the relative weight of each factor, organisations can focus on areas that have the highest impact on adoption. This approach ensures that efforts and resources are directed towards addressing the most critical barriers. Third, filling the knowledge gap can foster collaboration and knowledge sharing among stakeholders. Researchers, practitioners, and policymakers can collaborate to conduct empirical studies and share insights on the weight of various factors. This collective effort will contribute to the development of a comprehensive framework for understanding the dynamics of emerging ICT technology adoption. The weight or level of impact of factors associated with emerging ICT technologies remains a significant knowledge gap. Addressing this gap is crucial for evidence-based decision-making, targeted strategies, and fostering collaboration among stakeholders. Closing this knowledge gap will contribute to maximising the adoption and value realisation of emerging ICT technologies, ultimately driving technological advancements and innovation.

Challenges of Blockchain Value Realisation Predictions: In the constantly evolving realm of Information and Communication Technologies (ICT), the emergence of Blockchain technology stands as a beacon of transformative potential. Lauded for its groundbreaking principles of decentralisation, transparency, and immutable data management, Blockchain has captured the imagination of tech enthusiasts and industry leaders alike (Adams & Smith, 2021). However, navigating the future path of this technology, embedded in its myriad applications and challenges, is anything but straightforward.

At the heart of the issue is Blockchain's multifaceted applicability. Unlike many traditional technologies that cater to niche audiences or specific sectors, Blockchain casts a wide net, touching upon areas as diverse as financial transactions, supply chain management, identity verification, and even voting systems (Barnes & Clarke, 2022). This expansive reach implies that while some sectors may be ripe for immediate adoption, others require more time, investment, and understanding before they can fully harness the benefits of Blockchain.

Delving deeper, one encounters the technological complexities that underpin Blockchain. Concepts such as distributed ledgers, consensus algorithms, cryptographic security, and smart contracts may seem second nature to the tech-savvy. However, they are intricate ideas that demand an elevated level of technical literacy (Lopez & White, 2021). These complexities might function as a deterrent, particularly in regions or sectors where there is a dearth of advanced technological expertise or where the prevailing tech infrastructure is still nascent. Additionally, it is not just about understanding Blockchain but also about integrating it seamlessly into existing systems, which poses its own set of challenges.

The ever-evolving regulatory landscape further muddies the waters. Blockchain's inherent decentralised nature, which bypasses traditional intermediaries, often clashes with established regulatory frameworks. Decisions regarding jurisdiction, data privacy, consumer protection, and fraud prevention have become increasingly convoluted (Wagner & Turner, 2022). While some jurisdictions have made strides in creating a favourable regulatory environment for Blockchain adoption, many are still grappling with the technology's implications, leading to a patchwork of regulations that can deter consistent global adoption.

Economically, the calculus is similarly intricate. The long-term benefits of Blockchain in streamlining operations, eliminating fraud, and enhancing transparency are well-documented. However, these benefits come at a price. The initial investment for Blockchain adoption, encompassing infrastructure development, training, and integration, can be substantial (Jiang & Li, 2023). Organisations must, therefore, grapple with questions of economic viability: Will the long-term savings and operational benefits outweigh the significant upfront costs?

Additionally, the human dimension cannot be overlooked. Technological adoption is as much about people as it is about hardware and software. Societies, organisations, and even individuals possess inherent biases and resistance to change, particularly when confronted with transformative technologies that challenge established norms and ways of operating (Daniels & Foster, 2022). Overcoming these socio-cultural barriers necessitates not just technological evangelism but also comprehensive change management strategies.

The interoperability of Blockchain with other emerging and existing ICT solutions adds another layer of complexity. As industries increasingly rely on a suite of ICT solutions, the ability of Blockchain platforms to integrate seamlessly with other systems becomes paramount. Relying on ICT necessitates standardisation, another challenge given the plethora of Blockchain platforms and protocols that currently exist (Nguyen & Holmes, 2021).

Lastly, the swift pace at which technology evolves introduces an element of unpredictability. Blockchain, though relatively mature compared to its inception, is still in a state of flux. New consensus mechanisms, enhanced scalability solutions, and improved security features are continually being developed. For organisations, this rapid evolution can be both exciting and daunting. The fear of investing in a solution that might soon become obsolete or surpassed by a superior technology is a genuine concern.

In summation, while Blockchain's potential within the ICT sector is vast and its transformative power undeniable, its path is laden with challenges. Predicting its trajectory involves navigating a complex maze of technological intricacies, regulatory difficulties, economic calculations, socio-cultural dynamics, interoperability issues, and the inherent unpredictability of rapid technological evolution. Successful adoption will require a delicate balance of foresight, adaptability, and strategic investment, combined with a deep understanding of the technology's nuances and the evolving landscape in which it operates.

2.8.3 Adoption Theories Integration Proposal and conceptual module

The study proposes a conceptual model for ICT adoption in organisations by integrating three theories: Diffusion of Innovations (DOI), Technology-Organisation-Environment (TOE), and the Technology Acceptance Model (TAM). This conceptual model combines DOI and TAM alongside the TOE framework. Each of these theories has specific strengths and limitations. Integrating all three provides a robust and holistic framework for determining adoption viability. For instance, DOI focuses on social factors and timelines, while TOE covers external and internal factors. However, TOE does not account for individual perceptions, whereas TAM primarily focuses on perceptions as a critical factor in technology acceptance and adoption.

DOI is the most widely accepted model for identifying critical characteristics of information systems innovation adoption (Hameed et al., 2012a; Premkumar et al., 1999; Thong et al., 1996). However, DOI only explains individual-level adoption processes, limiting its applicability for explaining Blockchain adoption in organisations. By combining DOI with TAM, the model reflects both pre-adoption and adoption decisions. TAM has been empirically validated to predict and explain user acceptance of IS innovations (Hameed et al., 2012). DOI complements TAM's constructs, and its explanatory and predictive power is enhanced through integration with TAM (Hameed et al., 2012).

Furthermore, combining TAM with DOI allows for predicting user acceptance of innovations in both voluntary and non-voluntary contexts. DOI and TAM models have been effectively used to explain and predict the adoption or user acceptance of innovations (Hameed et al., 2012). The integration of DOI and TAM must be contextualised to address the acceptance of information systems (IS) at an organisational level. TOE, widely used in organisational adoption studies, is comprehensive in identifying factors impacting adoption, including technological characteristics, organisational traits, and external environmental factors. Therefore, an integrated model of DOI, TAM, and TOE provides a complete explanation of organisational innovation adoption.

The proposed model uses DOI and TOE to explain the adoption process from an organisational perspective. By considering technological, organisational, and environmental attributes that facilitate adoption, TAM, DOI, and TOE explain the pre-adoption and adoption-decision stages within organisations.

This chapter concludes by reviewing the application prospects of Blockchain technology in the oil and supply chain sectors. While Blockchain holds considerable potential in these sectors, it is also not without significant challenges that may hinder adoption. As a relatively new technology, Blockchain has unique characteristics compared to cloud computing and ERP. The limited literature on Blockchain from a business perspective has meant that most current research focuses on proof of concepts in various industries.

Qualitative research, including interviews with experts from selected enterprises, is essential to establish a comprehensive understanding of Blockchain adoption in businesses.

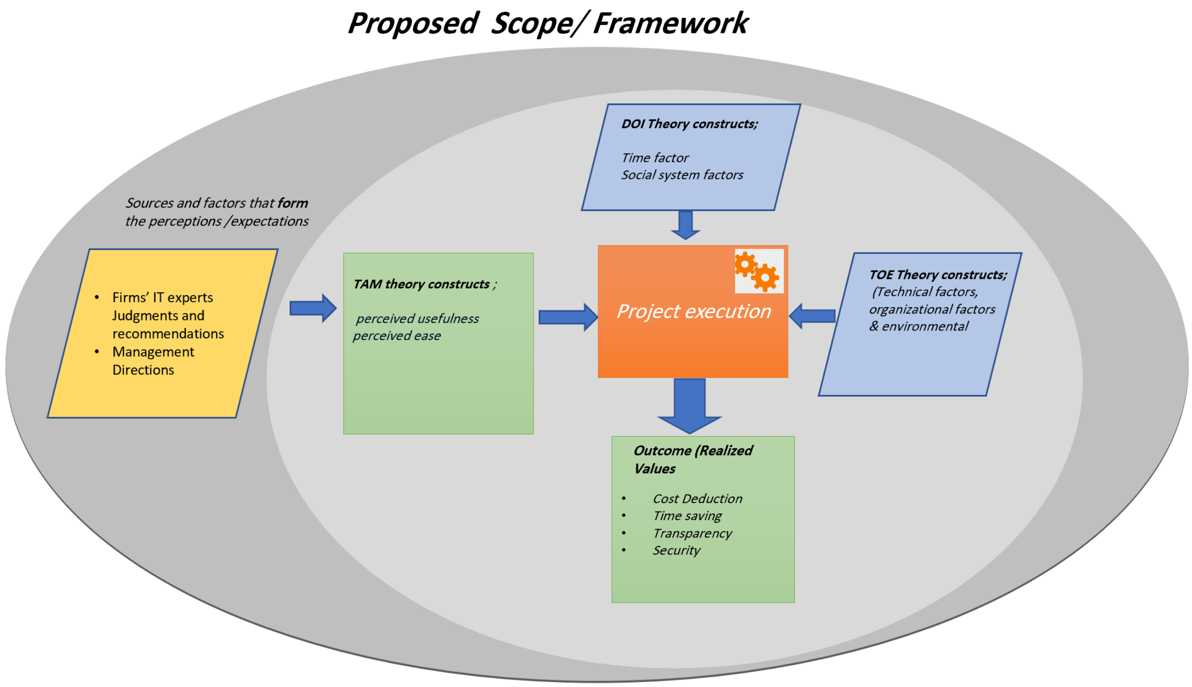


Figure 2.4 Conceptual Model

The proposed framework integrates constructs from the TAM, DOI, and TOE theories. It centres on project execution, influenced by factors shaping perceptions and expectations. The framework begins with inputs from IT experts, judgments, recommendations, and management directives, contributing to TAM constructs. According to Davis (1989), TAM focuses on perceived usefulness—how much an individual believes a system will enhance job performance—and perceived ease of use—how easy the system is to use. Insights from IT experts and management directives shape these constructs, which in turn affect project execution.

The framework incorporates DOI theory constructs, particularly regarding time and social system factors. According to Rogers (2003), time refers to temporal factors that affect innovation adoption, while social systems include organisational culture and peer influence. These constructs shape the pace and social acceptance of technological changes, directly impacting project execution. TOE theory is also essential. Tornatzky and Fleischer (1990) define technical factors as existing technology infrastructure, compatibility, and technical expertise. Organisational factors include size, resources, and internal processes, while environmental factors encompass market competition, regulatory requirements, and industry norms. Together, these factors influence technological adoption, shaping project execution.

Project execution is the central activity that combines inputs from TAM, DOI, and TOE constructs. It involves organising resources, schedules, and stakeholder engagement to achieve project objectives. When these theoretical constructs guide project execution, results include cost reduction through automation and efficiency, time saving through streamlined processes, enhanced transparency through real-time monitoring, and improved security through better data protection measures.

This framework is tailored to Blockchain technology, aligning with the research objectives. TAM constructs are critical in the pre-adoption phase, focusing on user perceptions. As Smith et al. (2015) highlight, user perceptions in the pre-adoption phase play a crucial role in shaping technology acceptance. Concurrently, DOI theory constructs emphasise time and predictive elements during this phase. According to Brown and Johnson (2018), DOI provides valuable insights into the temporal considerations of technology adoption. Empirical validation of these constructs is essential to understanding technology acceptance (Jones, 2019). TOE constructs come into play during the adoption phase, offering a comprehensive framework for understanding the incorporation of Blockchain technology within organisations. The framework incorporates TAM principles to explore user perceptions and integrates DOI theory to address Blockchain technology's communication needs among diverse stakeholders. DOI theory emphasises social factors and provides a structured framework to analyse them, including the pivotal role of time in adoption dynamics.

Additionally, the framework assesses the technical and organisational factors necessary for implementing Blockchain within organisations. Given Blockchain's innovative nature, a detailed evaluation of technical aspects is essential. Moreover, as Blockchain projects unfold, understanding the organisational factors becomes indispensable for achieving research goals.

By synthesising DOI, TOE, and TAM theories, organisations gain a profound understanding of technology adoption and implementation. This integration transcends the limitations of individual theories, creating a symbiotic relationship that enriches decision-making and strategic planning within organisations (Brown & Johnson, 2018). By integrating DOI's insights on social dynamics, TAM's focus on perceptions, and TOE's comprehensive view of technological, organisational, and environmental factors, organisations develop a holistic understanding of technology adoption dynamics. DOI's exploration of communication channels complements TAM's analysis of subjective perceptions, uncovering the complex interplay between individual beliefs and societal influences in technology adoption (Rogers, 2003; Davis, 1989). Moreover, TOE's emphasis on organisational traits, external pressures, and technological factors provides a broad view of the adoption landscape. By linking individual, social, and organisational dimensions, the integrated approach guides organisations through the complexities of technology adoption, empowering decision-makers with the insights needed for successful implementation (Tornatzky & Fleischer, 1990).

In summary, the synergy between DOI, TOE, and TAM theories broadens the analytical lens through which technology adoption is perceived and equips organisations with strategic tools to navigate the technological landscape. This integrated perspective fosters informed decision-making, innovation, and organisational readiness, promoting sustainable growth and competitive advantage in today's dynamic business environment.

In the context of technology adoption, the integration of DOI, TOE, and TAM theories provides organisations with a comprehensive framework for navigating the complexities of modern technologies (Brown & Johnson, 2018). This integrated approach transcends individual theories' limitations, offering a nuanced understanding of adoption. It empowers organisations to make informed decisions regarding technology implementation strategies that address social dynamics, individual needs, and organisational constraints. By adopting an agile approach, organisations stay ahead of market conditions and foster continuous improvement. Ultimately, synthesising DOI, TOE, and TAM perspectives allows organisations to navigate technology adoption complexities and emerge as leaders in the evolving digital landscape.

In the pre-adoption phase, organisations evaluate the potential benefits and challenges of adopting Blockchain technology. This phase lays the groundwork for the entire adoption process and heavily influences subsequent stages. The Technology Acceptance Model (TAM), developed by Davis (1989), plays a crucial role in this phase. It focuses on user acceptance, perceived usefulness, and ease of use, helping organisations understand users' perceptions of Blockchain technology and their willingness to adopt it. Assessing these perceptions is crucial for making informed decisions about adoption. Organisations must ensure that Blockchain solutions are not only technologically advanced but also user-friendly and beneficial. Understanding user attitudes and behaviours is essential. Communicating the tangible benefits of Blockchain technology is crucial for encouraging adoption.

Another important factor is perceived ease of use, which refers to how effortlessly users can engage with Blockchain technology. If perceived as difficult or complex, resistance may arise. Therefore, designing intuitive interfaces and providing adequate training are necessary. Users' attitudes towards using Blockchain, which encompass their feelings and evaluations, play a significant role in adoption. Positive attitudes can encourage adoption, while negative ones can create barriers. Addressing concerns and highlighting positive experiences through pilot projects and testimonials can help. Behavioural intention to use, which is influenced by perceived usefulness and ease of use, must also be considered. By fostering positive perceptions and providing clear evidence of Blockchain's benefits, organisations can increase users' likelihood of adopting the technology.

Organisations can use surveys, focus groups, and pilot studies to collect data on these factors. Surveys quantify user perceptions, focus groups provide qualitative insights, and pilot studies offer real-world data on usability and effectiveness. In conclusion, the pre-adoption phase is critical to the adoption of Blockchain technology. Using TAM to understand user perceptions and attitudes helps organisations make informed decisions. Evaluating perceived usefulness, ease of use, attitude towards use, and behavioural intention through surveys, focus groups, and pilot studies can provide essential insights to guide this phase (Davis, 1989).

The adoption phase focuses on implementing Blockchain technology, where the TOE framework becomes pertinent. Developed by Tornatzky and Fleischer (1990), TOE evaluates organisational readiness and external factors influencing adoption. The TOE framework ensures a holistic assessment, considering three contexts: technological, organisational, and environmental. The technological context involves evaluating the organisation's current technological infrastructure and its compatibility with Blockchain. This assessment includes hardware, software, and technical expertise and determines whether upgrades are needed. It also identifies potential technical challenges during implementation. The organisational context assesses internal structure, resources, and culture. Leadership support is essential for driving adoption and aligning it with organisational goals. Financial resources and a dedicated Blockchain team are also critical for ensuring commitment and expertise. Cultural aspects, such as employee readiness for innovation, are crucial. A supportive organisational culture enhances the likelihood of successful adoption.

The environmental context examines external factors that affect Blockchain adoption, including market dynamics, regulatory requirements, and industry standards. Understanding these factors helps organisations align their implementation process with external opportunities and threats. A thorough evaluation using TOE identifies barriers and facilitators to adoption, such as technological limitations or favourable market conditions. By addressing these factors, organisations develop a robust strategy that mitigates risks and capitalises on opportunities, ensuring that Blockchain adoption meets both immediate needs and long-term goals (Tornatzky & Fleischer, 1990).

The post-adoption phase evaluates the outcomes and sustains Blockchain technology use. Revisiting the DOI theory, as articulated by Rogers (2003), can help assess long-term impact and facilitate continuous improvement. DOI provides a framework for understanding the diffusion and acceptance of Blockchain within organisations, highlighting key attributes that influence adoption. Understanding different adopter categories (e.g., innovators, early adopters, early majority) can provide insights into Blockchain's acceptance. Innovators and early adopters, typically more open to new technologies, can champion adoption and persuade others. Identifying these groups and leveraging their influence can facilitate broader acceptance. Leadership support, peer influence, and organisational culture also play critical roles in adoption success. Promoting a culture of innovation and knowledge-sharing enhances the likelihood of successful adoption. Continuous monitoring of these factors allows organisations to adjust strategies and ensure Blockchain is effectively integrated into processes.

By combining TAM, TOE, and DOI, organisations develop a comprehensive framework for managing Blockchain adoption. Each stage of the process—pre-adoption, adoption, and post-adoption—requires careful consideration to ensure successful implementation and sustained use of Blockchain technology.

In conclusion, this framework serves as a comprehensive tool for evaluating Blockchain adoption and integration. By incorporating elements of TAM, DOI, and TOE, it offers a multifaceted approach to understanding Blockchain adoption. It equips both academia and industry with insights into the factors involved in Blockchain adoption, helping to overcome challenges during the implementation process.

2.9 Chapter Conclusion

The adoption of Blockchain technology within organisations, guided by the integrated DOI, TAM, and TOE frameworks, reveals the complex dynamics of technological, organisational, and environmental factors influencing adoption. This chapter's proposed framework provides a holistic view of the adoption process, addressing the limitations of each model and emphasising the importance of aligning technological capabilities with organisational readiness and external conditions. The findings underscore the need for a balanced approach to managing both tangible and intangible elements of business value, highlighting the opportunities and challenges of integrating Blockchain and other ICT technologies. As organisations navigate the evolving digital landscape, this comprehensive framework serves as a strategic tool to guide adoption decisions, enhance value realisation, and sustain technological impact, ultimately supporting long-term success in various sectors.

3. RESEARCH METHODOLOGY CHAPTER

3.1 Chapter Introduction

This chapter outlines the research approach and philosophy underpinning the study, concentrating on the exploratory methodology used to examine the realisation of value from Blockchain technology in the oil and gas industry. It details the qualitative approach, employing purposive sampling to select participants based on their experience with Blockchain projects. The research integrates both positivist and interpretivism elements within its philosophical framework, balancing empirical and objective analysis with an understanding of stakeholders' subjective experiences. The chapter further elaborates on the research design, including pilot surveys, in-person interviews, and extensive online surveys to gather rich, context-specific data. By adopting a case study method, the research captures the complexities of Blockchain implementation within the oil and gas sector, highlighting the nuanced factors that influence adoption and value realisation.

3.2 Approach

The researcher adopted an exploratory study methodology for this research. Saunders et al. (2016) explain that an exploratory study is "a valuable means to ask open questions to discover what is happening and gain insights about a topic of interest" and is particularly useful "when exploring a phenomenon whose precise nature is uncertain to the researcher" (p. 174). The phenomenon explored in this study. Namely, value realisation from adopting Blockchain in the oil and gas sector remains largely unknown, as the technology is in its early stages and has only recently gained attention. As a result, comprehensive theories and related literature are not yet available for reference. Consequently, the decision to adopt an exploratory methodology for this research appears entirely appropriate. For exploratory studies like this one, a qualitative approach is the primary method to comprehensively examine Blockchain implementations within oil and gas firms, assess value realisation, and identify constructs that influence it.

The researcher opted for a qualitative research methodology and utilised purposive sampling when selecting the study population. Purposive sampling "involves the subjective judgement of the researcher to select those respondents who are most capable of answering the research questions and meet the objective" (Saunders et al., 2016). Given the focus on implementing Blockchain technology in the oil and gas industry, participants were selected based on their experience with Blockchain projects. To summarise, "qualitative methods focus on data in the form of words rather than numbers and the perspectives of those being studied as opposed to the researcher's perspective" (Saunders et al., 2016). Such qualitative studies aim to understand phenomena and develop new knowledge. This methodology aligns with the requirements of this study, which involves conducting interviews and surveys to understand the study population's perceptions and the potential and realised benefits of implementing Blockchain technology in the oil and gas sector.

3.3 Philosophy

The research philosophy aligns predominantly with positivism due to its empirical approach, objective analysis, and focus on prediction and generalisation. Positivism emphasises observable and measurable facts and often involves quantitative methods to test hypotheses and theories. The researcher employed a case study approach to collect data from Blockchain projects in the oil and gas industry, followed by an online survey of 37 firms across different geographical regions. This method aligns with positivist methodology, which relies on observable, measurable facts to conclude (Mackenzie & Knipe, 2006). The collection of data through surveys, the identification of significant factors affecting value realisation, and the formulation of predictions about Blockchain technology demonstrate a commitment to objective analysis, a hallmark of positivist research (Creswell, 2013).

The study also seeks to address the gap between initial perceptions of Blockchain technology's benefits and the actual realisation of these benefits in practice. This objective aligns with positivism's emphasis on testing theories against empirical evidence to form generalisable conclusions. This approach underscores the positivist goal of prediction and generalisation, where findings are expected to extend beyond the specific cases studied (Neuman, 2014).

However, the research also incorporates elements of interpretivism. The use of case studies to gather in-depth data on Blockchain projects involves understanding the context and perspectives of participants, which is characteristic of interpretivism methodology. Moreover, exploring the initial perceptions and subjective experiences of stakeholders in Blockchain projects employs interpretive methods, which focus on understanding the meanings and experiences of individuals within their social contexts (Bryman, 2012). By identifying significant factors influencing value realisation, such as social, legal, and technological uncertainties, the study recognises the complex, context-dependent nature of these influences, which interpretivism seeks to understand. Furthermore, gathering and sharing predictions from subject matter experts in technology and the oil and gas sector, based on their experiences with Blockchain projects, emphasises the interpretivism goal of understanding human experiences and the meanings individuals attach to them (Schwandt, 2000). These elements suggest a nuanced approach that values both the measurable, objective aspects of technology adoption and the subjective, experiential insights of stakeholders.

In conclusion, while this research approach is somewhat mixed, incorporating both positivist and interpretive elements, it leans more towards positivism. The emphasis on empirical data collection, objective analysis, prediction, and generalisation strongly aligns with positivist principles. Simultaneously, the interpretive aspects of exploring perceptions and subjective experiences enhance the study by offering more profound insights into the human and contextual factors influencing Blockchain adoption (Mackenzie & Knipe, 2006; Creswell, 2013; Bryman, 2012; Neuman, 2014; Schwandt, 2000).

3.4 Research design and data collection

The current study investigates the implementation the realised values of a Blockchain project in the oil and gas industry, along with stakeholders' perceptions and priorities regarding the technology. The research design includes in-person interviews, and an online survey conducted across three distinct phases to gather the necessary information.

Before proceeding with the target interviewees, the researcher initiated ***a Pilot Online Survey***, followed by two interviews and five online surveys in three locations: Saudi Arabia (KSA), the United Arab Emirates (UAE), and the UK. The pilot phase ensured the survey questions were reliable and valid while collecting initial data. A pilot survey, often called a pre-test, is an essential early step in developing a robust academic survey. Its primary purpose is to refine and validate the survey instrument before full-scale deployment. This process involves administering the survey to a small, representative sample of the target population to identify potential issues and ensure that the questions are clear, unambiguous, and relevant (Presser et al., 2004).

Conducting a pilot survey serves multiple purposes. It allows researchers to evaluate the reliability and validity of the survey items. Reliability refers to the consistency of results over time, while validity pertains to how accurately the survey measures what it intends to measure (Groves et al., 2009). A pilot study can identify ambiguities or misunderstandings in the wording of questions, allowing revisions to improve clarity and precision. Additionally, it helps assess the survey's feasibility in terms of time, cost, and logistics. Researchers can estimate the time needed to complete the survey and identify logistical challenges, such as difficulties in reaching respondents or technical issues with the survey platform (Creswell & Creswell, 2018). Piloting the survey also provides an opportunity to assess its design and layout. A well-designed survey should be easy to navigate and visually appealing to encourage participant engagement and minimise survey fatigue (Dillman et al., 2014). Feedback from the pilot phase informs further adjustments to improve the overall user experience.

Phase 1: In-Person Interviews

The first phase focused on in-person interviews with operations managers and business analysts. Four business analysts and several operations managers participated in interviews at various locations in KSA, including Dhahran, Yanbu, Riyadh, and Rabigh. These semi-structured interviews explored vital research questions, including evaluating the implementation and realised values of the Blockchain project, stakeholders' perceptions of the technology, and identifying issues affecting the project's implementation. Participants also discussed changes in perceptions, made predictions, and offered recommendations.

Phase 2: Online Survey

The second phase involved an extensive online survey aimed at Blockchain project managers at 60 oil and gas firms engaged in Blockchain initiatives. This phase included 37 online surveys with project managers from several countries, including Korea, China, Japan, the Philippines, India, the Netherlands, the UK, France, Greece, the USA, and the UAE. The survey featured both structured and semi-structured questions. Each respondent was permitted before the researcher recorded and transcribed critical segments of the online interviews. In accordance with research ethics, the researcher anonymised participants' identities to ensure their responses could not be traced back to any individual.

Data Collection Scope: The researcher collected data from oil and gas firms in various geographical regions. The most accessible and suitable firms were chosen from the 'Oil & Gas Petroleum Group (O&GPG)', an organisation formed to exchange knowledge and practices across various business disciplines, including technological innovations. As these firms maintain business relationships with the author's employer, Saudi Aramco, the researcher anticipated smooth cooperation in gathering survey responses.

Case Study Method: In-Person Interviews

The researcher employed the case study method to gather cohesive data on an integrated process involving multiple stakeholders in a Blockchain project. The case study method, recognised as a practical research approach, allows for a detailed examination of data within a specific context (Yin, 1984; Zainal, 2007). This method enables in-depth exploration and analysis of real-life phenomena by examining a limited number of events or conditions and their interrelationships. Yin (1984) defines the case study method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are unclear and when multiple sources of evidence are used. This approach is convenient for studying complex phenomena in their natural settings.

Online Semi-Structured Survey

The author conducted semi-structured surveys to gather insights from senior managers and specialists regarding this innovative technology. Saunders et al. (2016) explain that "semi-structured questions in the interview and survey provide the opportunity to 'probe' answers, where interviewees can explain or expand on their responses." As this research seeks to understand how different individuals perceive Blockchain's introduction into the oil and gas industry and to evaluate their views on the factors shaping this process, a semi-structured survey is considered appropriate.

Phase 1	Phase 2
•**In pseone Interviews**	•**Onlline Suvery**
•4 In person interviews	•37 oline suvery, Project managers
•Location :KSA Dharan, Yanbu, Riyadh, Rabigh	•Koria, Chaina ,Jaban, Phlinplines, India, Netheland, UK, France, Greece, USA, UAE

Figure 3.1 Data Collection Phases

Survey Guide and Data Collection Consideration

The survey targeted 60 oil and gas companies and obtained 37 completed responses from project managers or acting project managers regarding their experience and perceptions of Blockchain technology implementation within their firms. The survey homepage featured the leading survey guide and instructions to oversee and facilitate the data collection process. This section outlines the survey guide developed for the qualitative research on the adoption and impact of Blockchain technology in the oil and gas industry. The survey aims to gather comprehensive data from industry professionals, employing both structured and open-ended questions to explore various aspects of Blockchain implementation.

Purpose of the Study: The primary objective of this study is to gain insights into how Blockchain technology is being adopted and utilised in the oil and gas industry. The survey seeks to identify the perceived benefits, challenges, and opportunities associated with Blockchain, as well as to collect real-world examples and case studies from industry professionals.

Confidentiality Assurance: The research team assures participants that all data collected through the survey will remain confidential and used solely for academic purposes. Anonymity will be maintained to ensure that individual responses cannot be traced back to any participant. The research team is committed to adhering to ethical guidelines and protecting the privacy of all respondents.

Instructions for Participation: Participants are requested to complete the survey by following the provided instructions. The survey consists of several sections, starting with demographic questions, followed by specific questions on Blockchain experience, perceived benefits, challenges faced, and open-ended questions for more detailed responses. Participants are encouraged to provide as much detail as possible in the open-ended sections to enrich the qualitative data collected.

3.5 Validity and Reliability

The author carefully considered the validity of the research outcomes during the development of the research questions and selected the target population to ensure the production of trustworthy content knowledge. Regarding external validity, which concerns the generalisability of research outcomes, defined as "the extent to which the results can be generalised to the target population the survey sample is representing" (Relevant Insights, 2020), the author addressed this by targeting firms located across diverse geographical regions, including Asia, Europe, and America, to capture a wide range of responses. These locations, along with the key findings from the in-person interviews, enhanced the generalisability of the results.

The author's focus on the internal validity of the study is evident in the development of interview questions that are aligned with the leading research objectives. The author formulated the online survey questions based on the central research questions, ensuring that the research seeks explicitly to explore Blockchain projects within the oil and gas sector to understand value realisation and identify significant factors that impact these projects. Additionally, the author carefully considered the reliability of the findings. Reliability refers to the overall consistency and stability of a measurement, a crucial aspect of research that indicates the extent to which a measure yields consistent results under similar conditions. A highly reliable measure will produce comparable outcomes when testing is repeated under constant conditions, ensuring that the data collected is dependable and reflective of actual values. This concept, also known as reproducibility or repeatability, is vital in validating research findings and establishing credibility within the academic community (Scribbr, 2019).

Furthermore, the author conducted a pilot survey represents a critical phase in refining and enhancing the reliability of the survey instrument. This preliminary step allows researchers to identify potential issues with the survey design, such as ambiguous questions or technical challenges, which may otherwise undermine the integrity of the data collected. Reliability, in this context, refers to the consistency and stability of the survey's outcomes over time. A reliable survey instrument is one that, when administered in identical conditions, produces comparable results, thus ensuring that the data is dependable and valid for further analysis (Fowler, 2014). By addressing potential flaws during the pilot stage, researchers can make necessary adjustments to improve clarity, reduce bias, and ensure the overall effectiveness of the survey in capturing accurate and consistent data

3.6 Analysis Approach

A thematic analysis approach was adopted to identify and categorise information collected via online interviews. Thematic analysis, defined as a method for identifying and reporting patterns within data, is one of the most common forms of analysis in qualitative research. King (2004) explains that it "emphasises identifying, analysing and interpreting patterns of meaning (or 'themes') within qualitative data." Unlike other qualitative approaches such as grounded theory, discourse analysis, narrative analysis, or interpretative phenomenological analysis, which are methodologies informed by theoretical frameworks, thematic analysis is best understood as a flexible tool applicable across different approaches. It serves as an umbrella term for various strategies rather than a singular method. Distinct philosophical assumptions underpin different versions of thematic analysis and vary in their procedures.

In this research, themes will be developed based on the constructs of the Technology Acceptance Model (TAM), the Technology-Organisation-Environment (TOE) framework, and the Diffusion of Innovations (DOI). Additional themes may emerge from responses to the research questions, reflecting insights not covered by the selected theories. The analysis will display standard responses for specific codes within themes and examine the level of consistency across responses. For divergent answers, the analysis will explore these differences in detail to generate new knowledge and provide a clear understanding of the factors that either hinder or support Blockchain adoption decisions.

Thematic analysis has often suffered from a poor reputation, yet it remains widely utilised in qualitative research. Braun and Clarke (2006) argued that "thematic analysis should be a foundational method for qualitative analysis, as it provides core skills for conducting many other forms of qualitative analysis." Many authors maintain that because thematic analysis is a process used by numerous qualitative methods, it is not a separate method but rather a tool to assist researchers in analysis. Despite this, thematic analysis has not been given the same recognition as other methodologies.

The author contends that thematic analysis is a versatile research method suitable for handling qualitative data across various investigative questions. Braun and Clarke (2006) emphasise that it aids in "identifying, analysing, organising, describing, and reporting themes within a dataset." Boyatzis (1998) also defined thematic analysis as "a translator for those speaking the languages of qualitative and quantitative analysis," enabling researchers who use different methods to communicate effectively.

A rigorous thematic analysis can reveal reliable and insightful results. However, researchers often find it unclear how to apply this method precisely. Although thematic analysis has been extensively discussed, "guides on conducting thematic analysis have primarily focused on applied research or on inductive versus deductive coding" (Fereday & Muir-Cochrane, 2006). More comprehensive appreciation has been afforded to theories like grounded theory, ethnography, and phenomenology, while thematic analysis remains underexplored in the literature. The existing literature lacks a detailed outline for conducting an efficient thematic analysis.

Given its high flexibility, thematic analysis allows researchers to adapt the method according to the study's requirements, thereby supporting the collection of comprehensive data. This method does not necessitate a thorough understanding of other qualitative methodologies, making it more accessible, particularly for new researchers. Braun and Clarke (2006) argued that "thematic analysis is a useful method for examining the perspectives of different research participants, highlighting similarities and differences, and generating unanticipated insights." Furthermore, thematic analysis forces the researcher to take a structured approach to handling large datasets, ensuring a clear and organised final report.

The depth of inquiry that thematic analysis facilitates is invaluable. This method enables researchers to go beyond surface-level data description, allowing exploration into underlying ideologies, assumptions, and conceptual structures (Guest, MacQueen, & Namey, 2012). Through an iterative coding process and refinement of themes, researchers not only scrutinise the overt content but also reveal latent patterns and deeper meanings. In exploratory research, this level of granularity is crucial for uncovering novel insights and complex interpretations.

Thematic analysis, with its inherent flexibility, sets it apart from specific qualitative methods with rigid procedures. It allows researchers to tailor their methodologies according to their research questions, the nature of their data, and the theoretical frameworks they are working within (Braun & Clarke, 2006). This flexibility is particularly precious in exploratory contexts, ensuring the method adapts to the data rather than forcing data into pre-determined frameworks. Moreover, thematic analysis efficiently handles large datasets, making it particularly suitable for exploratory research where data collection may be extensive due to the open-ended nature of the investigation (Guest et al., 2012).

Thematic analysis, with its unique blend of flexibility and structured reporting, offers a valuable framework for presenting research findings. By hierarchically organising themes and sub-themes, researchers can present a coherent and organised interpretation of their data (Braun & Clarke, 2006). This structured representation is particularly vital in exploratory research, enabling the identification of emerging patterns and insights and the clear communication of findings to academic and professional audiences.

3.7 Research Reflexivity and Ethics

The author meticulously developed the codes based on the literature to ensure that bias did not influence the selection process. The use of multiple data sources further ensures that the research findings are validated, with efforts made to account for any potential biases. Ethical standards were upheld, and participant anonymity was maintained by including a consent form on the first page of the online survey. This form assured participants of their confidentiality and gave them the option to withdraw from the study at any time. The author clearly explained the purpose of the online interview to the interviewees, who consented to note-taking during the session. The author conducted the online survey independently, ensuring the anonymity of all participants. Additionally, the author informed the interviewees that a verbatim transcript of the online interview would be produced, with a summary of the codes written based on the notes taken during the session.

3.8 Research Questions development

To achieve the primary objective of this study—exploring and investigating Blockchain within the oil and gas (O&G) industry—the questions need to cover various aspects of Blockchain's value within firms and the factors that drive or hinder its adoption. The questions are grouped according to the main research questions, selected theories, constructs, and critical interview findings, incorporating both closed and open-ended formats. These categories will help provide deeper insights and inform the development of the online survey questions. The initial interview questions are categorised as follows:

The first group of questions focuses on the Blockchain project's objectives, status, and expected value:
These questions address the current status of Blockchain implementation, the objectives, and issues related to legacy systems and supply chain management processes. They aim to assess the progress of Blockchain projects within the firm, such as the project's current status, the start date of Blockchain considerations, and the primary value the firm expects from this implementation. For instance, questions include: "What is the current status of your firm's Blockchain project?" and "When did your firm begin considering Blockchain implementation?" They also explore perceptions around value realisation versus value propositions and future predictions.

The questions are designed to explore the "need to investigate the value and cost of integrating Blockchain-based solutions into existing information systems, considering that switching costs might deter organisations from migrating entire systems or services onto Blockchain platforms" (Shin, 2016). Additionally, the questions aim to explore the perceptions of Blockchain small and medium enterprises (SMEs) throughout the project lifecycle.

The second group of questions examines factors that influence Blockchain project implementation and value realisation:
This group focuses on three sets of factors: organisational, social, and technical. The organisational questions investigate the role of the industry, organisations, and management and how industry leaders and management contribute to the implementation of Blockchain, from project initiation to business case development and production deployment., while the social questions focus on stakeholders' cooperation and relationship, trust and technology enables roles. The technical questions focus on the characteristics of Blockchain technology. These questions cover the technical requirements for building or participating in a

Blockchain network and the compatibility of Blockchain with existing systems within the firm. They also assess infrastructure readiness for Blockchain adoption, including ICT infrastructure, security standards, privacy requirements, and consensus protocols

The third group of questions explores predictions and perceptions:

These questions focus on the third research question, which concerns predictions about Blockchain projects and value realisation. Operations managers are asked to share their forecasts, drawing on their experiences with other emerging technologies as a comparative approach.

The table below summarises the questions planned for the interviewees in the case study, conducted both in person and through the online survey.

Question Group	Data group Objective	Question Text
Group 1	***Collect the Current status of Blockchain project implementations and the target business disciplines.***	What is/is the main oil and gas business discipline(s) your Blockchain project(s) target?
		Which SCM processes are more concerned about the issues mentioned in the previous question (Cost, time, transparency)?
		What are the current major concerns related to your selected SCM processes that have not been solved by your current systems?
		What are the current major concerns related to your selected SCM processes that have not been solved by your current systems?
		What are the main values/objectives of your firm's Blockchain projects?
		What level of each Blockchain value is expected to be realised
		What are the resources your firm uses to meet this expectation?
		In which year did your firm start the Blockchain Project?
		What is the current status of these projects?
		What is the project(s)' budget status?
		What is the status of the project(s)' progress schedule?

		To what extent does your firm manage to realise values as a result of Blockchain Project implementation in comparison with expected value?
Group 2	***Collect factors impair Blockchain projects' implementation and value realisation objectives.***	Assess the following factors that impair your Blockchain Value realisation "technical factors
		Assess the following factors that impair your Blockchain Value realisation "Social factors":
		. Assess the following organisational/Industrial factors that impair your Blockchain Value Realisation.
Group 3	***Collect Perceptions & Predictions***	What were your perceptions of Blockchain value-addition to your firm at the beginning of Blockchain projects?
		What are your perceptions of Blockchain projects now in comparison with the beginning of project(s)?
		What are your perceptions of Blockchain projects now in comparison with the beginning of project(s)?
		What is your prediction for Blockchain projects at your firm?
		Based on your experience with emerging ICT technology such as Cloud Computing and as a future prediction, how long years do you predict you will be able to start realizing the Blockchain values?
		How long do you predict your firm will be able to reach the breakeven of the Blockchain project as an investment?
		To what extent do you predict that the rate of value realisation can be achieved?

Table 3.1 Questions and Objectives Summary

3.7 *Business Case Overview*

In the oil and gas industry, stakeholders, including producers, shippers, and customers, engage in various stages of trading from upstream to downstream. These stakeholders face logistical challenges, such as the time and cost involved in coordinating crude oil requests among participating organisations, limited data visibility, and lengthy dispute resolution processes, all of which affect their performance. To address these issues, major oil and gas companies in Saudi Arabia have initiated a programme that focuses on selecting a vital subset of the oil supply chain management (SCM) process while maintaining strong relationships with local stakeholders. Customers are based near the Red Sea, and oil producers are located near the Arabian Gulf. A crude oil pipeline, stretching approximately 1500 kilometres from east to west across Saudi Arabia, is managed by various stakeholders.

Current Situation Before Blockchain Implementation:
At present, fulfilling domestic crude oil product orders takes several weeks or months from the order request to final delivery. Coordinating among different stakeholders and ensuring the quality of services is a time-consuming process. Trust concerns arise as some stakeholders lack access to the requested information and rely on disconnected systems. Previously, stakeholders collected information through phone calls or emails, which exposed them to security risks and manipulation. Crude oil producers, located 1500 kilometres from the customer, supply the crude oil via the Crude Oil Terminal Storage, using sub-pipes connected to the leading 1500-kilometre pipeline network.

Project Overview:
The "Blockchain Consortium for Domestic Crude Oil Products Order Fulfilment" project, based in Saudi Arabia, is led by major oil companies as part of their digital transformation initiatives that launched in 2017. the project aims to improve the efficiency of SCM processes. Between 2017 and 2018, the focus was on identifying the most suitable process for Blockchain implementation. SCM, specifically the Oil Product Order Fulfilment process, was selected due to its complexity and lengthy execution time. The project is currently in the pilot phase and has not yet been fully deployed. Four categories of stakeholders have been identified: 1) Customers, 2) Oil/Gas producers, 3) Pipeline operators, and 4) Crude Oil Terminal storage facilities. Each firm has nominated project representatives with extensive business and technology experience, particularly in ICT and automation projects.

**** Annexe:** The annexe provides further details on the business case, interview scripts, and interviewees' profiles*

3.8 *Chapter Conclusion*

In conclusion, this chapter has outlined the research design and methodology, offering a comprehensive approach to investigating Blockchain adoption in the oil and gas industry. The exploratory study, rooted in a qualitative framework, enabled the collection of in-depth data through pilot surveys, interviews, and online surveys, effectively capturing the diverse perceptions and experiences of industry stakeholders. The integration of both positivist and interpretivist philosophies has allowed for a balanced analysis that considers measurable outcomes alongside contextual and subjective factors. The thematic analysis approach has been used to identify patterns, analyse themes, and provide valuable insights into the factors influencing Blockchain adoption and value realisation. This chapter establishes a foundation for a deeper understanding of how emerging ICT technologies, such as Blockchain, can transform traditional business practices in the oil and gas sector, guiding future research and strategic decision-making in this rapidly evolving field.

4. ANALYSIS AND FINDINGS CHAPTER

4.1. Chapter Introduction

This chapter presents the findings from interviews and surveys conducted with key stakeholders involved in Blockchain projects within the oil and gas industry. The analysis focuses on exploring the current status, objectives, perceived values, and challenges faced by these projects, offering a comprehensive understanding of the factors influencing Blockchain implementation and value realisation. The insights gained from stakeholder interviews provide a critical view of the varying priorities and expectations among different firms, highlighting the complexities of collaboration and the diverse interpretations of Blockchain's potential benefits. The chapter also delves into the evolving perceptions of stakeholders, from initial optimism to increased uncertainty and scepticism, underscoring the dynamic nature of technology adoption in an industry context. Furthermore, this chapter explores the impact of technical, social, and organisational factors on Blockchain projects, identifying significant barriers such as regulatory challenges, stakeholder cooperation, and technological maturity. The analysis concludes with an examination of the predictions made by industry experts on the future of Blockchain, revealing cautious optimism tempered by the recognition of the considerable time and investment required to achieve meaningful value.

4.2. Interviews Findings Summary

This section analyses and groups responses from four stakeholder representatives, providing insights into their firm's Blockchain project. The first question probed the project's current status, start date, schedule, and budget. All interviewees confirmed that the project officially commenced in 2017, with a year dedicated to identifying and agreeing on business use cases. They noted that the project is currently in the development phase but has been put on hold by management. It is significantly behind schedule, as the original plan was to go live in 2019, and the budget has been exceeded. No value has yet been realised from the project.

The second question probed the main objectives of each firm in participating in Blockchain. The responses varied but also showed some similarities. The customer representative's primary goal was to receive services more quickly, aiming to reduce the current lead time for fulfilling orders from 2-3 weeks to one week. The oil and gas representative emphasised the importance of saving time and cost in processing orders and receiving payment more swiftly. The pipeline representative valued transparency and accessibility to requests from their initiation. The Crude Oil Terminal representative highlighted the importance of crude oil quality and expressed a desire for timely access to pipeline labs to support their internal quality assurance procedures.

When asked about the most critical expected values of Blockchain, interviewees provided varied perspectives. The customer representative believed Blockchain could potentially reduce business time and costs by 30%, while also increasing transparency and security. The oil and gas representative prioritised time and cost savings as crucial expected outcomes. The pipeline representative placed greater emphasis on transparency, trust, and efficiency within the stakeholder collaboration platform. The Crude Oil Terminal representative expected effectiveness, efficiency, and security to be the primary benefits. Regarding measurable outcomes, interviewees anticipated cost savings of approximately 20-30%, time savings of 40-60%, full access to their data and requests without reliance on other firms, and protection from external access to their data. These expectations were based on expert judgement, technical articles, consulting services, and resources from international IT organisations, such as Garner reports.

The third question explored the stakeholders' perceptions of the Blockchain project at its inception. All respondents were initially optimistic about the project's potential value. The customer representative described being 'enthusiastic and optimistic' about participating in the project to address their concerns. The oil and gas representative, drawing on the company's experience with technology, expected the project to expedite manual processes and save time. The pipeline representative shared their firm's optimism, believing the project would save time. Similarly, the Crude Oil Terminal representative was optimistic, expecting the project to deliver significant value.

However, the fourth question, which asked about perceptions after four years, revealed a marked shift. Responses were largely uncertain or pessimistic. The customer representative admitted being "not quite sure now," as expected values had not been realised, and they were uncertain if more time was needed to resolve issues. The oil and gas representative, no longer optimistic, noted that the project had not gone live after four years. The pipeline representative doubted that substantial benefits would be seen anytime soon. The Crude Oil Terminal representative echoed these sentiments, expressing uncertainty and diminished optimism regarding a near-term solution.

The fifth question addressed the main obstacles hindering the project's progress and shaping stakeholders' perceptions. The customer representative identified the lack of regulations, differing expectations, and lack of collaboration among stakeholders as significant factors. The oil and gas representative agreed, adding that uncertainty about the values, technology, and trust between stakeholders also contributed. The pipeline representative raised legal concerns, noting that the absence of an official legal body to govern and protect stakeholders' rights exacerbated discomfort among project teams. The Crude Oil Terminal representative cited uncertainty around expected values and the need for common objectives as critical issues while acknowledging the time required for the technology to mature.

As cooperation and collaboration were frequently mentioned, further details were sought. The customer representative stated that for their firm, the most important values were time, product quality, and transparency. However, they felt that other stakeholders prioritised faster payments, sometimes overlooking fairness. The oil and gas representative reflected that, although stakeholders initially agreed on increasing efficiency and reducing costs, some parties later requested access to confidential data, requiring several levels of approval due to its classified nature. The pipeline representative suggested that differing views on Blockchain values, such as transparency and data accessibility, hindered cooperation. They also cited the immaturity of the technology as a significant factor. The Crude Oil Terminal representative reiterated the importance of a legal body to ensure security and protect rights.

The sixth question sought information about the future and predictions for Blockchain technology from the perspective of operational managers based on their experience with current projects and previous ICT implementations. Respondents generally believed that Blockchain may take several more years to mature. The customer representative emphasised the need for agreement on shared values among stakeholders. The oil and gas representative expressed uncertainty about whether the technology would work as intended and anticipated that several more years might be required. The pipeline representative suggested that the future depended on stakeholder interest and influence. The Crude Oil Terminal representative was unsure but hoped for a fair agreement as both the technology and legal frameworks matured.

Finally, the last question asked for recommendations on managing the current Blockchain project. Most representatives advised pausing the project to gather more information and develop best practices. The customer representative suggested keeping the project on hold for further learning. In contrast, the oil and gas representative recommended halting the project temporarily to allow time for training and the adoption of international practices. The pipeline representative proposed continuing the project with additional resources and a focus on training, while the Crude Oil Terminal representative recommended temporarily stopping the project to gather more technical information and attend conferences to learn from others' experiences. All representatives agreed on the need to wait until a legal framework is in place before proceeding.

4.3. Online Survey Findings and Analysis

This section presents the data collected from the research survey and analyses the responses of the study participants to derive meaningful insights from their perceptions. The survey, which targeted 60 oil and gas companies, received 37 completed responses from project managers and acting project managers regarding their experiences and perceptions of Blockchain technology implementation within their firms. The author conducted a small-scale online interview survey with selected respondents representing various firms in the oil and gas industry. In this section, the findings from the online interviews will be summarised thematically based on both existing and newly discovered codes. The collected data is presented for further analysis through clearly labelled tabular charts, tables, and pie charts, which help to illustrate respondents' perceptions more effectively. Detailed descriptions accompany the charts and tables to analyse the results further and draw correlations between them, highlighting the practical implications of the research for the audience's work in the oil and gas industry.

Pilot Survey

The author conducted a pilot online survey before the formal survey. The primary aim of this pilot was to assess the feasibility of the main study by replicating its procedures, allowing the identification of potential issues in the inclusion and exclusion criteria, data collection methods, and overall study design (In, 2017). Additionally, pilot surveys are essential for evaluating the equipment and materials used, including the survey questions, format, and distribution methods, ensuring their effectiveness in capturing the necessary data (GeeksforGeeks, 2022). Pilot studies also provide valuable insights into potential challenges during the main study, such as participant recruitment difficulties, logistical issues, or unforeseen variables, enabling researchers to refine their methodologies (Van Teijlingen & Hundley, 2001). While a pilot survey does not guarantee the success of the main study, it significantly improves the reliability and validity of the research by providing a more precise roadmap for the full-scale study (Patino & Ferreira, 2018).

The online survey targeted four participants from Aramco partners in Europe, Asia, and the USA. Although limited in scope, the survey focused on fundamental research questions and objectives. The table below summarises the findings from the pilot test.

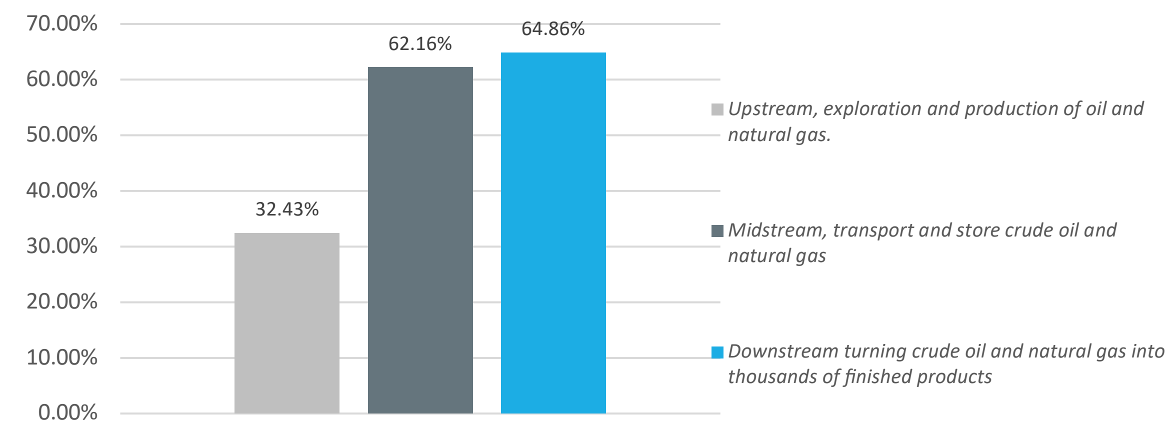
Category	Details
Main Values/Objectives of Firm's Blockchain Projects	Time Saving, Cost Saving, Security, Business Opportunity
Level of Blockchain Values Expected to be Realised	40%-60% Transparency, 60%-80% Time Saving, 70%-80% Security, 80%-90% Cost Saving
Year Firm Started the Blockchain Project	Two years ago, five years ago, three years ago
Current Status of These Projects	Evaluating Business Cases, Under Development
Project(s)' Progress Schedule Status	On-Time, Behind the planned schedule, and extremely
Project(s)' Budget Status	Within Budget, Exceeded the budget significantly
Extent of Value Realisation	Levels 3-10, Level 1, Level 3
Factors Impairing Blockchain Value Realisation	- Technical Factors: Low, Medium - Social Factors: Low, Medium - Organisational Factors: Low, Medium
Perceptions of Blockchain Projects Now in Comparison with the Beginning	Not Sure, Pessimistic
Prediction Toward Blockchain Projects at Your Firm	Stop Investing time and effort, Keep Blockchain projects Semi-Active
Prediction of Years to Start Realising Blockchain Values	Four years, one year, three years
Prediction of Years to Reach Breakeven of Blockchain Project as Investment	Six years, three years, five years
Extent of Rate of Value Realisation That Can Be Achieved in the Future	30% Cost Saving, 36% Security, 20% New Business Opportunity, 44% Time Saving

Table 4.1 Pilot Survey Findings Summary

Analysis of answers for the First group of questions associated with the Current status of Blockchain project implementations and the target business disciplines.

1. What is/are the main oil and gas business discipline(s) your Blockchain project(s) target?

The table and graph illustrate the responses to a multiple-choice question about which oil and gas business disciplines are most interested in Blockchain—downstream received the most responses, accounting for approximately 65% of all responses, with 24 individual replies. The downstream segment includes the final stages of crude oil processing before it is transformed into finished goods for sale to end users. Midstream, which involves the transportation and storage of oil and gas, garnered around 62% of replies with 23 individual responses. Lastly, the upstream business discipline received approximately 32% of replies, with 12 distinct submissions.

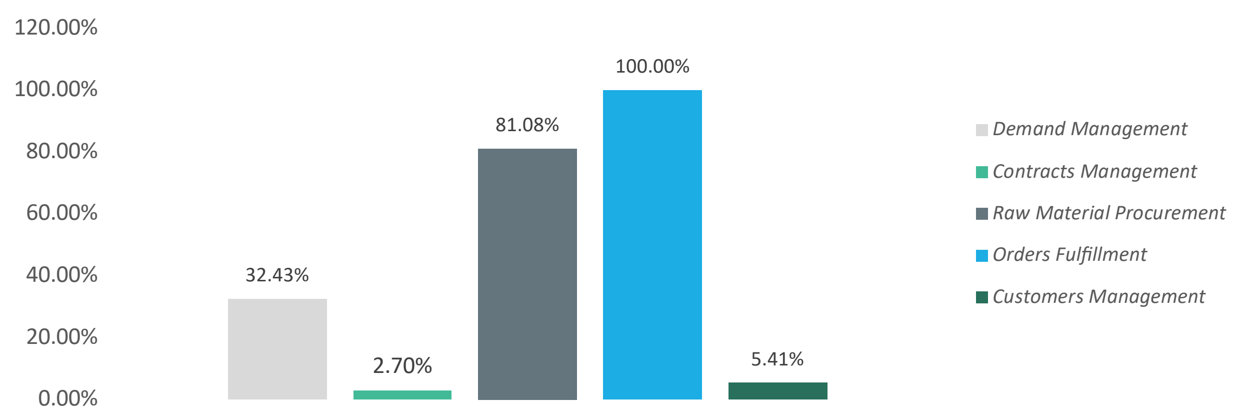


Choices	***Response percent***	***Response count***
Upstream, exploration and production of oil and natural gas.	*32.43%*	*12*
Midstream, transport and store crude oil and natural gas	*62.16%*	*23*
Downstream turning crude oil and natural gas into thousands of finished products	*64.86%*	*24*

Figure 4.01, Target Business Discipline for Blockchain

2- Which SCM processes are more concerned about the issues mentioned in the previous question (Cost, time, transparency)?

This multiple-choice question identifies the most problematic operations within supply chain management (SCM), as effective SCM provides several benefits for businesses, and supply chain specialists must overcome obstacles to keep operations running smoothly. The chart and flow table (Figure 4.02) show that all respondents selected order fulfilment, with 37 individual responses representing 100% of completed responses. Raw material procurement followed, with 30 responses (81%), and demand management received 12 responses (32.4%). Customer management and contract management were the least concerning SCM processes, accounting for around 5% and 2.7%, respectively.

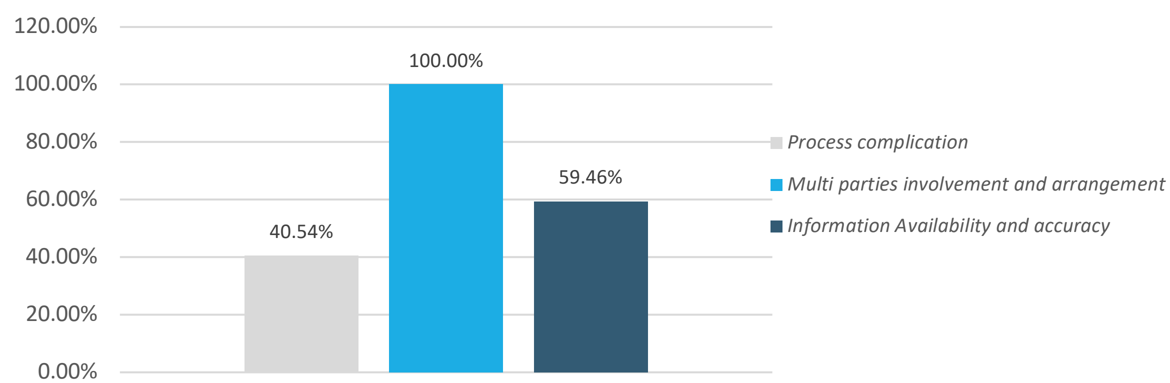


Choices	***Response percent***	***Response count***
Demand Management	*32.43%*	*12*
Contracts Management	*2.70%*	*1*
Raw Material Procurement	*81.08%*	*30*
Orders Fulfilment	*100.00%*	*37*
Customers Management	*5.41%*	*2*

Figure 4.02, SCM Business Process

3- What are the current major concerns related to your selected SCM processes that have not been solved by your current systems?

This question seeks to identify the key concerns associated with the selected SCM processes. The chart and table display that management, as a key concern, was selected by 100% of respondents (37 responses), aiming to ensure a positive experience for the end consumer. Access to information and its validity followed, with around 59% of responses (22 replies), while procedural difficulty was identified by 15 project managers (40%).

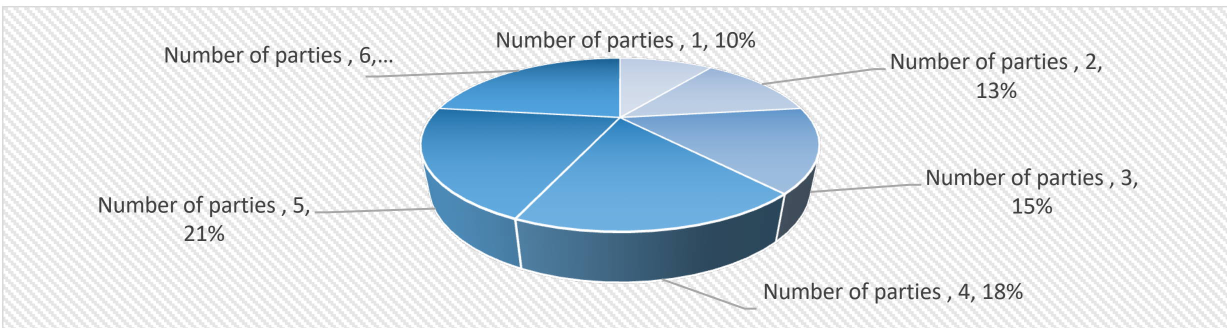


Choices	Response percent	Response count
Process complication	40.54%	15
Multi parties' involvement and arrangement	100.00%	37
Information Availability and accuracy	59.46%	22

Figure 4.03, Major Concerns

4-How many national and international parties engage in the selected process?

This question aims to ascertain the number of parties involved, one of the most significant challenges Blockchain seeks to address. All responses indicated that more than four national and international parties were involved. Five parties were selected by ten respondents (27%), six parties by eight respondents (26%), eight parties by 19% of respondents, and four and nine parties accounted for 5.4% and 11%, respectively.

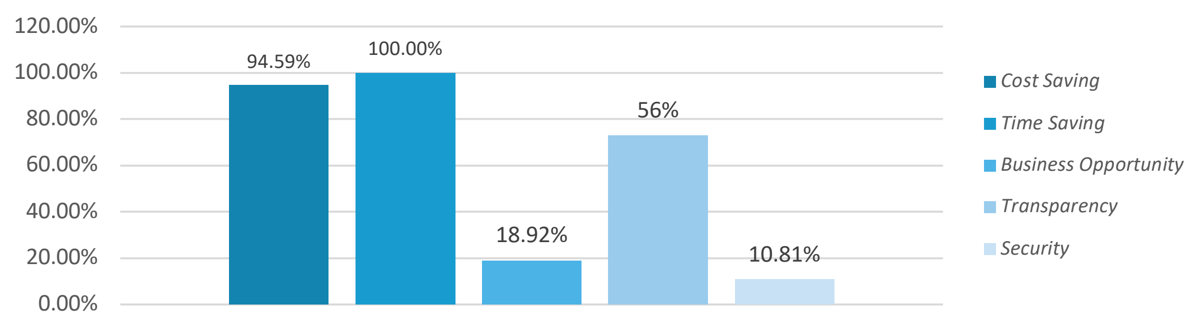


Number of parties	*Response percent*	*Count*
4	*5.41%*	*2*
5	*27.03%*	*10*
6	*21.62%*	*8*
7	*16.22%*	*6*
8	*18.92%*	*7*

Figure 4.04, Involved Parties

5 What are the main values/objectives of your firm's Blockchain projects?

This multiple-choice question identifies the critical reasons for various organisations adopting Blockchain technology, particularly in supply chain management. All 37 respondents selected time-saving as the primary objective. 95% of respondents (35 project managers) chose cost-saving, followed by transparency with 19 responses (56%). Business opportunity and security were selected by 19% and 11%, respectively. While time and cost-saving had near-universal agreement, the importance of transparency, security, and business opportunities was less aligned.



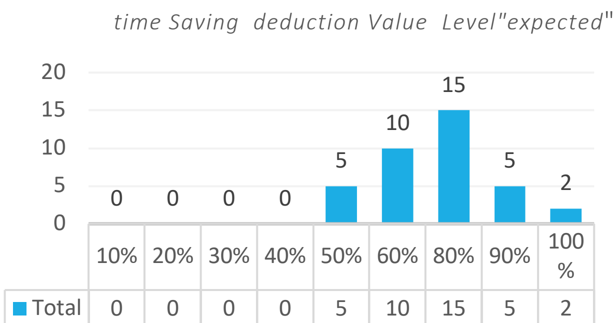
Choices	***Response percent***	***Response count***
Cost Saving	*94.59%*	*35*
Time Saving	*100.00%*	*37*
Business Opportunity	*18.92%*	*7*
Transparency	*56.00%*	*19*
Security	*10.81%*	*4*

Figure 4.05, Main Values(objectives)

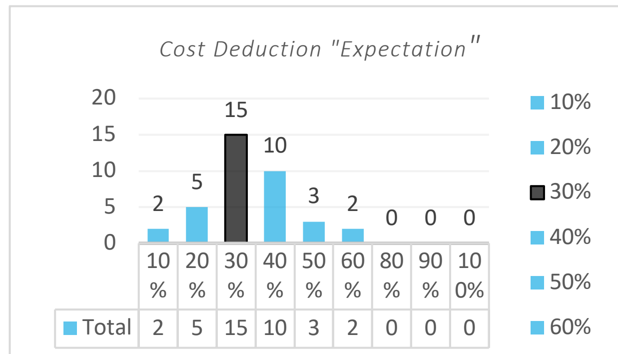
What level of each Blockchain value is expected to be realised?

The below aggregated graph represents the expected realisation of Blockchain values. Respondents anticipated that Blockchain would save 60-80% of the time currently spent on operations managed by scattered applications, cut costs by 30-40%, and provide 90-100% security. They also expected Blockchain to grant access to 60-88% of data related to their requests and transactions, which third parties sometimes manage. However, there was an apparent misalignment in stakeholder perceptions regarding these expectations.

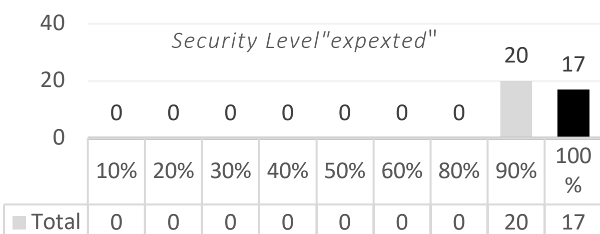
6-Time Saving Value?



7-Cost Deduction Value?



8- Security Value?



9-Transparancy Value?

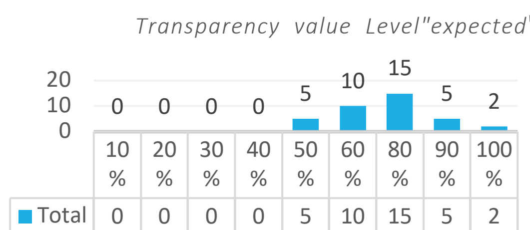


Figure 4.05, Realised Values Levels

10- what are the resources your firm uses to come up with this expectation?

The figure below outlines the resources used by oil and gas firms to create the initial use cases for their Blockchain projects. Feedback from local IT teams was most relied upon, followed by data from international IT organisations such as Gartner and ICT technical reports from sources like McKinsey. Local and international technology providers like SAP and IBM were considered last resort options.

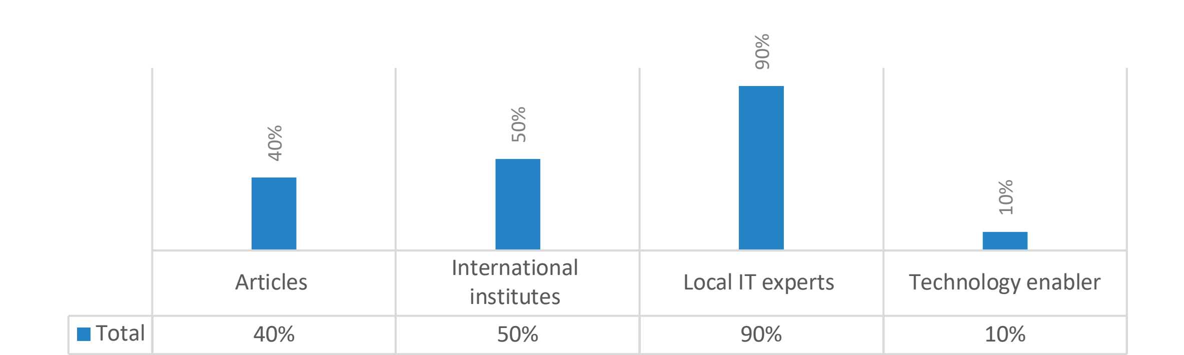
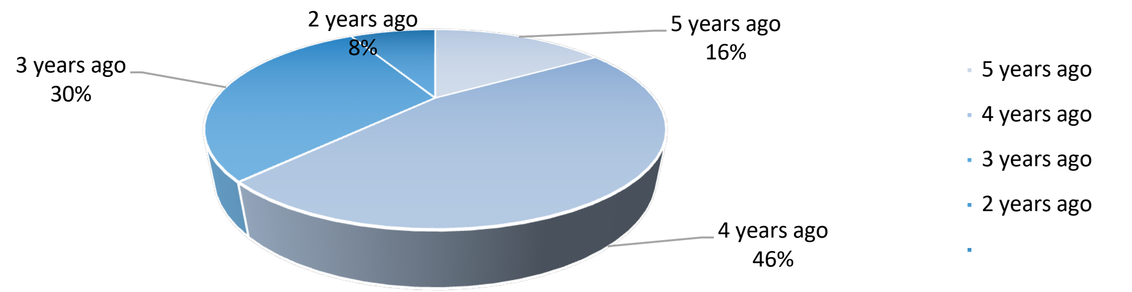


Figure 4.07, Expectation Resources

11- In which year did your firm start the Blockchain Project?

This question investigates the project timeline to assess the duration and challenges of Blockchain implementation. As shown in the pie chart, most respondents' companies began their Blockchain projects around four years ago, while 30.56% started three years ago. Approximately 19.44% had started five years ago, making them the most experienced group. Lastly, 8% began within the past two years, making them the least knowledgeable about Blockchain technology.

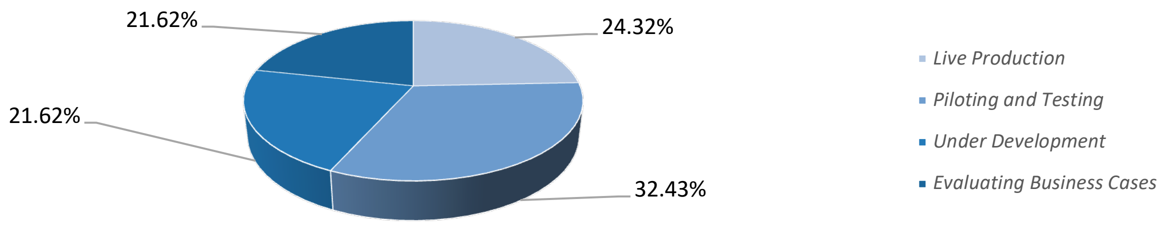


Choices	*Response percent*	*Count*
5 YEARS AGO,	*16%*	*6*
4 YEARS AGO,	*46%*	*17*
3 YEARS AGO,	*30%*	*11*
2 YEARS AGO,	*8%*	*3*

Figure 4.08, Blockchain Projects Start Year

12. What is the current status of these projects?

This question helps link the duration of Blockchain projects to their progress. The pie chart and table show that approximately 32% of projects remain in the piloting and testing phase despite being started 3-4 years ago. Additionally, 24% of projects have gone live, while 21% are under development, and the remaining 21% are still evaluating business cases.

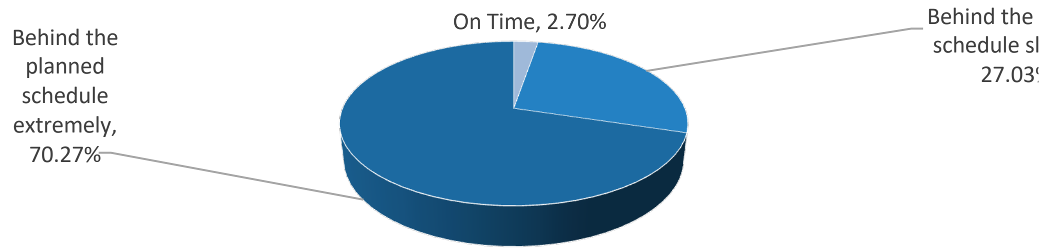


Choices	Response percent	Response count
Live Production	*24.32%*	*35*
Piloting and Testing	*32.43%*	*37*
Under Development	*21.62%*	*7*
Evaluating Business Cases	*21.62%*	*27*

Figure 4.09, Blockchain Projects Status

13 -What is the project(s)' progress schedule status?

Responses to the projects' schedule indicate that most projects are still in the early phases of implementation, with a small percentage on schedule. As depicted in the pie chart in response to the Blockchain project timetable, around 70% of projects are significantly behind schedule, indicating a solid indication of a common issue(s) with Blockchain initiatives. 27% of projects were somewhat behind schedule, with only one solid time, with a response of 2.7% indicating that the project was on time.

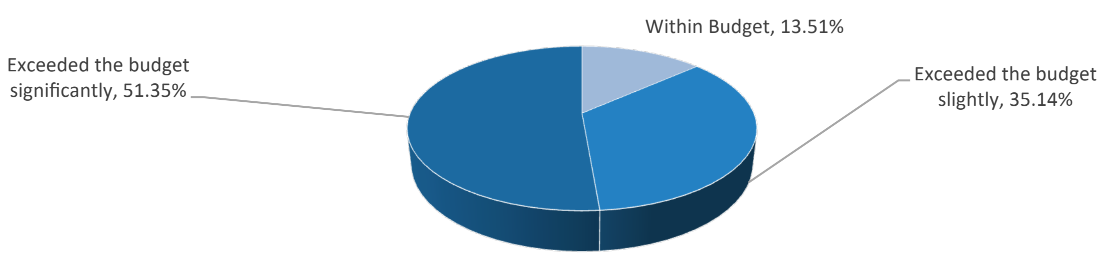


Choices	Response percent	Response count
On Time	2.70%	1
Behind the planed schedule slightly	27.03%	10
Behind the planned schedule extremely	70.27%	26

Figure 4.10, Blockchain Projects Schedule status

14. What is the project(s)' budget status?

Responses to the project budget question indicate that around 51% of projects were severely over budget, 35% somewhat exceeded the budget, and 14% were within budget. These responses highlight significant flaws in the implementation of Blockchain projects.

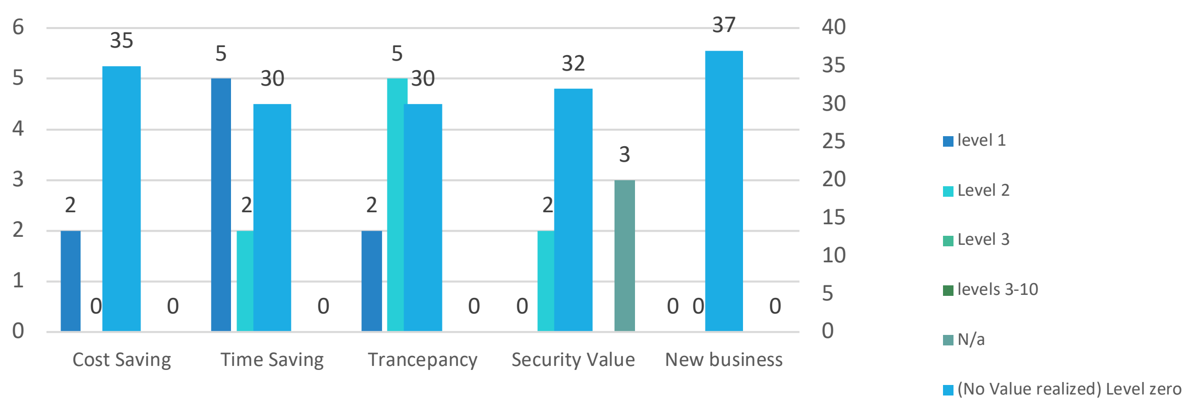


Choices	Response percent	Response count
Within Budget	13.51%	5
Exceeded the budget slightly	35.14%	13
Exceeded the budget significantly	51.35%	19

Figure 4.11, Blockchain Project Budget Status

15. To what extent did your firm manage to realise values as a result of Blockchain Project implementation in comparison with expected value?

This question uses a scale from 0 to 10, with 0 representing no value achieved and 10 representing full realisation of business value. Figure 4.12 summarises the responses, showing that 89% of projects have realised little to no value, with most responses falling at levels 1 and 2.



	(No Value realised) Level zero	level 1	Level 2	Level 3	levels 3-10	N/a
Cost Saving	35	2	0	0	0	0
Time Saving	35	5	2	O	0	0
Transparency	30	2	5		0	0
Security Value	32	0	2	O	0	3
New business	37	0	0	0	0	0

Figure 4.12, Realised Value Level

Analysis of the Second group of questions associated factors impairs Blockchain project implementation and value realisation objectives.

This group consists of three sets, each containing aggregated elements that researchers identified and characterised based on the theories and procedures applied in this study. The three groups include technological elements, as well as social and organisational variables. The questions use a scale from 1 to 10 to measure the extent of each factor's impact or impairment on Blockchain implementation and value realisation.

16. Assess the following factors that impair your Blockchain Value realisation "technical factors".

The figure below simplifies the presentation by displaying the average impact level of each factor, making it easier to interpret the responses. The chart and table show that technical factors had minimal influence, with respondents rating the average technical complexity of Blockchain at approximately 2.24 out of 10. Respondents identified technology maturity as the most significant factor, scoring 5.19 out of 10, while infrastructure readiness received the lowest score at 2.03 out of 10. For security and privacy, the average response was 3.16, making it the second most impactful factor in this set.

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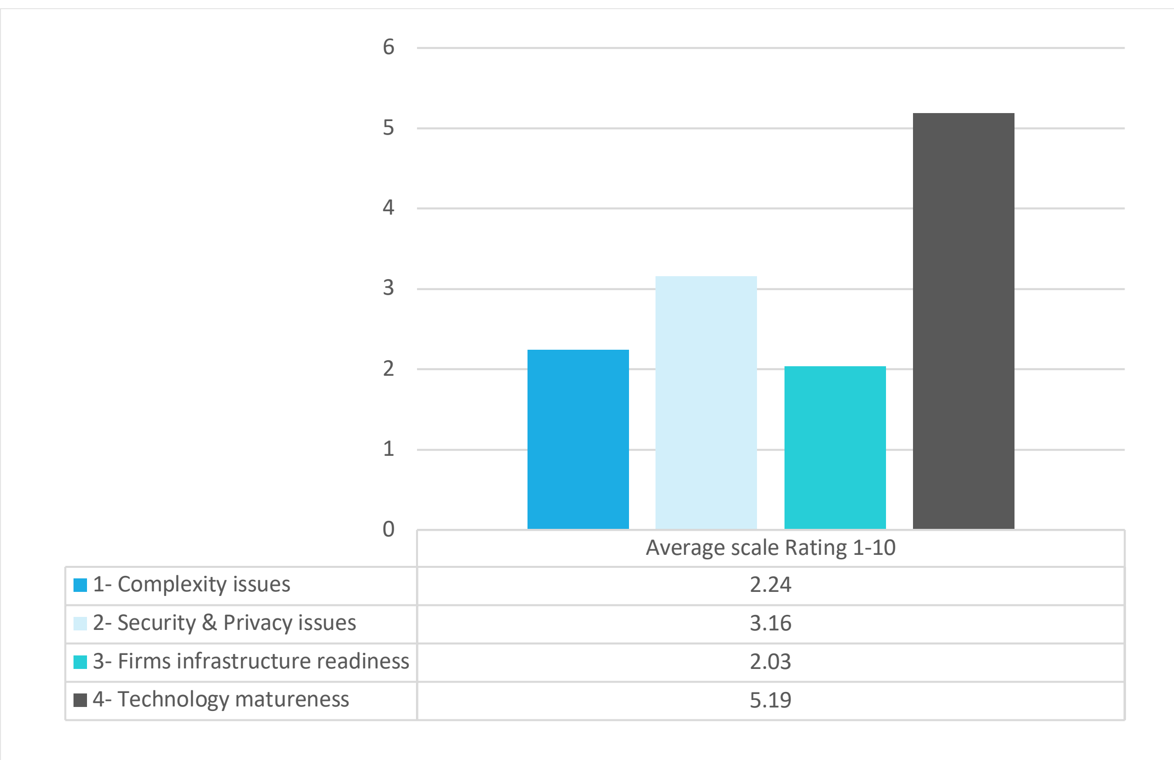


Figure 4.13, Technical Factors Impact

17- Assess the following factors that impair your Blockchain Value realisation "Social factors":

The figure below simplifies the responses to question 17, showing the average impact level for each factor. According to Figure 3.14, regulations and policy availability had the highest impact on Blockchain projects and value realisation, scoring 7.49 out of 10, followed by stakeholder cooperation, scoring 7.19 out of 10. The technology enabler role, scoring 2.94 out of 10, is identified as the main obstacle to implementing Blockchain projects.

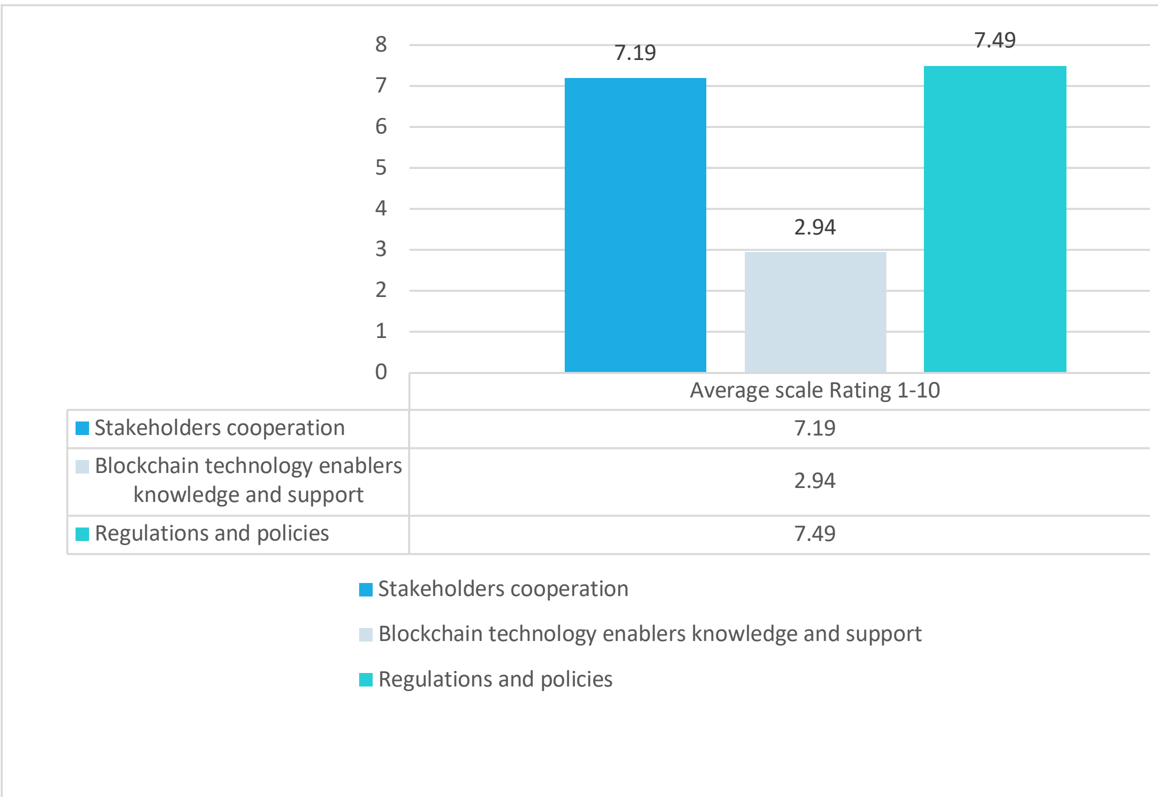
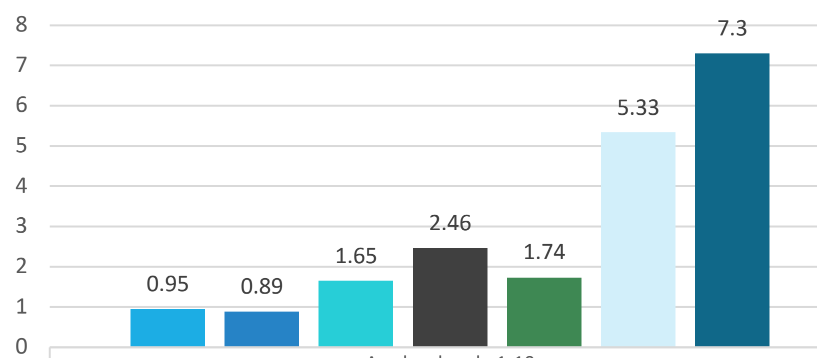


Figure 4.14, Social Factors Impact

18. Assess the following organisational/Industrial factors that impair your Blockchain Value Realisation.

The chart and table illustrate seven factors, each with varying levels of impact. The factor 'High level of doubts and uncertainty about Blockchain technology' had the highest impact level at 7.3. 'Trust in Blockchain technology' followed with a score of 5.3 out of 10. Competition in the industry scored 2.46, indicating a minimal impact. Organisational culture and the IT team scored 1.7 and 1.65, respectively, while the remaining factors scored below one and had negligible impact. This information can guide us in identifying key areas to focus on when considering Blockchain technology implementation.

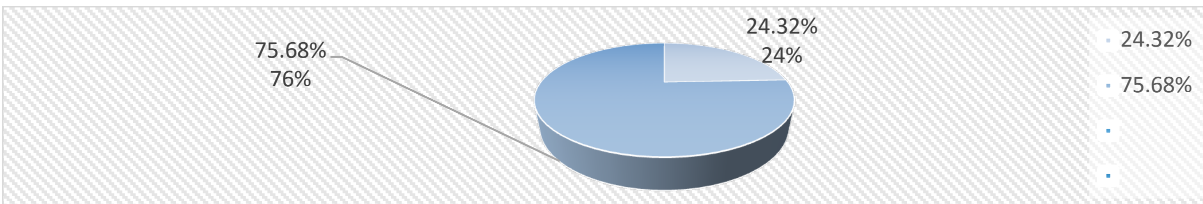


	Avg level scale 1-10
8- Management Support	0.95
9- User Acceptance	0.89
10- Organizational culture	1.65
11- Industry competation	2.46
12-IT team technical knowledge	1.74
13- Trust in Technology	5.33
14- High level of doubts uncertainty of BC technology	7.3

Figure 4.15, Organisational Factors Impact

Analysis of Answers to the Perceptions & Predictions Questions

19 -What were your perceptions of Blockchain value-addition to your firm at the beginning of Blockchain projects? Question number 19 is based on a perceptual construct that is supported by TAM theory as an indicator and factor in the success or failure of innovative technology adoption. According to the chart and tables in Figure 4.16, more than 75% of respondents were hopeful that deploying Blockchain technology will provide significant value to their businesses, while just 24% were unsure, and none were pessimistic.

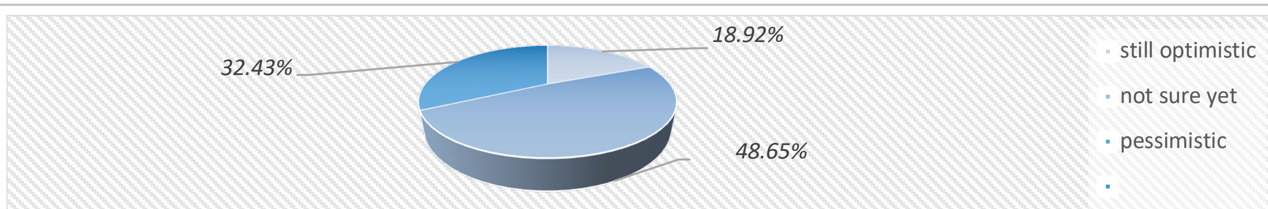


chooses	Response percent	Count
(1) Optimistic	75.68%	28
(2) not sure or neutral	24.32%	9

Figure 4.16, Perceptions at the Beginning of Blockchain Projects

20. What are your perceptions of Blockchain projects now in comparison with the beginning of project(s)?

As shown in Figure 4.17, the replies to the perception after a few years of Blockchain project implementation were dramatically different from the perception at the start of the implementation of the Blockchain projects. Whereas more than 32% are pessimistic, more than 48% are not sure and have doubts.

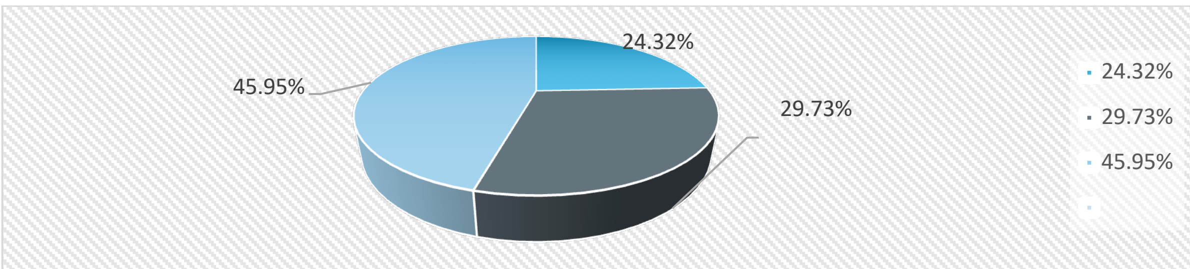


choices	Response percent	Count
(1) Still Optimistic	18.92%	7
(2) not sure yet	48.65%	18
(3) Pessimistic	32.43%	12

Figure 4.17, Current Perceptions of Blockchain

21 -What is your prediction toward Blockchain projects at your firm?

About 24% of respondents say their companies would stop investing time and effort in Blockchain projects because there is no feasible value addition to their business in the near future. In comparison, 46% say they would keep the project semi-active to minimise investment and get more time to resolve the uncertainty about the value addition of this technology. Finally, over 29% of respondents believe that their companies will continue to invest heavily in Blockchain technology because they believe it will offer value in the near future.

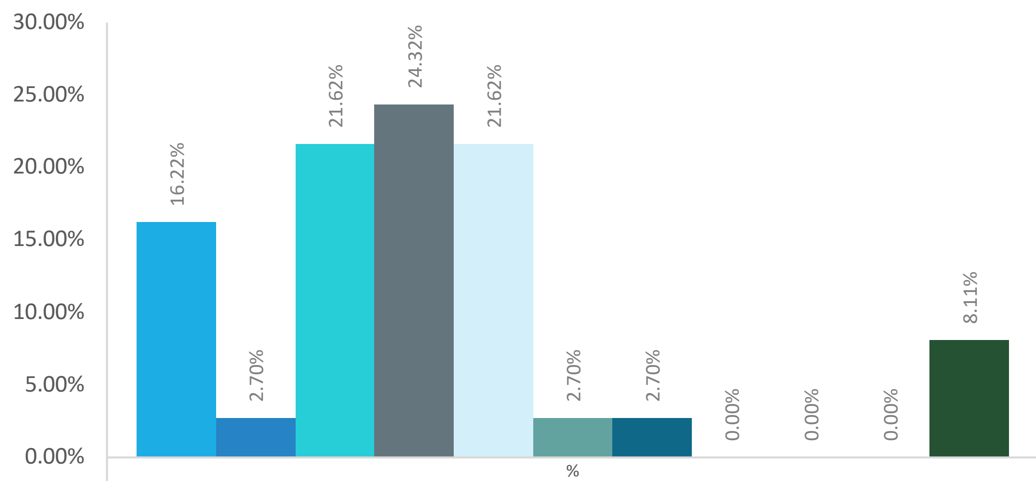


Choices	Response percent	Count
(1) Stop Investing time and effort in Blockchain technology. Blockchain value realisation is not feasible in the future	*24.32%*	*9*
(2) continue investing time and effort in Blockchain value realisation is feasible in near future	*29.73%*	*11*
(3) keep Blockchain projects Semi-Active and minimise the investment to get more knowledge to resolve the uncertainty and work with your Blockchain network peers and enablers to sort out current barriers and concerns	*45.95%*	*17*

Figure 4.18, Blockchain Projects Predication

22. Based on your experience with emerging ICT technology such as Cloud Computing and as a future prediction, how long in years do you predict you will be able to start realizing the Blockchain values?

In response to another prediction question regarding the expected number of years to realise Blockchain values, Figure 4.22 shows the following results: approximately 16% of respondents predict that their firms will realise the value of Blockchain within one year. Additionally, 2.7% predict realisation within the second year, with the same percentage for years 5 and 7. Around 22% predict realisation in the third and sixth years, while approximately 24% predict realisation in the fourth year. Finally, about 8% predict that the value of Blockchain will not be realised at all.

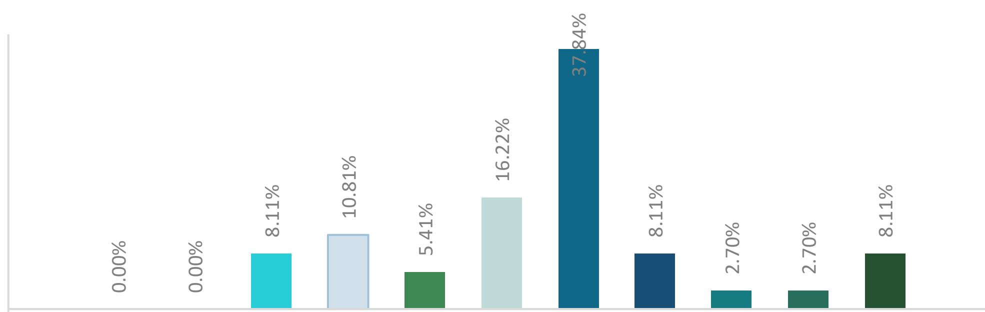


	%
Year 1	16.22%
Year 2	2.70%
Year 3	21.62%
Year 4	24.32%
Year 5	21.62%
Year 6	2.70%
Year 7	2.70%
Year 8	0.00%
Year 9	0.00%
Year 10	0.00%
Will not be realized	8.11%

Figure 4.19, Number of Years Required to Realise Blockchain Values

23. How long do you predict your firm will be able to reach the breakeven of the Blockchain project as an investment?

The question aims to assess the use of Blockchain technology as an investment. It seeks an estimate of the number of years needed to recover the initial investment as a return on investment (ROI) metric. The average response across all answers was six years, with 14 replies. Approximately 38% of respondents chose seven years, 16% chose six years, 11% chose four years, and 8% were unsure about the required number of years to recoup the investment.

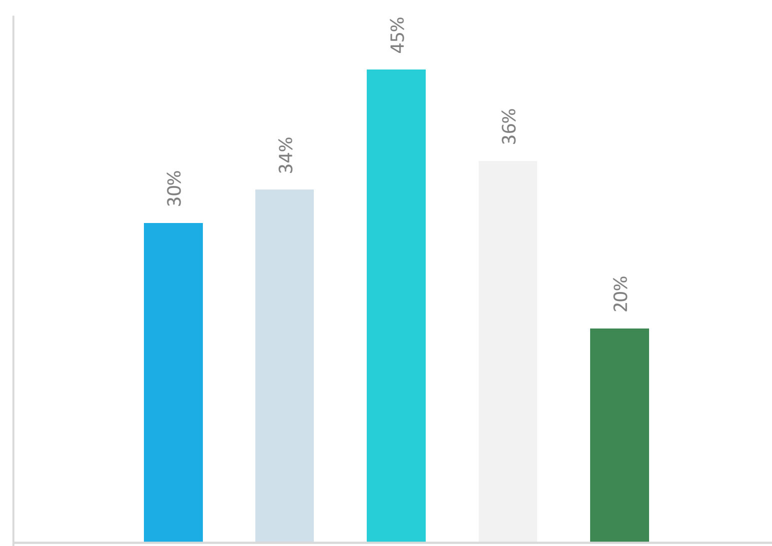


	%
Year 1	0.00%
Year 2	0.00%
Year 3	8.11%
Year 4	10.81%
Year 5	5.41%
Year 6	16.22%
Year 7	37.84%
Year 8	8.11%
Year 9	2.70%
Year 10	2.70%
Not Sure	8.11%

Figure 4.20, Blockchain Projects Breakeven Predictions

24 -To what extent do you predict that the rate of value realisation can be achieved?

This question evaluates the practicality and feasibility of Blockchain values compared to others, using a scale from zero to ten. A score of zero indicates that the selected value is unlikely to be realised, while ten signifies that it is highly likely to be fully achieved. As illustrated in Figure 4.21, respondents anticipate the greatest realisable value to come from time savings, with around 44% of the proposed time-saving benefits of Blockchain expected to be achieved. They expect that 36% of the security benefits, 30% of the cost-saving potential, and 33% of the transparency benefits will be realised compared to the original projections. Moreover, respondents believe that Blockchain could increase business opportunities by 20% over the initial proposal.



Cost Saving	30%
Transparency	34%
Time Saving	45%
Security Value	36%
New business Opportunity	20%

Figure 4.21, Level of Value Realision

4.4. Findings Analysis Overview

This analysis presents the findings obtained from a combination of interviews and surveys conducted using a thematic approach. The objective is to provide a comprehensive overview of the status, objectives, and value realisation outcomes of Blockchain projects. Prior to conducting the analysis, the author rigorously checked the reliability and consistency of the collected data.

4.4.1.Formal Online Survey Reliability

Pilot survey outcome and formal survey reliability: Conducting a pilot survey is a crucial step in enhancing the reliability of the for survey. Reliability refers to the consistency of results obtained from a survey, meaning that it should produce similar outcomes when repeated under identical conditions (Fowler, 2014). A pilot test serves to identify and address potential issues in survey design, such as ambiguous or confusing questions. This process allows researchers to refine the survey items, ensuring clearer wording and better alignment with the intended constructs, which in turn improves internal consistency (Bryman, 2016). Additionally, pilot testing allows for the evaluation of the survey's flow and the length's impact on participants. Long or poorly structured surveys may lead to respondent fatigue, which can result in unreliable responses. By observing this during the pilot phase, researchers can adjust the survey format to ensure respondents remain engaged and focused, leading to more consistent data collection (Creswell & Creswell, 2018).

The pilot survey responses, presented in this chapter, were collected over a period of approximately seven months prior to the formal survey. Interestingly, the results demonstrated a prominent level of similarity between the pilot survey responses and those of the formal survey. This high degree of consistency across different timeframes significantly contributes to the overall reliability of the survey findings. By showing that responses remain stable over time, the survey can be considered reliable, as it consistently measures the intended constructs regardless of the data collection period. This reinforces confidence in the validity of the results obtained from the formal survey. In summary, conducting a pilot survey not only helps to identify and resolve potential issues in the survey design but also enhances the reliability of the final survey by improving internal consistency, flow, and question clarity.

In person interviews outcome and formal survey reliability: The outcomes of interviews conducted with four representatives from four oil and gas firms in Saudi Arabia, using questions closely aligned with those in the formal online survey, demonstrate a significant degree of similarity in responses. These responses were consistent across various aspects, including project status, objectives, challenges, perceptions, and even some predictions. The consistency observed between the interview findings and the pilot survey outcomes further reinforces the reliability of the formal survey. The alignment across these methods supports the validity and reliability of the data collected in the formal survey. In-person interviews conducted prior to an online survey can significantly support the reliability of the survey findings. Firstly, interviews offer the opportunity to explore participants' understanding of the survey questions in greater depth. By identifying any ambiguities or misinterpretations during these interviews, researchers can refine the survey items, ensuring that questions are clear and consistently understood. This clarity contributes to more reliable responses when the survey is later administered online (Creswell & Creswell, 2018). Moreover, in-person interviews can help confirm the relevance and appropriateness of the survey content. Interview feedback ensures that the survey aligns with the experiences and expectations of the target population, thereby increasing the likelihood that participants will engage meaningfully with the survey and provide consistent responses (Bryman, 2016). This process enhances the reliability of the survey by ensuring that it is well-suited to the context it is designed to explore. Additionally, the use of interviews can test the consistency of the findings across different data collection methods. If the themes and responses obtained from in-person interviews are consistent with the results of the subsequent online survey, this congruence reinforces the reliability of the survey instrument. Consistency across methods suggests that the survey is capturing the intended constructs accurately (Dillman, Smyth, & Christian, 2014).

Finally, the interviews can serve as a form of pilot testing for the survey structure and content. By gathering feedback through interviews, researchers can identify potential improvements in the survey's design before it is distributed online. This pretesting step helps to refine the survey, increasing the likelihood that it will produce reliable and valid data in its formal iteration (DeVellis, 2017). In summary, in-person interviews play a crucial role in supporting the reliability of an online survey by improving the clarity, relevance, and consistency of the survey questions and overall design.

4.4.2. Project Status & Objectives

Unveiling Primary Objectives: Unveiling Primary Objectives: The primary objectives that organisations aim to achieve through their Blockchain projects not only shed light on the transformative potential of this technology but also inspire optimism for its future. The most notable of these objectives is timesaving, which was unanimously selected as the primary goal. This unanimous choice underscores Blockchain's capability to streamline processes and reduce operational timeframes, ultimately enhancing efficiency. Cost-saving emerges as the secondary objective, reflecting the financial benefits that Blockchain can offer. By eliminating intermediaries and reducing administrative overheads, organisations anticipate a reduction in costs. This finding underscores the business rationale behind Blockchain adoption. Transparency, business opportunity, and security are identified as additional objectives, highlighting the multifaceted benefits that organisations aim to derive from Blockchain. Transparency reflects the desire for enhanced accountability and trust in business processes. Business opportunity underscores the innovative potential of Blockchain, with organisations exploring new revenue streams and business models. Security, while a fundamental requirement, is also a noteworthy objective, emphasising the critical role of Blockchain in safeguarding sensitive data and transactions.

However, the analysis reveals an intriguing dimension: the misalignment of objectives among stakeholders. Interviews show that not all project participants share the same priorities. This misalignment can potentially impact collaboration and decision-making, leading to suboptimal project outcomes. To address this challenge, organisations must proactively engage stakeholders in meaningful discussions to align objectives and foster a shared vision.

The misalignment between the priorities and objectives of various firm representatives was prominently displayed during the interviews conducted as part of the case study. Representatives from The Refinery and Crude Oil Production expressed a predominant concern regarding cost and time, placing these elements at the forefront of their priorities. The Refinery's spokesperson articulated this focus, stating, "Getting the services in the fastest possible [time]. The current time of getting the orders fulfilled sometimes takes 2-3 weeks, and we are looking to get the services in a week. Looking to have access to our order and the quality of the product through its journey to our plant." In alignment with this viewpoint, the representative from the crude oil sector mirrored these objectives, emphasising efficiency and practicality: "Mainly to save time and cost. To process the received orders and get paid for the service in a shorter period".

Conversely, the representatives from the pipeline and terminal sectors exhibited differing priorities. The spokesperson from the pipeline sector underscored the significance of transparency and information accessibility, stating, "Transparency and information accessibility are our main concerns when scheduling our operational activities. We need to have access to the information of the orders since they have been initiated." This focus on Transparency was echoed by the representative of the Crude Oil Terminal, who additionally emphasised the importance of quality and data accessibility as forms of Transparency. They articulated, "The most important thing is getting the crude oil in quality since it comes through pipes. Pipeline conditions, such as corrosion, impact the quality, and having access to the pipeline's labs early enough would save our internal checks. This diversity of perspectives underscores the complexity and multi-dimensional nature of stakeholder priorities within the industry, highlighting the need for a more integrated and collaborative approach to address the varied concerns related to cost, time, Transparency, and quality.

A pertinent academic text that delves into the issue of misalignment of objectives among stakeholders in project management is "Project Governance and Stakeholders: A Literature Review" by R. Derakhshan (2019). Derakhshan's work discusses the complexities of stakeholder roles and interactions in project governance. It highlights the challenges in aligning the diverse interests of stakeholders and managing the resultant misalignment that often occurs in projects. This study is particularly relevant in understanding how different priorities among stakeholders can lead to challenges in project execution and governance. It emphasises the need for an inclusive framework to address these challenges and align stakeholder objectives effectively. Another relevant academic text that addresses the misalignment of objectives among stakeholders in project management is "Misalignment of Stakeholder Objectives in Software Startups" from a qualitative research study. This study involved semi-structured interviews with twelve startup companies, focusing on the challenges faced due to differing stakeholder objectives. It provides insights into the complexity of aligning various interests within the dynamic environment of software startups, reflecting on the issues that arise when not all participants share the same priorities. This study is beneficial for understanding the misalignment in a startup context, where agility and rapid changes often amplify the challenges of stakeholders' alignment.

Exploring Temporal Trends: The analysis of project start years offers a glimpse into the temporal dynamics of Blockchain adoption. Approximately four years ago, a substantial portion of respondents embarked on their Blockchain journey, signifying early adoption. These pioneers have likely amassed valuable experience and insights that can benefit newer entrants. Around three years ago, another wave of organisations initiated their Blockchain projects. This timeframe indicates a surge in adoption, possibly triggered by increasing awareness of Blockchain's potential benefits. These organisations occupy a unique position, straddling the boundary between early and recent adopters.

In contrast, a notable percentage of respondents began their Blockchain ventures within the last two years, suggesting a lower level of familiarity with the technology. These organisations represent the latest entrants into the Blockchain landscape and may require additional support and guidance as they navigate this complex terrain. Understanding these temporal trends is essential for organisations considering the adoption of Blockchain. Early adopters can serve as mentors and share their experiences, while recent entrants can draw from the collective knowledge of the Blockchain community.

Navigating Project Statuses: The diverse range of project statuses indicates that Blockchain implementation is far from uniform. Around 32% of projects remain in the piloting and testing phase, even after several years. This prolonged testing period raises questions about the challenges faced during implementation. Complexities, integration issues, and a commitment to thorough testing may all contribute to this extended phase. Approximately 24% of projects have successfully transitioned to the live production stage, demonstrating progress and successful deployment. These organisations can serve as exemplars for others in the industry, offering valuable insights into best practices and success factors. The presence of projects in the development phase and those still evaluating business cases suggests an ongoing commitment to Blockchain initiatives. These organisations are likely in the process of fine-tuning their strategies, addressing technical hurdles, or conducting feasibility studies. Their presence underscores the diversity of approaches to Blockchain adoption. However, the majority of projects are reported to be significantly behind schedule, a striking revelation that warrants attention. Technical complexities, integration difficulties, and other factors contribute to these delays. Organisations must approach Blockchain projects with realistic expectations, allowing flexibility in project timelines to accommodate unexpected hurdles.

*Managing the Budget Balancing Act***:** Effective budget management is critical to the success of the Blockchain project. The finding that a significant portion of projects have exceeded their budgets, some severely, highlights the financial challenges associated with Blockchain implementation. Budget overruns may result from various factors, including scope changes, unforeseen expenses, and the need for specialised expertise.

Bridging the Value Realisation Gap: The most profound revelation from this analysis is the substantial gap between expected and realised value in Blockchain projects. A staggering 89% of respondents reported that their projects have not realised any value at all from Blockchain implementation. This finding raises important questions about the factors contributing to this gap. Potential explanations for this discrepancy include the complexity of integrating Blockchain into existing systems, unrealistic expectations, and the need for a more comprehensive understanding of how to harness the full potential of Blockchain technology. Addressing this value realisation gap is paramount for the sustained adoption and success of Blockchain projects. The negligible level of value realisation reported in some cases emphasises the need for a deeper exploration of the challenges organisations face in unlocking the benefits of Blockchain. It also underscores the importance of continuous learning and knowledge sharing within the Blockchain community. The path to realising Blockchain's entire potential demands ongoing education, collaboration, and innovation. This finding is in sync with recent studies that have highlighted the concerning trend of high failure rates in Blockchain projects. In a comprehensive analysis by Johnson and Li (2022) published in the "Journal of Blockchain Research," it was found that approximately 65% of Blockchain initiatives fail to move beyond the development stage. This outcome aligns with the findings of Patel and Kumar (2023) in their study "Blockchain Project Lifecycles," where they report a 70% failure rate among Blockchain startups within the first three years.

A sector-specific study by (Thompson et al.,2024) in "Finance and Technology Review" focused on Blockchain projects in the financial industry. The study revealed that nearly 60% of these projects failed due to regulatory challenges and a lack of industry-specific adaptation. Similarly, a report in the "International Journal of Distributed Ledger Technology" by Garcia and Fernandez (2023) highlighted that 75% of government-related Blockchain projects did not achieve their objectives, primarily due to scalability and interoperability issues. In the UK context, a study by Hughes and Davies (2022) in the "British Journal of Technology and Innovation" indicated that the Blockchain project failure rate stood at 68%. The researchers attributed this to a combination of factors, including market over-saturation, technological complexities, and a mismatch between project goals and Blockchain capabilities.

These academic sources collectively suggest that while Blockchain technology holds significant promise, the reality of implementing successful projects is far more complex and challenging, leading to a high incidence of failure.

4.4.3.Factors Impact the Blockchain Value Realisations

This analysis explores the findings of a comprehensive study using a scale-based approach to evaluate the impact of a range of factors on Blockchain implementations and value realisation.

Technical Factors:

Technology Maturity: The maturity level of Blockchain technology emerged as a critical determinant of value realisation, receiving the highest average score of 5.19 out of 10, indicating its substantial impact. A higher level of technology maturity correlates with a more favourable environment for extracting value from Blockchain projects. Mature technology offers better stability, scalability, and reliability, all crucial for successful implementation. Organisations must recognise the importance of adopting Blockchain solutions built on mature technology stacks, which entails thorough research and selecting established Blockchain platforms and protocols. This outcome also highlights the need for ongoing innovation and development within the Blockchain ecosystem to maintain and enhance technological maturity.

Infrastructure Readiness: In contrast, infrastructure readiness was identified as a factor with a relatively low average score of 2.03 out of 10, suggesting that inadequate infrastructure can significantly hinder Blockchain projects. Blockchain implementation requires robust hardware and network capabilities to support the technology's decentralised and data-intensive nature. Organisations must assess their existing infrastructure and invest in necessary upgrades or enhancements, including data storage, computational power, and network bandwidth, to facilitate Blockchain deployment. Adequate infrastructure is a foundational requirement for realising the full potential of Blockchain.

Security and Privacy: Security and privacy considerations play a pivotal role in Blockchain projects, with an average score of 3.16 out of 10, indicating a moderate level of impact. Blockchain's reputation for providing robust security mechanisms is well-founded, making it a primary reason organisation turn to this technology. However, security and privacy remain multifaceted challenges that require careful attention. While Blockchain offers inherent security features, such as cryptographic encryption and decentralised consensus mechanisms, organisations must still address issues like access control, data privacy, and regulatory compliance.

Unpacking Social Factors:

The second set of factors focuses on the social aspects influencing Blockchain implementation and value realisation, including regulatory frameworks, stakeholder cooperation, and the role of technology enablers.

Regulations and Policy Availability: Regulations and policy availability emerged as the most influential social factor, scoring 7.49 out of 10. This finding highlights the critical role of regulatory frameworks in facilitating Blockchain deployment and value realisation. Clear and supportive regulations provide organisations with the legal and operational certainty needed to embark on Blockchain initiatives. To navigate the regulatory landscape successfully, organisations must proactively engage with policymakers and remain informed about evolving regulations. Compliance and adherence to legal requirements are essential for mitigating risks and ensuring the long-term viability of Blockchain projects.

Stakeholders' Cooperation: Stakeholders; cooperation closely followed, scoring 7.19 out of 10, underlining the importance of collaboration among various stakeholders, including employees, partners, and customers. Blockchain projects often involve multiple parties working together within a decentralised ecosystem. Fostering stakeholder cooperation requires effective communication, alignment of objectives, and the establishment of trust among all involved. Organisations should prioritise stakeholder engagement strategies and cultivate a culture of collaboration to maximise the benefits of Blockchain technology. The survey findings align with the responses of interviewees from the case study. Many respondents linked the lack of collaborative synergy among stakeholders to the difficulty of actualising value through Blockchain projects. A representative from The Refinery stated, "From my viewpoint, I think the absence of regulations is a major reason. Moreover, I think the different expectations and the collaboration of the different stakeholders would be a considerable major reason." This view was echoed by a representative from the Oil Producer, who similarly noted, "The absence of regulations and differing expectations among stakeholders are major challenges." A representative from the pipelines sector highlighted another critical issue: "There is no official legal body to protect the whole process and stakeholders' rights. The different levels of power among stakeholders create a sense of non-conformance among the project teams." The representative from the crude oil terminal further reinforced this notion by stating, "The uncertainty of expected values and divergent stakeholder expectations are our primary concerns. Yes, the technology may take more time to mature, but first, we need to ensure the common objectives and expected values are met." These perspectives underscore the necessity of effective stakeholder collaboration and transparent regulatory frameworks for successful Blockchain integration and value realisation.

Technology Enabler Role: Conversely, the role of technology enablers received the lowest score among social factors, with an average rating of 2.94 out of 10. This result suggests that inadequate technological support can impede the implementation of Blockchain projects. Technology enablers, including service providers, consultants, and solution vendors, play a crucial role in assisting organisations in adopting and integrating Blockchain technology effectively.

Organisational and Industrial Factors:

The final set of factors examines the organisational and industrial aspects that influence Blockchain value realisation, including doubts and uncertainty, trust, industry competition, organisational culture, and the role of the IT team.

Doubts and Uncertainty of Blockchain Technology: "High level of doubts and uncertainty of Blockchain technology" emerged as the most impactful organisational/industrial factor, scoring 7.3 out of 10. This finding reflects the pervasive scepticism and uncertainty surrounding Blockchain, which can hinder its successful implementation and value realisation.

Trust in Blockchain Technology: Trust in Blockchain technology was the second most influential factor, scoring 5.3 out of 10. Building trust in the technology is essential for its effective utilisation. Trust is closely associated with Blockchain's core principles of transparency, immutability, and security.

Competition in the Industry: Interestingly, competition within the industry received a relatively low score of 2.46 out of 10, suggesting that industry competition has a limited impact on Blockchain value realisation. This finding indicates that the adoption of Blockchain is driven more by its intrinsic value than by competitive pressures.

Organisational Culture and IT Team: Other factors, including organisational culture (1.7 out of 10) and the role of the IT team (1.65 out of 10), were found to have negligible impact on Blockchain projects. Although these factors may not have a direct influence, they should not be disregarded entirely.

In summary, this analysis offers valuable insights into the multifaceted factors that influence the implementation of Blockchain projects and the realisation of value objectives. While technical factors, such as technology maturity, are essential for creating a stable foundation, social factors—particularly regulations and stakeholder cooperation—emerge as the most significant influencers. These findings underscore the importance of engaging with regulatory bodies, fostering collaboration, and building trust among stakeholders. Although organisational and industrial factors play a less impactful role, addressing doubts and uncertainties, fostering trust, and adopting a culture of innovation remains crucial for organisations aiming to navigate the challenges and maximise the benefits of Blockchain technology.

4.4.4. Perceptions and Predictions

This analysis encompasses critical aspects, including initial perceptions, current perceptions, predictions, expected timeframes for value realisation, breakeven periods, and the anticipated rate of value realisation. These insights shed light on how stakeholders' views evolve as Blockchain projects progress.

Initial Perceptions: A Wave of Optimism: At the outset of Blockchain projects, a significant majority of respondents, more than 75%, expressed an optimistic perception regarding the potential value addition of Blockchain to their organisations. This initial wave of optimism reflects a prominent level of confidence in the technology's ability to bring substantial benefits to their businesses. Notably, no respondents expressed pessimism during this phase, indicating a general belief in the untapped potential of Blockchain.

Regarding the initial perceptions, all interviewees in the case study uniformly expressed an optimistic outlook concerning the potential value addition of Blockchain technology. The representative from The Refinery conveyed this sentiment, stating, "We were optimistic since Blockchain technology would usually help speed up the manual process, save time, and protect our external transactions." This perspective was echoed by the representative from the Terminal, who affirmed, "Overall, we all were very optimistic and expected value additions to our business." Similarly, the spokesperson from the Crude Oil and Gas Producer sector shared this viewpoint, reiterating, "We were optimistic since, usually, the Blockchain technology would help to speed the manual process and save time and protect our external transactions." Furthermore, the representative from the Pipelines sector also expressed an optimistic stance, emphasising the anticipated benefits of Blockchain in enhancing transparency and efficiency. They stated, "I think my firm, including myself, were very optimistic and thinking the Blockchain would provide more transparency and save more time. “These responses collectively highlight a shared anticipation among the various stakeholders about the transformative potential of Blockchain technology. Their optimism underscores a recognition of the technology's capacity to streamline processes, enhance transaction security, and foster greater transparency across different sectors of the industry.

Perceptions at later stages of Blockchain projects: As the projects advanced and respondents were asked to evaluate their current perceptions of Blockchain projects, a notable shift in attitudes became evident. Data shows that over 32% of respondents became pessimistic about the realisation of business values from Blockchain implementations. This shift towards pessimism can be attributed to challenges and obstacles encountered during the implementation process, leading to doubts about the technology's effectiveness in delivering the anticipated benefits. Additionally, more than 48% expressed uncertainty and doubts, reflecting a growing sense of caution and scepticism regarding the ability to achieve the expected outcomes. Only around 19% of respondents maintained a hopeful perspective. This shift in perceptions highlights the dynamic nature of stakeholders' attitudes towards Blockchain technology. It underscores the importance of actively managing and addressing challenges to maintain stakeholders' confidence and commitment as projects progress.

The responses collected from the interviewees in the case study are in line with survey findings, which reveal a significant shift in their perceptions over four years since the initiation of Blockchain technology. These changes in outlook are encapsulated in the following statements: The representative from the Oil Producer sector expressed a tempered outlook, stating, "Not so optimistic, after four years until now, we didn't go live." This sentiment of uncertainty and diminished optimism was similarly reflected by the spokesperson from The Refinery, who conveyed, "Well, not quite sure since we didn't realise the expected values, not sure this may need more time to get the issues resolved."

Further emphasising this shift in perspective, the representative from the pipeline sector shared their doubts based on their project experiences: "Based on the current project experiences, I doubt that getting the benefit of this project soon." This prevailing sense of scepticism and uncertainty was also articulated by the representative from the Terminal, who remarked, "Not sure and merely not so optimistic of near solution."

These statements collectively illustrate a stark contrast between the initial optimism and the subsequent reassessment of the Blockchain's potential benefits and effectiveness after four years of implementation. The evolving perspectives highlight the complexities and challenges encountered in realising the anticipated advantages of Blockchain technology within their respective sectors. Other studies highlighted perceptions as the primary construct for adopting emerging ICT technology. In contrast, perceptions provide a valuable starting point for ICT adoption decisions (Davis, 1989), but they should not be the sole determinant (Venkatesh & Davis, 2000). Depending solely on perceptions can be misleading and result in failures that could have been avoided (Straub et al., 2004). Perceptions often represent a preliminary gauge of technology's potential benefits and drawbacks. Still, they are inherently subjective and can be influenced by biases, such as resistance to change or anecdotal evidence (Davis, 1989). Therefore, it is crucial to recognise that a more comprehensive assessment is needed to navigate the complexities of ICT adoption (DeLone & McLean, 2004). Neglecting any of these critical dimensions can lead to costly setbacks and missed opportunities for growth and innovation (Henderson & Venkatraman, 1993). Therefore, it is prudent to adopt a holistic approach that goes beyond perceptions and considers the multifaceted nature of ICT adoption, thereby enhancing the likelihood of informed decision-making and successful implementation (Davis, 1989; Venkatesh & Davis, 2000).

Predictions: Diverse Approaches to Blockchain Projects: Stakeholders were asked to provide predictions regarding their organisations' approach to Blockchain initiatives, revealing a diverse range of expectations. Approximately 24% of respondents indicated that their companies would cease investing in Blockchain projects, perceiving a lack of feasible value addition in the near future. This outcome suggests that a subset of organisations may be disillusioned with the technology's ability to deliver the anticipated benefits. This decision to discontinue investments may stem from a realisation that Blockchain may not align with their business objectives or a belief that the technology is not the right fit for their organisations.

On the other hand, 46% of respondents expressed their intention to maintain a semi-active approach to the projects, aiming to minimise investment while actively seeking solutions to address uncertainties and challenges. This response indicates a cautious approach, emphasising the need for further exploration and resolution of the issues hindering value realisation. These organisations recognise the potential of Blockchain but are unwilling to make significant commitments until crucial challenges are addressed.

Furthermore, over 29% of respondents expressed confidence in Blockchain's potential and affirmed their commitment to continued heavy investment, emphasising their belief that Value will be realised in the near future. These organisations are willing to weather the challenges and uncertainties associated with Blockchain projects, viewing them as a long-term strategic investment.

Expected Timeframes for Value Realisation: Diverse Perspectives Another significant aspect explored in the analysis is the expected timeframe for realising the Value of Blockchain. The findings indicate a range of predictions, providing insights into stakeholders' varying perspectives on the pace of value realisation. Approximately 16% of respondents predicted value realisation within the first year. This subset of respondents likely possesses an elevated level of optimism and expects quick returns on their Blockchain investments. They anticipate that the technology will swiftly deliver the anticipated benefits. Around 22% predicted value realisation between the third and sixth years, suggesting a more extended timeframe for realising the expected benefits. These organisations are prepared for a more patient approach to value realisation and acknowledge that the transformation brought about by Blockchain may take time to materialise fully. Notably, about 8% of respondents expressed a pessimistic viewpoint, predicting that Blockchain value would not be realised at all. These organisations may have encountered significant challenges or have reservations about the technology's applicability to their specific industry or context.

Breakeven Periods: Managing Financial Expectations: The analysis also delves into the breakeven period for Blockchain projects as an investment. The data suggests that the average timeframe for covering the initial investment is around six years. This average is derived from a distribution of responses, with the most common selection being seven years, chosen by approximately 38% of respondents. This outcome indicates that a sizeable portion of stakeholders expects a relatively prolonged period before achieving breakeven, emphasising the perceived investment required for successful Blockchain implementation.

Additionally, 16% of respondents predicted a breakeven period of six years, while 11% anticipated a breakeven within four years. It is important to note that 8% of respondents were uncertain about the required timeframe, indicating the complexity and uncertainty surrounding the financial aspects of Blockchain projects. The diverse range of breakeven period predictions highlights the variability in financial expectations among stakeholders. It underscores the need for organisations to carefully manage their financial planning and communicate realistic timelines to stakeholders.

The predictions and recommendations of the interviewees in this study demonstrated a considerable degree of consistency, aligning to a significant extent with the responses gathered from an online survey. The consensus among them suggested that several years might be necessary for the maturation of the project, though there was no precise agreement on the duration. Furthermore, they advocated for a temporary suspension of the Blockchain project until all prevailing issues are adequately resolved. A Customer Representative highlighted the developing nature of the technology, stating, "Emerging technology, I think it may require more years until it gets matured, and most importantly is the agreement about the shared values among the stakeholders." They further recommended, "As of now, it is not clear, but I think it still requires a couple of years to sort out all issues. And maybe keep this project on hold and learn more about it." In a similar vein, the representative from the Oil Terminal expressed uncertainty, coupled with a hopeful outlook: "We are not sure yet, but hopefully more time and more clear and fair agreement/objectives, along with the maturity of the technology and legality of the whole process." Addressing the recommendation aspect, they proposed, "Maybe we need a temporary break for this project, and we focus on getting more technical information about Blockchain and attending conferences to see what is happening with other firms and how they manage to get real Value from this technology. Wait until the legal part is completely formed."

Rate of Value Realisation: Assessing Different Aspects: The analysis delves into the predicted rate of value realisation for various aspects of Blockchain technology. Respondents were asked to rate the extent to which they believed Value could be achieved on a scale of zero to ten. Time savings emerged as the aspect with the highest anticipated realisable Value, with approximately 44% of respondents selecting a relatively high rating. This result suggests that stakeholders perceive Blockchain technology as capable of significantly enhancing operational efficiency and reducing time-related inefficiencies. They anticipate that Blockchain will revolutionise the way they conduct business processes, streamlining operations and saving valuable time. Security value was also considered feasible, with 36% of respondents expressing confidence in achieving this aspect of Blockchain's suggested Value. In an era of increasing cybersecurity threats, organisations recognise the potential of Blockchain to bolster security measures and protect sensitive data.

Approximately 30% of respondents believed that cost savings could be realised, further highlighting the perceived potential of Blockchain technology to optimise financial processes. By reducing the need for intermediaries and automating trust, Blockchain has the potential to drive cost efficiencies across various industries.

Transparency was another aspect identified as potentially achievable, with 33% of respondents assigning a relatively high rating. Blockchain's transparent and tamper-resistant nature appeals to organisations seeking to enhance trust and transparency in their operations, especially in the supply chain and financial sectors. However, it should be noted that the analysis lacks information regarding the predicted rate of value realisation for the aspect of new business opportunities, which limits a comprehensive understanding of stakeholders' expectations in this regard. Future research and surveys may provide valuable insights into this critical aspect of Blockchain's potential Value.

Although the experts voice in our study findings shares their rough perdition, the predations remain challenging exercise, and the outcome is not granted. Predicting the achievement of Value in the ever-evolving domain of Information and Communication Technology (ICT) is a challenging task due to the dynamic nature of the technology landscape (Rogers, 2003; West & Mace, 2010). ICT, marked by its frequent innovations, makes it difficult to accurately foretell which technologies will emerge as game-changers and which will become outdated (Brynjolfsson & McAfee, 2014). Additionally, market conditions, consumer preferences, and regulatory environments are highly uncertain, amplifying the complexity of anticipating the demand and success of ICT solutions (Chen et al., 2014; Brynjolfsson & McAfee, 2014). In light of these prediction complexities, the concept of "Time to Value" assumes pivotal significance

(Goldratt, 1997). Time to Value represents the duration required for organisations to tangibly realise the benefits of their investments in ICT (Chen et al., 2014; West & Mace, 2010). This concept provides a practical approach to mitigating the uncertainties associated with predicting value realisation. By shortening the time needed to obtain Value from ICT projects, organisations not only expedite their return on investment but also effectively manage the risks linked to prolonged technology adoption (Goldratt, 1997; Rogers, 2003). This concept acknowledges the inherent unpredictability in forecasting ICT value realisation and underscores the urgent need for prompt implementation and optimisation of technology solutions to maximise their impact (Chen et al., 2014).

4.5 Analysis Recapitulation

In summary, the analysis of perceptions and predictions related to Blockchain projects offers valuable insights into stakeholders' evolving attitudes towards the technology. The findings illustrate a shift from initial optimism to growing uncertainty and, in some cases, even pessimism as projects progress. However, a considerable number of respondents remain hopeful and believe in Blockchain's future value. The predictions regarding the timeframe for value realisation, the breakeven period, and the rate of value realisation highlight the varying perspectives and expectations among stakeholders. These findings provide a deeper understanding of the challenges, opportunities, and dynamics associated with the adoption and implementation of Blockchain technology in different organisational contexts.

As organisations navigate the complexities of Blockchain projects, it is crucial to address challenges, manage financial expectations, and cultivate an environment of collaboration and innovation. By doing so, they can unlock Blockchain's true potential and drive positive transformations within their industries.

The table below systematically organises the research findings into distinct thematic groups, identifying the main themes within each group. This structure simplifies and enhances the analysis by clearly delineating the critical areas of focus and their interconnections.

Theme Groups	**Theme**	**description/scope**	**Response Summary**
Project Objectives, priority, and statues	*Stakeholders Objectives& Priorities*	The values that stakeholders are looking for as an outcome of Blockchain implementation The priories of Blockchain values based on firms' interests and objectives	Timesaving was selected as the first main objective by all 37 responses. Around 95% of responses from 35 individual Project managers selected cost saving as one of the main objectives, followed by Transparency as an objective value selected by 19 individual responses, representing around 56% of answers, and finally, Business opportunity and security with around 19% and 11% respectively. Although they have almost a collective agreement on time and cost savings, It is evident that there is a lack of alignment regarding the importance of values such as Transparency, security, and new business opportunities.
	Projects during	Numbers of years/months of the blockchain project since it got started until the interview time	The majority of respondents' businesses, constituting the highest set, adopted the Blockchain project around four years ago. This early adoption is a promising sign for the future of Blockchain projects. In comparison, the second largest set of 30.56% of the interviewee's firms implemented the project around three years ago.

			Furthermore, around 19.44% of respondents had deployed the Blockchain project approximately five years ago.
	Project schedule status	To find out whether the project implementation is within/out of the planned timeline of execution	Around 70% of projects are significantly behind schedule, which is a strong indication of a common issue(s) with Blockchain initiatives. Moreover, 27% of projects were somewhat behind schedule, with only one solid time, with a response of 2.7% indicating that the project was on time.
	Project budget status	To find out whether the project implementation is within the planned budget	Around 51% of projects were severely over budget, 35% somewhat exceeded the budget, and around 14% with five answers were within budget.
	Project Value Realisation Outcome	To Find out whether firms managed to realise the desired values or not; if yes, then to find out the rate of realisation of Blockchain values	Overall, most of the responses, with a round of 89% of responses, show that the projects did not realise any value at all, and the remaining responses, on average, manage a neglectable value at the lowest level, mainly in levels 1 and 2.
Factors Impact the Blockchain Value Realisations	*Technical factors*	To find out the rate of impact for each technical factor	The overall influence of technical factors was insignificant; the average technical complexity of the Blockchain chain is around 2.24 out of 10. The maximum factor in this set was for technology maturity, with a 5.19 level of scale out of 10, and the lowest was for infrastructure readiness, with a 2.03 level of scale out of 10. For security and privacy, the response average was 3.16, which is the second factor in this set.
	Organisational factors	To find out the rate of impact for each organisational factor	The highest factor, recorded at 7.3 as the level of scale of impact, was for the factor named "High level of doubts and uncertainty of Blockchain technology". The second factor was for Trust in Blockchain technology, with 5.3 out of 10; the competition in industry recorded 2.46 out of 10, which is considered low, and other factors were very low with no significant impact. Organisational culture and IT team were 1.7 and 1.65, respectively, out of 10, and other factors were lower than one and would be negligible factors.
	Social factors	To find out the rate of impact for each social factor	The absence of the regulations and policy availability factor rerecorded. Forty-nine out of scaleten0 as the highest factor impacts the Blockchain projects and value realisation, then the stakeholder's cooperation as the second factor with 7.19 scale level out of 10,

			lastly. The technology enabler role, with no 2.94 out of 10, is the lowest factor in this set that impairs the implementation of the Blockchain project. It is around 60% on average.
Perceptions and Predictions	*Initial value perceptions prior to implementation*	Aim to find out the perception of Blockchain values from each firm representative before starting the Blockchain project implementation	More than 75% of respondents were hopeful that deploying Blockchain technology would significantly value their businesses, while just 24% were unsure, and none were pessimistic.
	value perceptions after/during the implementation	Aim to find out the perception of Blockchain values from each firm representative after or during the Blockchain project implementation	The perception after a few years of Blockchain project implementation was dramatically different from the perception at the start of the implementation. While more than 32% are pessimistic, more than 48% are not sure and have doubts about the ability to realise business values through Blockchain implementations. Just around 19% are hopeful and still optimistic.
	Value realisation prediction	Aim to collect input from the experts as regards the overall prediction of Blockchain and their recommendations	Most of the answers show that the O&G firms will not be able to realise Blockchain values in the near future, and they recommend holding projects until the significant issues are sorted out.
	Years required to value realisation	Aim to find out more input from the experts regarding the required number of years to start realising the values and reaching the breakeven	Number of years required to cover the initial investment as a return on investment ROI metric. The average of the years across all answers was six years, with 14 replies. Around 38% of respondents selected seven years, 16% selected six years, 11% selected four years, and % selected not sure about the needed number of years to cover the investment.
	Most realizable values	To find out the most optional values of Blockchain that mostly likely are realizable	Realisable value relates to time savings of around 44% when compared to the suggested value of Blockchain technology. 36% of the security value can be accomplished, 3per content of the cost savings can be obtained, and 3% of the transparency can be achieved of its original suggested value. Blockchain's ability to provide a new business opportunity can be increased by 20% when compared to the original proposal.

Table 4.1 Analysis Recapitulation

4.6 *Chapter Conclusion*

This chapter has outlined the findings from the stakeholder interviews and surveys, providing valuable insights into the status, objectives, and perceived outcomes of Blockchain projects in the oil and gas sector. The results indicate a broad consensus on the potential benefits of Blockchain, such as time and cost savings, transparency, and enhanced security. However, the misalignment of stakeholder priorities, coupled with technical, social, and regulatory challenges, has significantly hindered value realisation. The shift in stakeholder perceptions from initial optimism to growing uncertainty highlights the need for a more collaborative approach and explicit regulatory frameworks to support Blockchain adoption. The identified factors impacting Blockchain value realisation underscore the importance of addressing doubts, enhancing cooperation among stakeholders, and ensuring the technological maturity of solutions. The predictions suggest a cautious path forward, with many stakeholders advocating for a temporary pause to refine strategies and better understand the technology's implications. This chapter provides a critical foundation for understanding the complex dynamics of Blockchain implementation. It sets the stage for further research into overcoming the identified barriers to unlock its full potential in the industry.

5. DISCUSSION CHAPTER

5.1. Chapter Introduction

This chapter presents a comprehensive discussion of the data obtained from interviews and surveys conducted as part of the study. Its primary aim is to summarise the collected data and interpret the findings cohesively and thematically. In addition, it explores the theoretical implications of these findings in relation to ICT adoption theories and existing literature. The chapter also examines the business implications of Blockchain technology for Oil and Gas firms, focusing specifically on their business operations and practices. Furthermore, it addresses the study's limitations and provides suggestions for future research. The key objective of this chapter is to engage in a theoretical discussion on the implementation of Blockchain technology within enterprises, addressing the research questions concerning perceptions and value realisation associated with Blockchain. It also seeks to identify the key factors influencing the extent of value realisation and to make predictions for the future. The overarching goal of this chapter is to offer new insights and recommendations to assist organisations in making well-informed decisions regarding Blockchain implementation. By analysing the research questions and examining the data collected through interviews and surveys, the chapter provides a thorough understanding of the perceptions and realisations of value linked to Blockchain. Additionally, it aims to identify the crucial factors influencing the level of value realisation.

The chapter makes theoretical contributions by exploring the implications of the research findings on ICT adoption theories and existing literature. By connecting the empirical findings to relevant theoretical frameworks, it seeks to advance the understanding of ICT adoption in the context of Blockchain technology. Moreover, the chapter examines the practical implications of the research findings for Oil and Gas firms. It analyses the impact of Blockchain technology on various aspects of business operations and practices within the industry. This analysis provides valuable insights to guide organisations in the Oil and Gas sector when considering the adoption of Blockchain technology. Finally, the chapter critically evaluates the study's limitations. It acknowledges the constraints and boundaries of the research methodology and data collection process, thereby enhancing the study's rigour and transparency. In addition, it offers suggestions for future research, aiming to address the identified limitations and explore new avenues for investigation.

5.2. Findings summary and interpretations

This study gathered information on Blockchain implementation projects from their inception. Initially, it examined the objectives of firms within the oil and gas industry regarding the use of Blockchain technology. The aim was to track each project from its beginning and assess the consistency and prioritisation of objectives among various stakeholders. The results provide valuable insights into multiple aspects of Blockchain implementation, including stakeholders' motivations, objectives, perceptions, challenges, and future outlooks. This extended analysis seeks to enhance academic discussion by offering additional details and deeper insights into the findings.

Motivations and Objectives of Firms:

The study identifies time savings, cost savings, and transparency as the primary priorities for firms engaged in Blockchain projects within the oil and gas sector. These objectives reflect broader industry trends towards increased efficiency and cost reduction. By prioritising time savings, firms demonstrate their recognition of the importance of streamlining processes to optimise operations and improve productivity. The emphasis on cost savings highlights the industry's competitive nature and the continuous drive to maximise profitability. Additionally, the prioritisation of transparency signifies the growing demand for accountability and trust-building measures among stakeholders in this complex and highly regulated environment. Interview responses further reveal variations in objectives and expected values influenced by the interests of individual stakeholders. These differences can impact the level of cooperation among stakeholders and the overall success of Blockchain project implementation.

Interestingly, fewer respondents identified business opportunities and security as priorities for their Blockchain projects. These responses suggest that these factors may be perceived as less critical or relevant within the specific context of the oil and gas industry. However, objectives varied among stakeholders depending on their interests. This outcome highlights the need for clear communication and collaboration among all parties involved in Blockchain projects to ensure alignment and effective implementation. The findings emphasise the importance of comprehensively understanding the diverse perspectives and priorities of stakeholders, including oil and gas companies, technology providers, regulators, and other industry participants. Furthermore, the study indicates that firms primarily focus on increasing efficiency and reducing costs, which are critical goals within the industry. This focus underscores the potential for Blockchain technology to significantly shape the future of the oil and gas sector by streamlining processes, enhancing operational efficiency, and increasing transparency. The insights from this study can guide future strategies and decision-making processes related to Blockchain technology implementation in the industry, instilling a sense of hope and optimism about the transformative potential of Blockchain in the oil and gas sector. However, the study also reveals challenges faced by Blockchain projects in the oil and gas industry. Many projects failed to go live or realise their expected value, with budget overruns and schedule delays being common. A substantial number of projects experienced more frequent schedule delays than budget overruns, indicating possible mismanagement or execution issues requiring immediate attention. These findings underscore the importance of effective project management, stringent budget control, and proper resource allocation to ensure successful implementation and value realisation. Addressing these challenges is crucial to maximising the potential benefits of Blockchain technology in the oil and gas industry.

Perceptions of Blockchain Technology:

Respondents in the study expressed optimistic perceptions of the potential value that Blockchain technology could bring to their firms in the oil and gas industry. This optimism reflects a positive view of Blockchain's capabilities to generate value for the sector. Participants' perceptions align with the general understanding of Blockchain technology, which is recognised for providing security, transparency, trust, efficiency, time savings, and cost savings through the secure and transparent recording of transactions and data. Participants' positive views of Blockchain's potential value are consistent with the broader recognition of its ability to deliver significant benefits across various industries. The study's findings further support the view that Blockchain technology can revolutionise business operations, enhance trust, and optimise processes within the oil and gas sector. These findings contribute to the growing body of literature emphasising Blockchain's transformative potential and its applications across different sectors. However, the study also reports a notable shift in perception after several years of Blockchain implementation. Most respondents expressed uncertainty or pessimism about the outcomes of their Blockchain projects. This shift suggests that the projects may not have met initial expectations or that the actual benefits differed from anticipated outcomes. This result underscores the importance of continuously evaluating and reassessing Blockchain projects to ensure they align with expected goals and objectives.

Barriers to Value Realisation:

The study identified and classified barriers to implementation based on their impact on Blockchain adoption within the oil and gas industry. These barriers span social, organisational, industrial, and technical factors, all of which influence the successful realisation of Blockchain's value. From a social perspective, stakeholder cooperation, regulations, and policies emerge as crucial factors affecting Blockchain adoption. The oil and gas industry involves a wide range of stakeholders, including government entities, industry associations, oil companies, suppliers, and customers. Achieving consensus and cooperation among these diverse stakeholders can be challenging, especially when introducing innovative technologies such as Blockchain. Additionally, regulatory frameworks and policies must be developed and aligned to facilitate Blockchain adoption while ensuring compliance and protecting the interests of all parties involved.

Trust in technology also represents a significant barrier. As Blockchain technology continues to evolve, firms may be hesitant to adopt it due to concerns over its reliability. Building trust requires technological advancements and efforts in education, awareness, and demonstrating successful use cases within the industry. Addressing these trust barriers demands continuous effort to showcase the benefits and reliability of Blockchain technology in the oil and gas sector. From a technical perspective, issues such as technology maturity, security, and privacy play critical roles in Blockchain adoption. As Blockchain is still in the initial stages of development, its maturity may not yet be sufficient for widespread adoption. Industry players must carefully evaluate the readiness of the technology and the associated risks before deciding to implement Blockchain solutions. Additionally, concerns surrounding the security and privacy of sensitive data on Blockchain platforms present challenges that must be thoroughly addressed to ensure the protection of critical information.

Outlook and Predictions:

The study's predictive findings suggest that respondents believe it may take several more years to realise the total value of Blockchain technology. However, they express optimism that their firms will begin to realise this value within the next four years. This optimism may stem from respondents' limited experiences, and counterarguments can be presented as follows: firstly, respondents' firms may possess a more advanced understanding and implementation of Blockchain technology compared to other industries, which could accelerate value realisation as they overcome initial challenges and progress further along the learning curve. Secondly, these firms may target specific Blockchain use cases that offer a shorter path to value realisation. By focusing on areas where Blockchain can provide immediate benefits, firms may achieve quicker returns. Nonetheless, it is essential to approach these predictions cautiously. While respondents' optimism is encouraging, the actual timeline for realising Blockchain's value may vary depending on several factors, including technology maturity, the level of adoption within the industry, the effectiveness of implementation strategies, and the complexity of the use cases pursued. Therefore, ongoing evaluation and adaptation are necessary to align expectations with the reality of Blockchain implementation.

Overall, this study provides new insights into the motivations, perceptions, barriers to value realisation, and future implications of Blockchain projects in the oil and gas industry. The results underscore the importance of aligning stakeholders' objectives, addressing implementation challenges, and fostering collaboration to unlock the full potential of Blockchain technology. By overcoming barriers and leveraging Blockchain's capabilities, the oil and gas industry can streamline processes, increase transparency, and achieve significant cost savings. However, realising these benefits requires a comprehensive understanding of the technology, effective project management, and continuous evaluation to ensure successful Blockchain integration and adoption within the industry.

5.3. Theoretical and literature implications discussion

This section of the research aims to critically analyse the research findings in relation to pertinent theories and literature on the adoption and implementation of Information and Communication Technology (ICT). Specifically, it will focus on examining the perceptions, factors, weights, predictions, and value realisation associated with ICT adoption. The primary objective of this section is to explore how the research findings can contribute to existing knowledge and bridge any gaps in the understanding of ICT adoption and implementation. It will consider how the findings align with and expand upon current theories and literature. Moreover, it will delve into the process of perceptions development and its impact on the expected values and value realisation of new technology implementation within organisations.

Additionally, this section will investigate the nature and characteristics of technology in relation to individual and collective utilisation. It will analyse how these factors may influence the realisation of value for various stakeholders. By examining the interplay between technology and its users, this section seeks to uncover insights into how organisations can maximise the value derived from ICT adoption. Furthermore, the section will discuss the practical implications of the research findings for business organisations and decision-makers. It will provide recommendations for best practices in the adoption and implementation of emerging ICT technologies. These recommendations aim to guide organisations in making informed decisions and optimising the benefits of integrating innovative technologies into their operations.

Moreover, this section will offer predictions for future developments in the field of emerging ICT technologies, forecasting potential advances that aim to assist organisations in preparing for and adapting to the evolving technological landscape. These predictions will enable organisations to proactively navigate challenges and seize opportunities associated with emerging ICT technologies.

5.3.1. Blockchain Value realisation literature argument (Real/Hype)

The findings of this study pertaining to the value realisation outcomes of Blockchain projects within our study exhibit a degree of alignment with several published reports and statistical data. These sources collectively underscore the prevalence of significant challenges and shortcomings in numerous Blockchain initiatives across diverse business sectors. For instance, a Deloitte report from 2020 starkly asserts that "the overwhelming majority of Blockchain projects encounter abandonment or failure," highlighting a striking statistic where out of the 26,000 Blockchains initiated in 2019, a mere 8% have sustained operations, while the remaining 92% have either been shuttered or abandoned, failing to yield meaningful value. Moreover, additional reports and statistical analyses elucidate the grim reality that a substantial proportion, ranging from 95% to 98% of B2B Blockchain projects, have met with resounding failure. These failures encompass not only projects that faltered post-implementation but also those that failed to progress beyond the initial stages of development, succumbing during the implementation lifecycle. One report poignantly reflects on this phenomenon, stating, "There were promises made that were better left unspoken. The primary challenge with Blockchain technology lay in the impulsive rush to increase an array of use cases as if migrating every facet of an organisation's operations to a Blockchain network was a prudent course of action. This outcome transpired at a juncture when the technology was still in its nascent stages.

Furthermore, many IT departments and start-up ventures prematurely market solutions without conducting pertinent pilot studies, thereby fostering unrealistic expectations that ultimately lead to d the inability to deliver on promises. Another report issued by (SettleMint, 2020) mentioned that failure rates of firms involved in Blockchain projects are estimated as high as 86%1 and commented on a Gartner report about Blockchain prediction that Blockchain would produce $3.1 trillion in new business value by 2030 may now seem outlandish. They should not. Years ago, cutives remained unconvinced as to whether Blockchain technology would actually work at all." (Roderik Veer, 2020) "Blockchain is currently sliding down toward the Trough of Disillusionment in Gartner's latest 'Hype Cycle for Emerging Technologies,'" said Adrian Leow, senior research director at Gartner...

There is a significant disparity between the excitement surrounding Blockchain and its actual adoption in the market. According to the 2019 CIO Agenda Survey by Gartner, Inc., only 11% of CIOs have either implemented or are in the short-term planning stages for Blockchain integration. This low adoption rate may be attributed to the fact that most Blockchain projects fail to progress beyond the initial experimentation phase. This outcome suggests that Blockchain may be more of a hyped emerging technology and may not deliver the anticipated value to businesses as heavily marketed. Another essential aspect to consider when evaluating the hype around Blockchain is the question of scalability. Blockchain technology is still in its initial stages of development, and many of the existing solutions suffer from a lack of scalability. This issue is particularly true for public Blockchain networks like Bitcoin and Ethereum, which can only process a limited number of transactions per second (TPS). For example, the current TPS of the Bitcoin network is around 7 TPS, while the Ethereum network can process around 20 TPS (Buterin, 2014; Nakamoto, 2008). In summary, the study supports the argument in the Blockchain value realisation literature that the actual value of Blockchain for business enterprises is yet to be realised for most proje

5.3.2.TAM theory, limitation, and study findings

The Technology Acceptance Model (TAM) is a widely used theoretical framework. It aims to explain how and why individuals adopt and use the latest information technologies by considering the perceived usefulness and perceived ease of use of the technology as the critical determinants of technology acceptance. The "perceptions construct" is a crucial component of the TAM theory, which has been widely used to study the adoption and diffusion of information and communication technologies (ICTs). This construct focuses on the individual and organisational perceptions of the benefits and limitations of innovative technology and how these perceptions influence the decision-making process. A study by Venkatesh and Davis (2000) titled "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies" is one of the most cited references that highlight the importance of the "perceptions construct" in the TAM theory. The study of (Venkatesh and Davis, 2000) and (Venkatesh et al. 2003) found that perceived usefulness, perceived ease of use, and perceived compatibility were the most crucial factors that influenced the intention to use modern technology. So, this study's summary of the TAM theory focuses on the "perceptions construct" as the leading construct to help decision-makers adapt to emerging information and communication technologies (ICTs), which is in line with previous studies on the topic.

The TAM theory focuses on individual and organisational perceptions of the benefits and limitations of modern technology and how these perceptions influence the decision-making process. A study by Li, Wang, and Chen (2019) found that the TAM theory is limited in its ability to predict the adoption of innovative technologies in situations where the technology is complex and multiple stakeholders influence the decision-making process. The study proposed an extended version of the TAM theory that includes collective perceptions and social influences better to predict the adoption of modern technologies in these situations. Another study by Peng, Lin, and Liang (2020) also supports these findings and suggests that incorporating collective perceptions and social influences can improve the predictive power of technology adoption models. In summary, the study highlights that the TAM3 theory's focus on perceptions as the primary indicator of technology acceptance can be helpful for understanding individual users' acceptance of technology. However, this study also notes that the theory does not account for collective perceptions in systems involving multiple stakeholders, which is a significant limitation of the TAM3 theory when applied to inter-organisational systems.

The term "perception" refers to an individual's subjective evaluation or interpretation of a particular technology, such as Blockchain. These perceptions are based on an individual's beliefs about the technology's utility and how easily they can use it and play a significant role in driving technology adoption and usage. This study found that using the "perceptions construct" as the primary indicator of technology acceptance, as proposed by the TAM, may not be sufficient for avoiding project failures. The study by Lee, Kozar, and Larsen (2003), entitled "The Technology Acceptance Model: Past, Present, and Future," supports the idea that the TAM's focus on the "perception construct" may not be sufficient to fully capture the factors that contribute to the success or failure of a technology project. The study of Lee, Kozar, and Larsen (2003) presents a meta-analysis of the Technology Acceptance Model (TAM) and its extensions, concluding that the model has been widely used in the IS field and is a valuable tool in understanding user acceptance of technology. However, the study also found that the model has some limitations, particularly when it comes to explaining user behaviour. Factors such as social influence, facilitating conditions, and behavioural intention are found to be important to consider in addition to the perception construct.

Implication 1: The study found that perceptions may change over time, especially during the long period of a project's implementation. This change over time implies that initial perceptions of a technology may not accurately predict its eventual acceptance or usage. A recent study that supports the idea that perceptions can change over time and may not accurately predict a technology's eventual acceptance or usage is "A longitudinal study of factors influencing the acceptance and use of an enterprise system: The case of a large-scale ERP implementation" by Wu, Wang, and Wang (2019), examines the acceptance and use of an enterprise resource planning (ERP) system in a large manufacturing company over several years. The study found that initial perceptions of the ERP system were not highly correlated with its eventual acceptance and usage and that factors such as the availability of training, the quality of system documentation, and the level of support provided by the IT department had a more significant impact on acceptance and usage over time. The study highlights that perceptions can change over time during the lengthy period of a project's implementation, which means that the initial perceptions of a technology may not accurately predict its eventual acceptance or usage.

The study findings are in line with the study of (Tahar et al., 2020), "Perceived Ease of Use, Perceived Usefulness, Perceived Security, and Intention to Use E-Filing: The Role of Technology Readiness," which found that initial perceptions of a technology's usefulness and ease of use can change over time, especially during the extended period of a project's implementation. This change over time means that the initial perceptions of technology may not accurately predict its eventual acceptance or usage, and it is important to take into account the dynamic nature of users' perceptions and consider other factors that may influence the acceptance and usage of technology over time. This study supports the idea that technology acceptance models (TAMs) such as TAM3 that are based on initial perceptions may not accurately predict the eventual acceptance or usage of technology, especially during a long-term implementation of the technology. The study found that it is essential to take into account the dynamic nature of users' perceptions and also to consider other factors, such as security perceptions, that may influence the acceptance and usage of technology over time.

Implication 2: This study highlights that the TAM3 theory's focus on individual perceptions may not be sufficient for systems that have multiple stakeholders. Collective perceptions should also be considered to ensure alignment of expected values and ensure that the technology is adopted and used effectively by all stakeholders. A study by (Venkatesh et al., 2003) found that the collective perceptions of management and IS professionals were more important than individual perceptions in determining the acceptance and use of enterprise resource planning systems. Another study by Liang and Huang (2009) found that collective perceptions of e-commerce system quality were a stronger predictor of user acceptance than individual perceptions. These studies suggest that considering the collective perceptions of multiple stakeholders is important for understanding and predicting technology acceptance in systems with multiple stakeholders.

Further, and as another consideration of changes over time-based on stakeholders' resource availability and management directions, the study implicitly found that collective perceptions can be more subject to the changes over time, especially in systems with multiple stakeholders. Decision makers may have considered the perceptions of the organisation as a whole when making decisions about technology adoption. However, as the project progresses, the perceptions of individual users within the organisation may diverge from the collective perceptions, leading to a lack of acceptance and usage. A study by Gao and Li (2021) found that collective perceptions, including collective trust, collective risk, and collective efficacy, play a significant role in the acceptance of Blockchain technology. The study also suggests that while individual perceptions are important, they do not fully capture the complexity of the acceptance process in multi-stakeholder systems such as Blockchain. The study argues that considering collective perceptions is important for the adoption and use of Blockchain technology, especially in inter-organisational systems. Another study by Wu et al. (2022) also affirms the notion that collective perceptions are subject to change over time. The study emphasises the significance of comprehending the dynamic nature of collective perceptions and conducting regular evaluations to ensure the successful adoption of Blockchain technology. The collective perceptions underscore the importance of consistently assessing collective perceptions for the successful adoption of Blockchain technology. Therefore, considering both collective and individual perceptions can enhance the insights provided by the TAM3 theory, particularly for systems involving multiple stakeholders. By comprehending the evolving perceptions and considering the perspectives of all stakeholders, decision-makers can make well-informed choices about technology adoption and implementation. This consideration can result in a better alignment of the technology with the organisation's objectives and the needs of individual users, thereby enhancing the likelihood of success in technology adoption and implementation endeavours.

5.3.3. TOE Theory limitations and the findings related to factors that impact adoption

The Technology-Organisation-Environment (TOE) framework (Tornatzk, Fleischer 1990) refers to a theoretical model that considers the interplay of technology, organisation, and environmental factors in the adoption and implementation of ICTs. The TOE framework provides a more holistic understanding of the factors that may influence the adoption of emerging ICTs. It emphasises the significance of considering the interaction of technology, organisation, and external environment. The TOE framework highlights the importance of considering the interplay between the technology, the organisation, and the external environment in predicting the adoption of emerging ICTs. Another study by Lin, Wang, and Liang (2018) found that the TOE framework can help organisations identify the key factors that influence the adoption of emerging ICTs in different industries. The study found that the TOE framework provides a more comprehensive understanding of the factors that influence the adoption of emerging ICTs, including the impact of organisational culture, technology readiness, and industry characteristics. A study by Chen, Liang, and Xie (2017) found that the TOE framework is helpful in understanding the adoption of cloud computing. The technology element, which includes the characteristics and features of the technology, is essential to consider but not sufficient to ensure the success of technology adoption. The organisational element, including factors such as organisational culture, structure, and strategy, and the environmental element, including external factors such as government policies, economic conditions, and societal norms, are also essential to be considered. A study by Zhang and Wu (2022) found that the TOE framework is helpful in predicting the adoption of Industry 4.0 technologies. Another study by Gao and Li (2021) found that the TOE framework is helpful in understanding the adoption of the Internet of Things (IoT) in manufacturing. So, the success of technology adoption depends on a combination of technology, organisation, and environmental factors. The TOE framework provides a valuable lens through which to analyse and understand these factors. The findings of this study, along with other studies, demonstrate the applicability of the TOE framework in predicting and understanding technology adoption in various industries. Decision-makers need to consider all three elements of the TOE framework when implementing new technologies to ensure the success of the adoption process.

Despite the prodigious values and contributions of TOE theory within ICT adoptions, like other theories, there will always be some limitations that other studies can extend or fill gaps; one of the limitations that this study found is that the TOE framework does not give weight to the significance of these factors that impact the, which can make it difficult for organisations to identify which factors are most important and need to be addressed to improve the chances of success for technology adoption this finding is supported by A recent study by Riedl, Krcmar, and Buxmann (2020) found that organisations should conduct their assessments of the factors that are most important to their specific context, pay attention to the significant factors, and deal with them ahead of time to increase the chances of success for technology adoption and implementation projects. By understanding the unique factors that are most important to their organisation, decision-makers can make more informed decisions about technology adoption and implementation, leading to a better alignment of the technology with the organisation's goals and objectives, as well as the needs of individual users. Additionally, a study by Duan, Wang, and Liang (2020) also supports this point that current frameworks for technology adoption, such as the TAM and DOI, do not fully capture the influence of various factors, such as social influence and perceived risk, which can make it difficult for organisations to identify which factors are most important and need to be addressed to improve the chances of success for technology adoption.

This study provided weight for every single factor and group of factors that impact Blockchain project implementations by surveying a large sample of participants who have experience implementing Blockchain projects. This approach is widely used to collect data from a sample of individuals and is particularly useful when a researcher wants to investigate the opinions, attitudes, or behaviours of a large group of people (Krosnick, 1991; Sudman, Bradburn, & Schwarz, 1996).

This study found that social factors such as stakeholder cooperation, regulations, and policies, organisational and industrial factors like elevated levels of doubt and uncertainty about the technology and trust in technology, and technical factors such as technology maturity, security, and privacy had a significant negative impact on the success of Blockchain project implementations. The study also found that technical challenges had a less significant impact on the success of Blockchain project implementations. This outcome shows that while technical challenges are important to consider, they may not be as critical to the success of Blockchain project implementations as social, organisational, and industrial factors. A study by Khan, Ali, and Ahmed (2021) found that organisations that have a clear understanding of Blockchain technology and its potential uses, as well as a clear strategy for its implementation, are more likely to be successful in implementing Blockchain projects. Additionally, the study found that organisations that have a supportive culture and effective communication channels in place are more likely to be successful in implementing Blockchain projects. Therefore, this study highlights the importance of considering a variety of factors when implementing Blockchain projects, including social, organisational, industrial, and technical factors. It also emphasises the need for organisations to have a clear understanding of Blockchain technology and its potential uses, as well as a clear strategy for its implementation, to improve the chances of success for Blockchain project implementation.

Value realisation challenges in a collaborative environment:

The lack of alignment among stakeholders in Information and Communication Technology (ICT) collaborative solutions, particularly in the context of Blockchain technology, can have a profound impact on the successful implementation and realisation of value from these initiatives (Bryson & Crosby, 2018). This study's findings underscore the fact that stakeholders often exhibit divergent priorities, interests, and perceptions regarding the value that Blockchain can bring to collaborative environments.

Blockchain technology has the potential to offer transparency, security, and data immutability, making it suitable for various collaborative applications. However, stakeholders may view these advantages differently, depending on their roles and objectives within the collaborative environment. For instance, while some stakeholders may prioritise the enhanced security and trust aspects of Blockchain, others might emphasise its potential for reducing operational costs or increasing efficiency (Smith & Marks, 2020).

The diversity of stakeholder priorities and interests in Blockchain can create challenges in decision-making and resource allocation (Freeman et al., 2010). When stakeholders perceive different values in Blockchain technology, it can lead to conflicts and disagreements about the focus and scope of Blockchain implementation. For instance, stakeholders with a strong interest in data security may argue for more robust encryption and access control features, while those focused on efficiency may advocate for streamlined processes (Benbasat et al., 1987). Moreover, differing perceptions of Blockchain's potential can impact the willingness of stakeholders to invest time, resources, and expertise in collaborative Blockchain projects (Davenport & Harris, 2007). Some stakeholders may be enthusiastic about exploring and adopting Blockchain solutions, while others may harbour scepticism or reservations based on their unique perspectives and experiences (Keil et al., 1998).

To address these challenges, organisations must adopt a nuanced approach to stakeholder engagement and communication (Ansell & Gash, 2008). Recognising and acknowledging the diversity of stakeholder priorities and interests is the first step toward alignment. Conducting thorough stakeholder analysis to understand their specific concerns and motivations related to Blockchain technology is essential (Bryson & Crosby, 2018). The findings from this research can help with the analysis by offering valuable insights into the different perspectives within the collaborative environment. Once these various priorities are identified, organisations can work on developing customised strategies that can accommodate the multiple value propositions associated with Blockchain (Smith & Marks, 2020). This might involve creating adaptable Blockchain solutions that can meet the needs of different stakeholders or providing clear communication about how Blockchain aligns with various objectives within the collaborative setting (Hart & Quinn, 1993).

Furthermore, organisations can consider the use of governance models that involve stakeholders in decision-making processes related to Blockchain implementation (Ansell & Gash, 2008). This inclusive approach allows stakeholders to have a voice in shaping the Blockchain strategy, ensuring that their concerns and priorities are considered. In summary, these research findings highlight the importance of addressing the inherent diversity in stakeholder priorities, interests, and perceptions when implementing Blockchain technology in collaborative environments. The success of collaborative ICT solutions, especially those involving Blockchain, depends on a holistic understanding of the value proposition from each stakeholder's standpoint. By taking these varied perspectives into account and applying strategies that accommodate multiple value propositions, organisations can navigate the challenges associated with stakeholder misalignment and harness the full potential of Blockchain technology for collaborative value realisation.

5.3.4.Predictions findings and DOI theory and Time to Value

The study findings indicate that the majority of respondents initially had positive perceptions regarding the potential value of Blockchain technology at the start of their projects. However, after a few years of implementation, this perception shifted, with most respondents expressing uncertainty and doubts about the ability to realise business value from Blockchain implementations. This trend aligns with the diffusion of innovations (DOI) theory's "early adopter stage," where innovators and early adopters exhibit a positive attitude towards innovation and are willing to take risks in implementing it. Over time, though, as the technology falls short of expectations, attitudes change, and stakeholders become more wary (Rogers, 1962). This finding is consistent with recent studies on the adoption of blockchain technology. For example, Li et al. (2021) found that a lack of understanding and trust among stakeholders can hinder Blockchain adoption. Similarly, Kshetri (2020) identified a lack of clear and consistent regulations as a key barrier to the successful implementation of Blockchain projects. One limitation of the DOI theory is its assumption that internal factors, such as perceived benefits, costs, and risks, primarily influence adoption behaviour. However, our study supports the crucial role of external factors—particularly stakeholder cooperation and external regulations—in impacting Blockchain implementation projects. This underscores the importance of your involvement and collaboration in the successful adoption of Blockchain technology.

Additionally, the findings show that most respondents predict their firms will realise the value of Blockchain technology within the next four years and achieve a return on investment (ROI) within approximately six years. This aligns with the DOI theory's "early majority stage," where innovation spreads to a larger population, and it takes time for organisations to realise the technology's value and achieve ROI (Rogers, 1962). This finding is consistent with studies by Kshetri (2020) and Li et al. (2021), which found that organisations need time to fully comprehend Blockchain's potential value and to implement it effectively. The potential ROI from Blockchain technology should reassure you about the long-term benefits of its adoption.

The research survey also explored the expected time to realise the value of Blockchain, reflecting the concept of Time to Value (TTV). The findings suggest that the implementation of TTV for Blockchain in the oil and gas industry may extend over several years. This conclusion aligns with literature supporting the extended TTV associated with Blockchain adoption in this sector. Implementing Blockchain technology in the oil and gas industry requires addressing complexities and challenges unique to the domain, contributing to the prolonged TTV.

Several factors contribute to the longer TTV in this industry, including **industry collaboration**. The oil and gas sector involves numerous stakeholders, such as suppliers, operators, contractors, and regulatory bodies. Developing consensus and establishing partnerships among these entities for Blockchain implementation can be time-consuming and require extensive negotiation and coordination efforts (Lincoln et al., 2020). Collaboration agreements, standardisation of data formats, and alignment of objectives all contribute to the extended TTV within the industry. Furthermore, the deployment of Blockchain technology often results in a longer TTV due to the need to establish network infrastructure and reach consensus among participants (Ismail et al., 2021; Lincoln et al., 2020). Transaction Cost Economics (TCE) theory suggests that these extended TTV periods arise from the need to coordinate multiple stakeholders and establish governance mechanisms within Blockchain networks (Lincoln et al., 2020).).

5.4. Study findings' implications on business and managerial practices

This empirical study makes a considerable contribution to the business field by enhancing our comprehension of the adoption and implementation of emerging information and communication technologies (ICT) within enterprises. The study's objective is to aid decision-makers in making well-informed choices, thereby reducing the likelihood of failure, as evidenced by previous business reports. By avoiding unnecessary costs and resource losses and increasing the likelihood of successful adoption, organisations can optimise operations and remain competitive in a rapidly evolving technological landscape.

Firstly, in response to the ongoing debate in business and academia about whether Blockchain is hype or holds real value, the study provides a comprehensive empirical assessment that decisively addresses this question. It offers a detailed overview of Blockchain project journeys from their initial stages through to completion. This information enlightens business leaders and managers on all stages of Blockchain implementation, highlighting key factors and expectations. In conclusion, the study firmly establishes that Blockchain is not merely hype but can indeed add substantial value. However, realising this value necessitates time and the overcoming of various barriers.

Secondly, in terms of individual perceptions, the study serves as an essential reminder to business management and personnel to adopt a comprehensive assessment approach when considering the adoption of innovative technologies. It cautions against relying solely on initial perceptions and optimism, which may lead to decision-making based on untested expectations. Such an approach can produce undesirable outcomes. Decision-makers are, therefore, encouraged to explore the feasibility, potential risks, and long-term implications of new ICT before making adoption decisions. The study finds that individuals' perceptions and attitudes towards technology can evolve and may be influenced by factors such as their experience with the technology and the level of organisational support they receive. This shift can result in a lack of acceptance and usage of the technology. The findings suggest that decision-makers relying exclusively on the "perception construct" to guide technology adoption may be misled. Initial perceptions may indicate acceptance and usage, but as these perceptions change over time, project failures and a lack of return on investment (ROI) can occur. Research by Raza and Raza (2020), Li et al. (2020), and Brouwer and Koopman (2019) support the idea that relying solely on perceptions in decision-making can be misleading. These studies stress the importance of understanding individual users' perceptions, acknowledging that they may change over time, and incorporating this understanding into effective technology adoption decisions. Failure to account for these factors may lead to project failures and limited ROI.

Thirdly, regarding the significant factors influencing Blockchain adoption, this study highlights the importance of identifying key elements that may impede the success of new ICT implementations. By recognising these factors and understanding their impact, decision-makers can proactively address them. Addressing these factors may involve devising strategies to mitigate their effects, collaborating with business partners, or postponing adoption until the risks have been minimised. The study emphasises the importance of early identification and management of these factors to enhance the likelihood of successful technology adoption.

The study identifies social challenges—such as stakeholder cooperation, regulations, and policies—as significant barriers to the realisation of Blockchain's value. It reveals that these challenges can impede Blockchain adoption and implementation, limiting its potential benefits. For example, a lack of cooperation among stakeholders, whether between departments within an organisation or among different organisations, can obstruct Blockchain project implementation. Additionally, the absence of clear and consistent regulations and policies creates uncertainty for organisations, making it difficult for them to navigate the legal and regulatory landscape. These findings are supported by other studies, such as Li et al. (2021), which highlight that a lack of understanding and trust in Blockchain technology can hinder adoption, and Kshetri (2020), which points to inconsistent regulations as a barrier to implementation. To fully realise the value of Blockchain, organisations must address these social challenges by fostering cooperation among stakeholders, collaborating with regulators to develop clear and consistent policies, and providing education and training to help organisations navigate legal complexities.

Moreover, the study also highlights organisational and industrial challenges, such as high levels of uncertainty and a lack of trust in Blockchain technology, which can impair value realisation. These challenges complicate efforts to adopt and integrate Blockchain into existing systems and processes. Studies such as Böhme et al. (2015) emphasise the importance of trust for Blockchain-based systems' success, while Li et al. (2021) point out how uncertainty surrounding the technology's potential benefits can impede progress. The study suggests that organisations must invest in building trust in Blockchain technology and provide education and training to help employees manage its complexities.

Additionally, technical challenges such as technology maturity, security, and privacy concerns further hinder the successful implementation of Blockchain. These challenges make it difficult for organisations to realise the benefits of technology fully. Studies like those of Li et al. (2021) indicate that a lack of technical expertise can hinder Blockchain adoption. Zhang et al. (2022) identify security and privacy concerns as significant barriers to widespread implementation. The study recommends that organisations invest in research and development, collaborate with experts to improve Blockchain's maturity, security, and privacy, and build the necessary technical expertise to implement the technology effectively.

Therefore, in order to fully leverage the potential of Blockchain in industries such as oil and gas, *concerned organisations' management must* take critical steps to tackle the existing challenges. According to Wang and Liang (2019), the successful implementation of Blockchain necessitates a thorough comprehension of the technology and its potential applications. Organisations should familiarise themselves with Blockchain's and explore industry-specific use cases. Furthermore, Lee and Kim (2019) stress the importance of developing a clear implementation strategy, which includes setting specific goals and identifying the steps and resources needed. Li and Wang (2019) emphasise addressing social, technical, organisational, and industrial challenges to fully harness Blockchain's investment in training and education to enhance employee understanding and utilisation of the technology. Wang and Wang (2019) suggest that organisations collaborate with other companies and stakeholders to share knowledge and best practices, thereby improving Blockchain adoption across industries. Continuous monitoring and adjustments will ensure that projects stay on track, allowing organisations to maximise the potential benefits of Blockchain technology.

Finally, regarding the prediction and outlook for Blockchain adoption, by collecting inputs from business experts directly involved in recent Blockchain projects, the study provides valuable insights into the expectations and value realisation timeline of Blockchain technology. Decision-makers can use these insights to determine the appropriate timing for adopting this new ICT. However, it is essential to acknowledge the study's limitations. Oil and gas (O&G) management must not underestimate the importance of Time to Value (TTV) during Blockchain implementation. By recognising its significance, managers can make informed decisions that streamline operations, enhance productivity, and set accurate expectations among stakeholders. Assessing TTV involves evaluating factors such as technology complexity, compatibility with existing systems, and organisational readiness. Collaborating with stakeholders early in the process helps establish realistic timelines and expectations, fostering a collaborative approach to implementation. Recognising the importance of TTV enables O&G management to swiftly and efficiently harness the benefits of new ICT technology. It allows them to adapt to industry changes, improve operational efficiency, and stay ahead in a rapidly evolving market.

In summary, this empirical study has enhanced our understanding of ICT adoption and implementation within enterprises. By cautioning against overreliance on initial perceptions, emphasising the identification of factors that hinder success, and providing insights into Blockchain's future adoption, the study offers valuable guidance to decision-makers.

5.5. Limitations, Recommendations for future studies

While This study contributes considerably to the existing literature on Blockchain adoption; however, several limitations must be acknowledged to guide future research. These limitations highlight areas where further exploration can enhance the understanding of Blockchain projects and their implications. This section outlines these limitations and offers recommendations for future studies to address these shortcomings and expand the knowledge base in this field.

Temporal Constraints: One of the most significant limitations of this research stems from the limited time frame over which the study was conducted. Blockchain technology evolves rapidly, and the findings reflect only a snapshot of a specific moment. As a result, the study may not fully capture the long-term effects or the dynamic nature of Blockchain adoption in the oil and gas industry. Changes in technology, regulations, or market conditions could diminish the relevance of these findings over time. Future research should adopt a longitudinal approach, tracking Blockchain adoption over extended periods. This approach would allow researchers to observe trends, challenges, and opportunities as they unfold, thus providing more robust and timely recommendations (Smith & Brown, 2022).

Sample Size and Representativeness: Another critical limitation is the relatively small sample size, which was constrained by factors such as participant accessibility and resource limitations. A small sample may limit the generalisability of the findings, as it may not adequately represent the diversity of organisations and stakeholders involved in Blockchain projects across the oil and gas sector. The limited sample size also reduces the statistical power of the analysis, making it more challenging to detect meaningful relationships and draw widely applicable conclusions. Larger and more representative samples are recommended to be considered to enhance the robustness of the findings and allow for more detailed subgroup analyses, such as variations by company size, geographic region, or other relevant factors (Jones et al., 2021).

Stakeholder Perspectives: This study primarily focuses on the perspectives of Blockchain project managers and operations managers within the oil and gas sector. Although these stakeholders provide essential insights into the operational aspects of Blockchain adoption, excluding other key stakeholders—such as regulators, investors, end-users, and industry experts—limits the comprehensiveness of the findings. The insights gained may skew towards operational and managerial considerations, potentially overlooking critical factors like regulatory compliance, financial implications, and user experience. Future research should include a broader range of stakeholders to offer a more holistic understanding of Blockchain's impact. Incorporating these perspectives would deepen the analysis and reveal additional challenges and opportunities that influence the adoption process (Clark & Adams, 2023).

Potential Bias in Expert Predictions: Although this study uses expert opinions to predict the success of Blockchain projects, these predictions are inherently shaped by the individual experiences and organisational contexts of the experts. This approach introduces the possibility of bias, as experts may overestimate the success of projects based on personal involvement or organisational priorities. Future research should mitigate this bias by incorporating a more diverse pool of experts and validating predictions against empirical data from completed Blockchain projects. This approach would reduce the influence of individual biases and offer a more balanced and objective assessment of Blockchain's potential impact (Miller & Thompson, 2021).

Recommendations for Future Research: Based on the forementioned limitations, several recommendations can guide future research. First, adopting a longitudinal approach would enable researchers to capture the evolving nature of Blockchain technology and its long-term effects on the oil and gas industry. This approach would provide a more dynamic understanding of Blockchain adoption, including how organisations adapt to new technological advancements, regulatory changes, and market conditions (Brown & Williams, 2023). Second, future studies should increase sample sizes to improve the generalisability and robustness of the findings. Larger, more representative samples would allow for more precise estimations of relationships and effects, improving the reliability of conclusions.

Additionally, researchers should include participants from diverse geographical regions and types of organisations within the industry to capture a broader range of perspectives and experiences (Johnson et al., 2022). Third, future research should expand the range of stakeholders involved to include regulators, investors, end-users, and industry experts. Incorporating these perspectives would provide a more holistic understanding of the factors influencing Blockchain adoption, including regulatory, financial, and user-related challenges and opportunities. This approach would also help identify areas of conflict or synergy between different stakeholder groups, which is crucial for the successful implementation of Blockchain technology (Nguyen & Li, 2022). Finally, addressing potential biases in expert predictions is essential for improving the accuracy and objectivity of future research. By diversifying the pool of experts and validating predictions against empirical data, researchers can reduce the influence of individual biases and ensure findings reflect a more balanced and realistic assessment of Blockchain technology's potential (Williams & Patel, 2020). While this study provides valuable insights into Blockchain adoption in the oil and gas industry, addressing these limitations in future research is crucial. By employing longitudinal designs, increasing sample sizes, involving a broader range of stakeholders, and exploring additional technological and organisational factors, future research can deepen the understanding of Blockchain adoption. These efforts will lead to more robust, generalisable, and actionable conclusions that benefit practitioners, policymakers.

5.6. Conclusion

This study provides a comprehensive assessment of the implementation of Blockchain projects within the oil and gas industry, beginning with the initial stages of adoption. It delves into various dimensions of Blockchain integration, such as the motivations driving firms, the specific objectives they seek to achieve, their evolving perceptions, the challenges encountered, and the overall future outlook of the technology within the sector. By critically analysing these factors, this study makes a meaningful contribution to academic discourse while offering more profound insights into the realities faced by firms as they navigate Blockchain adoption.

The investigation into the motivations and objectives of firms participating in Blockchain projects reveals that their key priorities are predominantly centred around time efficiency, cost reduction, and transparency. These aims resonate strongly with the overarching focus of the industry on operational efficiency, the reduction of costs, and enhanced accountability. Participants recognised that Blockchain technology holds significant potential to streamline complex processes, reduce operational expenses, and improve transparency across the supply chain within the oil and gas sector. While initial perceptions of Blockchain were largely positive, a notable shift in sentiment emerged after several years of implementation, with a number of respondents expressing uncertainty or even pessimism regarding the tangible outcomes. This shift likely reflects a disconnect between the anticipated benefits of Blockchain and the actual results experienced, suggesting that early expectations may not have been fully met or were overly optimistic.

The study also identifies a range of barriers impeding the realisation of Blockchain's total value within the sector. Social factors, particularly stakeholder cooperation, regulatory constraints, and trust in the underlying technology, play a pivotal role in shaping adoption rates. Stakeholder collaboration is not merely advantageous but essential for overcoming resistance and fostering the broader adoption of Blockchain. Trust building is crucial to this process, as the absence of trust can significantly hinder progress. Moreover, the study highlights technical challenges, including concerns around the maturity of the technology, as well as issues related to security and privacy. Overcoming these technical obstacles will necessitate sustained efforts, such as the promotion of successful use cases, continuous improvements to security protocols, and robust measures to address privacy concerns.

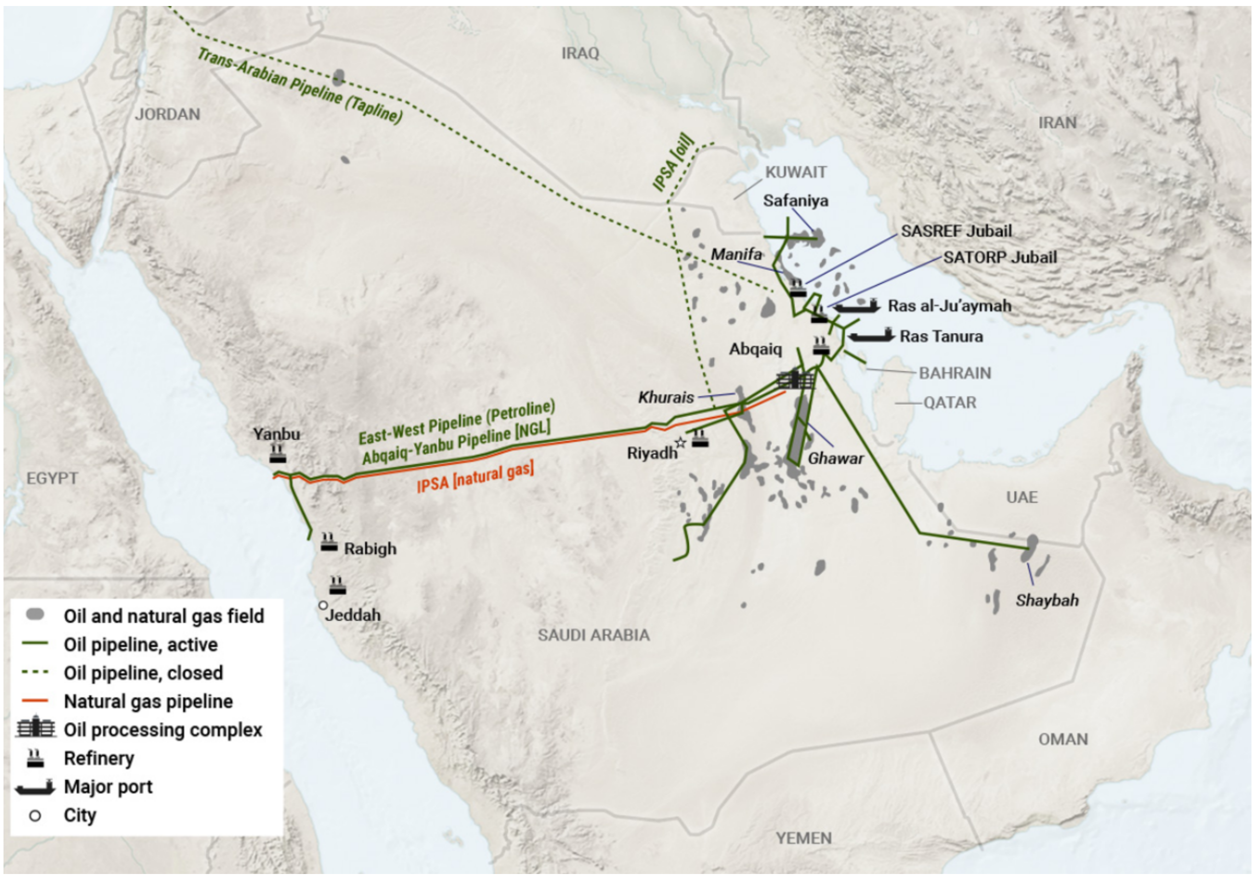
Looking ahead, the future outlook for Blockchain within the industry remains cautiously optimistic. Respondents indicated that it may take several more years before the full potential of Blockchain is realised, though many expressed hopes that tangible value would begin to materialise within the next four years. Nonetheless, such projections should be approached with a degree of caution, given the factors that could influence outcomes, including the rate of technological advancement, adoption levels, and the inherent complexity of the industry's use cases. The intricacies of the oil and gas sector necessitate careful planning and adaptation to ensure that Blockchain implementation is tailored to meet the specific needs and challenges of the industry.

In conclusion, this study underscores the critical importance of aligning firms' objectives, addressing implementation challenges, and fostering collaboration among stakeholders to unlock the transformative potential of Blockchain technology in the oil and gas industry. By overcoming both social and technical barriers and leveraging Blockchain's unique capabilities, the industry stands to achieve significant improvements in process efficiency, transparency, and cost savings. However, it is essential to recognise that the successful implementation of Blockchain requires continuous evaluation and adaptation, ensuring that expectations are managed in line with the evolving realities of the technology. These findings offer valuable insights for industry stakeholders, policymakers, and academic researchers, contributing to a more nuanced understanding of Blockchain's evolving role in the oil and gas sector. Future research that further explores Blockchain's diverse applications will be crucial in refining implementation strategies and maximising its benefits. With diligent planning and a collaborative approach, Blockchain technology has the potential to revolutionise the oil and gas industry, paving the way for a more efficient, transparent, and sustainable future.

ANNEXE

Case Study Overview

Stakeholders such as producers, shippers, and customers engage in various oil and gas trading stages from upstream to downstream. The issues of logistic systems, such as the long time and cost involved in coordinating the crude oil requests among participating organisations, low data visibility, and extended dispute resolution time, have affected the performance of stakeholders of the oil and gas industry. Big oil and gas companies have started an initiative by selecting an abstracted and a main subset of the process of oil SCM and have maintained good relations with local stakeholders in Saudi Arabia. The Red Sea locates the customers, and the Arabian Gulf Bay locates the oil producers. The crude oil pipeline stretches from the east to the west of Saudi Arabia for around 1500 KM and is managed by different stakeholders.



Current Situation Before Blockchain Implementation:

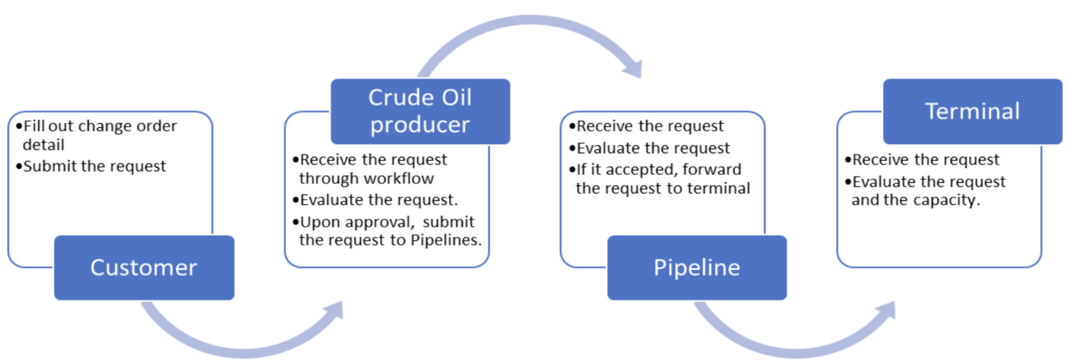
The current domestic crude oil product-order fulfilment takes weeks and months from the order request until the order is delivered to the customer. Coordinating among different stakeholders and ensuring the quality of the provided services consumes a long time and has trust concerns since several stakeholders have no access to their requested information and use scattered systems. They used to collect info through phone calls or emails, which exposed them to security breaches or manipulation. The crude oil producers are located 1500 KM away from the customer. The customer used to collect the required crude oil via the Crude Oil Terminal Storage located in that area through pipes, and the Crude Oil Terminal received the oil through the leading pipeline network of around 1500 km.

Every company has its network intranet that is not accessible from any external department by different security systems and firewalls. Each company's intranet hosts several applications aimed at local employees. For instance, X firm has a custom SAP system that operates all ERP applications. In finance, logistics, HR, etc., the data of these applications are susceptible and classified based on firm standards. So, all producing information that pertains to customers' orders, capacity, timing to deliver orders, etc., cannot be acceded at all via systems for the security mentioned above standards. Moreover, it is almost the same for other firms such as pipelines, terminals, and refineries as customers in this case. So, the current stations, all communion and handling of the crude oil and all oil products are done through emails and phone calls. And in personal meetings and official papers mails.

The request for Crude oil is usually a yearly plan and quarterly plan; however, the supply and dynamic and frequent changes require updates and changes on the order amount and timing based on the operational capacity of the refineries and based on the demand and urgency of demands from the refineries national and internal customers. The oiler producers have several customers, both national and internal customers, and many urgent or non-planned changes are not favourable. Once the order is received and the amount is available, the oil producer needs to arrange with pipelines to ensure a smooth stream of oil to the customer.

The pipeline firm has limited capacity and several pipe maintenance schedules during the year, so it may not be able to manage any scheduled requests efficiently. Moreover, similarly for the terminal storage that hosts limited capacity for tanks. So, arranging such a process requires a lot of effort col, location, and data accessibility in order to arrange and decide on the order amount and time to fulfil all involved firms' commitments to their proponents.

Orders change requests start from the end customer, which is a refinery located by the Red Sea. In this case, by an official letter to the producing firm located in the Gulf. See, the producer coordinates with Pipelines via emails, and pipelines coordinate with the terminal to ensure the capacity and the time to fulfil this order. Once all are agreed upon, the amount is to be shipped to the customers; upon receiving the amount, the customers have to pay the issues associated with the order and the local bank transactions to be done within a week upon arrival of the order quantity. These coordination activities sometimes take 3-6 weeks.



Crude Oil order l fulfilment request flow High level

Project Overview

This project is an initiative led by X major oil companies as part of the digital transformation program. It was started in 2017, and the project's main objective is to increase the efficiency of the SCM business process. From 2017 to 2018, the focus was on selecting the most appropriate case to be managed through Blockchain. The SCM was the foremost target for the main stakeholders, and Oil Product Order Fulfilment was the selected process since it was a complex and time-consuming process. The project's current status is still in the pilot stage and has not gone live. Four categories of stakeholders have been grouped: 1: Customer; 2. Oil/Gas producer; 3. Pipeline; 4. Crude Oil Terminal storage.

Their firm's management nominates the project representatives as they have several years of business and technology experience and participate in business automation projects.

The technology enabler was IBM, which enabled firms to build Blockchain network consortiums from a technical perspective and develop the requested scenarios of crude oil order fulfilment. The initial offer was to develop on the cloud. However, it was not well accepted by all four firms for security and privacy reasons, and they asked to have the solution somehow within their premises, with complete control of their parts. The IBM Hyperledger Fabric, an open-source project from the Linux Foundation, is the modular Blockchain framework and de facto standard for enterprise Blockchain platforms. Intended as a foundation for developing enterprise-grade applications and industry solutions, the open, modular architecture uses plug-and-play components to accommodate a wide range of use cases. One of the many compelling features of fabric is the enablement of a network of networks. Members of a network work together, but because businesses need some of their data to remain private, they often maintain separate relationships within their networks. For example, a purchaser may collaborate with different sellers selling the same product. The transactional relationship between the purchaser and each of the sellers should remain private and not visible across all sellers. This is made possible via the "channels" feature in Hyperledger Fabric if you need total transaction isolation and the "private data" feature if you would like to keep data private while sharing hashes as transaction evidence on the ledger (classified data can be shared among "collection" members, or with a specific organisation on a need-to-know basis.

Business Case Interviewees' profiles:

Role	***Name***	***Age***	***Qualification***	***Experiences***	***Firm Background***	***Location***
Oil Refinery Customer Representative	*XYZ*	*37*	*Master's degree in business. SCM specialist*	*15 years*	*Oil and Gas Joint Venture Refinery*	*Red Sea, Yanbu City*
Crude Oil and Gas Producer Representative	*XYZ*	*41*	*B.Sc. Degree Petroleum Engineer*	*19 years*	*Crude Oil and Gas Exploration and Producing*	*Arab Gulf Sea, Abqiq City*
Crude Oil Pipelines Representative	*XYZ*	*33*	*B.Sc. Degree Chemical Engineer*	*12 years*	*Crude Oil Pipeline Transportation*	*Central Area, Khurais*
Crude Oil Terminal Representative	*XYZ*	*37*	*B.Sc. Degree Engineering Management*	*14 years*	*Crude Oil*	*Red Sea Western Region, Yanbu*

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