BLOCKCHAIN TECHNOLOGY IN THE HEALTHCARE INDUSTRY: AN EMPIRICAL STUDY OF FACTORS INFLUENCING ORGANIZATIONAL ADOPTION OF BLOCKCHAIN TECHNOLOGY

by

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ABSTRACT

FATMA M. ABDELSALAM. Blockchain Technology in the Healthcare Industry: An Empirical Study of Factors Influencing Organizational Adoption of Blockchain Technology (Under the direction of DR. CHANDRA SUBRAMANIAM and DR. REGINALD SILVER)

Blockchain has been gaining traction in many industries due to its relative advantage. While many industries see blockchain as a game-changing technology, its potential in healthcare is especially promising. Despite the growing interest in blockchain technology within the healthcare industry, the adoption of the technology in this sector has been slow. An empirical study combining the diffusion of innovation model (Rogers, 1983) and the technology-organization-environment model (Tornatzky and Fleishcher, 1990) is proposed to investigate the relatively low rate of the technology's adoption in healthcare. This study considers how innovation (relative advantage, technology complexity), technology (technology interoperability), organization (readiness of the organization, top management support), and environment (competitive pressure and government regulatory support) affect blockchain adoption intention in the healthcare industry. A total of 170 valid questionnaires were collected and analyzed using the PLS-SEM technique with SmartPLS software. The results show a significant impact of top management support, organizational readiness, and competitive pressure on blockchain technology adoption intention in the healthcare industry. This study contributes to the growing body of knowledge on blockchain adoption in healthcare by providing a comprehensive analysis of the factors influencing the adoption intention of this technology.

Keywords: Blockchain Technology, Adoption Intention, Healthcare Industry, Technology-Organization-Environment (TOE) Framework, Diffusion of Innovation (DOI) theory.

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DEDICATION

First and foremost, I dedicate this work to Almighty God, whose grace, wisdom and blessings have guided me through every step of this journey. Without His strength and favor, none of this would have been possible. To my beloved mother, whose unconditional love, endless sacrifices and steadfast prayers have been my foundation. Your resilience and faith in me have shaped the person I am today.

To my precious son Adham, and my beautiful daughters Noreen and Lyla - you are my greatest motivation and joy. May this achievement inspire you to pursue knowledge with passion, work with integrity, and always trust in God's plan for your lives. To all those working to advance healthcare information management for the greater good, may this research contribute meaningfully to innovations that serve humanity.

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LIST OF ABBREVIATIONS

TOE	Technology-Organization-Environment
DOI	Diffusion of Innovation
TAM	Technology Acceptance Model
UTAUT	Unified Theory of Acceptance and Use of Technology
PHI	Protected Health Information
EHRs	Electronic Health Records

CHAPTER ONE: INTRODUCTION

The healthcare industry has inherited severe challenges through its information systems, including issues of data integrity, accuracy, system availability, data loss, and network security (Seh et al., 2021). A prominent challenge is the inability and inefficiency of the systems to securely manage and retrieve protected health information (PHI) (AbdelSalam, 2023; Chenthara et al., 2019). Healthcare is a data-intensive domain that handles a great deal of non-standardized data generated through medical records, clinical research, medical insurance claims, remote patient monitoring sensors, wearables, and health apps (Kassab et al., 2019). Therefore, effective data management systems are needed for healthcare providers to capture important information on patients' medical history and well-being while improving care coordination and patient engagement (Mettler, 2016).

Another key issue in the healthcare domain is ensuring patient data privacy when exchanging information among healthcare providers, researchers, and other stakeholders. The introduction of cloud-based data management systems has solved some of the scalability barriers as well as timely accessibility to patients' data. However, the single point of failure issue of the cloud-based systems remains a challenge (Gangwar et al.,2015). Furthermore, cybersecurity attacks have been increasingly targeting the healthcare industry, resulting in more data breaches that expose patients to economic threats and potential social stigma (Kassab et al., 2019; Luna et al., 2016). From 2018–2022, there has been a 93% rise in large breaches reported to the Office of Civil Rights (OCR) (369 to 712), with a 278% growth in breaches involving ransomware (Assistant Secretary for Public Affairs, 2023). Healthcare data persistently present an attractive target for data breaches. Therefore, it is imperative to ensure privacy and security for all health data and records (Kassab et al., 2019).

In drug discovery, the pharmaceutical industry is increasingly reliant on bioinformatics resources to support translational drug development, emphasizing the need for further investment in this area (Wooller et al., 2017). Moreover, the pharmaceutical industry's supply chain management faces severe challenges due to lack of coordination and inventory management (Esmaeillou et al., 2023; Gereffi, 2020). Additionally, the pharmaceutical industry is struggling with the costly issue of counterfeit drugs that are falsified and administered to thousands of U.S. patients (Mackey et al. 2015). Research has also projected that insurance fraud within the healthcare sector results in annual costs amounting to tens of billions of dollars (Agbo et al., 2019). Therefore, adopting information management technology can enhance trust and significantly reduce the falsification of shared data. Kim et al. (2017) highlight the importance of secure, efficient, and reliable technologies to address the challenges outlined above. Among the new generation of information technology, blockchain is seen as a promising solution for the data issues currently facing healthcare systems (Tandon et al., 2020).

Blockchain technology is a peer-to-peer network that enables secure data exchange and transaction verification (Agbo et al., 2019). Unlike traditional centralized databases, which are managed by single entities such as banks or governments, blockchain-based systems are distinguished by their decentralized structure (Kuo et al., 2017; Zhao et al., 2017). This decentralization not only mitigates the single point of failure vulnerability but also improves transparency and security, preventing any single party from altering the decentralized network (Abu-Elezz et al., 2020). Blockchain also employs cryptography utilizing mathematical formulas, which makes the network extremely difficult to compromise or hack (Cao, et al., 2022). Each transaction on the blockchain is accessible to all approved participants in the continuum, fostering trust and removing the necessity for intermediaries. The advantages of blockchain technology

include enhanced security, improved transparency, and cost effectiveness (Aich et al., 2021; Lansiti & Lakhani, 2017).

Blockchain technology is promising for some important applications such as sensitive data management (governance), information interoperability, and safe information exchange (Attaran, 2020; Park et al., 2020). Several researchers' analyses have shown that the technology's potential to secure patient data, provide easy access to medical records, and improve coordination in healthcare can all be achieved by leveraging blockchain technology (Abu-elezz et al., 2020; Agbo et al., 2019; Attran, 2020). Healthcare systems and applications that are blockchain based are predicted to augment interoperability among all participating entities, resulting in effective data exchange and communication (McGhin et al., 2019). The features of blockchain technology enable transparency, security, anonymity, and immutability in business operations (Przhedetskiy et al., 2019), thus enhancing the ability to share healthcare data without the risk of compromising patient security and privacy (Javed et al., 2021; Khezr etal.,2019). Furthermore, blockchain has the potential to enhance interoperability, coordination of care, and reduce delays in patient data exchange (Haddad et al., 2022).

Blockchain has been cited as a technology that has the potential to significantly improve drug supply chain management, allowing pharmacists and healthcare providers to verify and trace the distribution of legitimate drugs accurately and promptly (Agbo et al., 2019; Khezr et al., 2019; Mackey & Nayyar, 2017). Notably, the Institute of Electrical and Electronics Engineers (IEEE) held a conference focusing on the integration of blockchain technology into medical records and enhancing research integrity (Gammon, 2018). The immutability feature of blockchain can speed up the processing, verification, and payment of health insurance claims because it ensures that the data is legitimate and that it can be tracked (Hasselgren et al., 2020). Blockchain can streamline

clinical trial recruitment by identifying appropriate patients through their anonymized data, enhancing both the efficiency and accuracy of the process (Dimitrov, 2019). Furthermore, this technology can leverage smart contracts, that is, digital agreements that verify and track blockchain transactions. Smart contracts ensure the data integrity of clinical trials and eliminate the possibility of data manipulation (Abdu & Wang, 2023). Blockchain technology may enable scientists, healthcare providers, and policymakers to trust the clinical trials process (Haleem et al., 2021).

1.1. Problem Statement and Research Goals

Blockchain features have enabled better management and offered modern solutions for myriads of healthcare challenges (Haleem et al., 2021). However, several healthcare organizations remain hesitant to adopt blockchain technology. Despite the increased curiosity about technology within the healthcare industry, there is no clear or comprehensive understanding regarding the factors that promote or hinder blockchain adoption as well as how blockchain technology can be successfully adopted into healthcare systems (Epiphaniou et al., 2019). Understanding the key factors that support blockchain technology adoption in healthcare can inform policymakers who are attempting to develop a supportive ecosystem to accelerate the expansion of health data exchange through blockchain technology (Allen et al., 2020).

The objective of this research study is to delve into the adoption of blockchain technology, a topic of interest for scholars and practitioners seeking a clear analysis of the technology adoption dynamics and the various elements influencing its uptake in the healthcare ecosystem. This research study adds to the limited scope of quantitative research studies on blockchain adoption in the healthcare sector. The research focuses on exploring the fundamental factors contributing to blockchain adoption and deployment, not from a technical viewpoint but through the lens of subject matter experts and leaders engaged in the process of adopting blockchain decision making

in different healthcare systems. Furthermore, this research enriches current literature by investigating and pinpointing challenges that impede blockchain technology adoption and highlighting potential salient areas for future investigation. The key research question for my dissertation is as follows:

What are the key determinants influencing the adoption intention of blockchain-based systems in healthcare organizations?

This research contributes to the extant literature in three ways. First, the research study tests and reaffirms the theoretical foundation of TOE in healthcare settings. Second, the integration with DOI theory extends the TOE framework, explaining drivers of organizational behavioral intention to adopt blockchain technology. Third, this research adds to the limited number of quantitative research studies on blockchain adoption in the healthcare industry. For healthcare practitioners and policymakers, the findings from this research can guide their strategies and policies to aid in the broader adoption of blockchain in their industry. The subsequent sections of this research are designed as follows. Chapter 2 includes a literature review on blockchain characteristics and implementation in the healthcare industry, followed by the conceptual model and proposed hypotheses to study constructs, including their relevant literature. Next, Chapter 3 presents the proposed research method of the study, and the sample characteristics. Chapter 4 shows results of data analyses and hypotheses testing. In closing, Chapter 5 discusses the findings and presents contributions to theory and practice.

CHAPTER TWO: LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The major streams of research underlying this dissertation are underpinned by the diffusion of innovation (DOI) and the technology-organization-environment (TOE) frameworks. I begin by reviewing the literature on challenges facing the healthcare industry. The literature explores the advantages of blockchain technology for healthcare information systems. I then elaborate on the characteristics of technology and how these features can demonstrate the value proposition of blockchain in the healthcare industry. Lastly, I present the current literature on DOI and TOE to discuss factors determining blockchain adoption intention in the healthcare industry.

2.1. Methodology and Database Search

Systematic reviews are commonly used in the healthcare industry as an effective way to conduct research pertinent to a specific research question, topic domain, or phenomenon of interest, thus drawing from previous research findings (Turner et al., 2010). For instance, Kuo et al. (2019) conducted a systematic review examining the adoption of blockchain platforms within the healthcare sector and their impact on industry outcomes. A meta-analysis was conducted to identify peer-reviewed studies focused on blockchain adoption along with literature investigating factors driving or impeding the technology's adoption in the healthcare industry, highlighting detrimental factors in each study (Bazel et al., 2023). To synthesize the knowledge on blockchain technology integration in healthcare systems, I conducted a review of conceptual and empirical research studies.

The systematic review sourced articles by searching and including publications indexed electronically across these digital databases: Google Scholar, Science Direct, Springer, IEEE, Emerald, Taylor & Francis, MDPI, EBSCO, ProQuest Central, PubMed, Scopus, EBSCO, MEDLINE, and Wiley. The focus was on identifying literature pertinent to the adoption of

blockchain technology with keywords and word strings comprised of blockchain AND (adoption, OR healthcare, OR factors, OR adoption OR influence adoption OR impede adoption OR challenges OR TOE OR DOI). Initially, 1,850 articles were identified. The Boolean operator process then identified 40 articles as relevant to this study. Backward referencing was conducted to identify more relevant literature (Abdel-Basset et al., 2021), and eight additional articles were identified. In total, 48 studies were identified as relevant to this study. After removing duplicates and limiting studies to those published in the healthcare domain, conference proceedings, book chapters, and technical articles were excluded along with studies that investigate technology adoption from engineering perspectives to maintain relevance and rigor of content. Ultimately, 39 studies were selected based on the preferred reporting items for systematic reviews and meta-analyses (PRISMA) for the identification and inclusion process of systematic reviews, as demonstrated in **Figure 1** (Liberati et al., 2009).

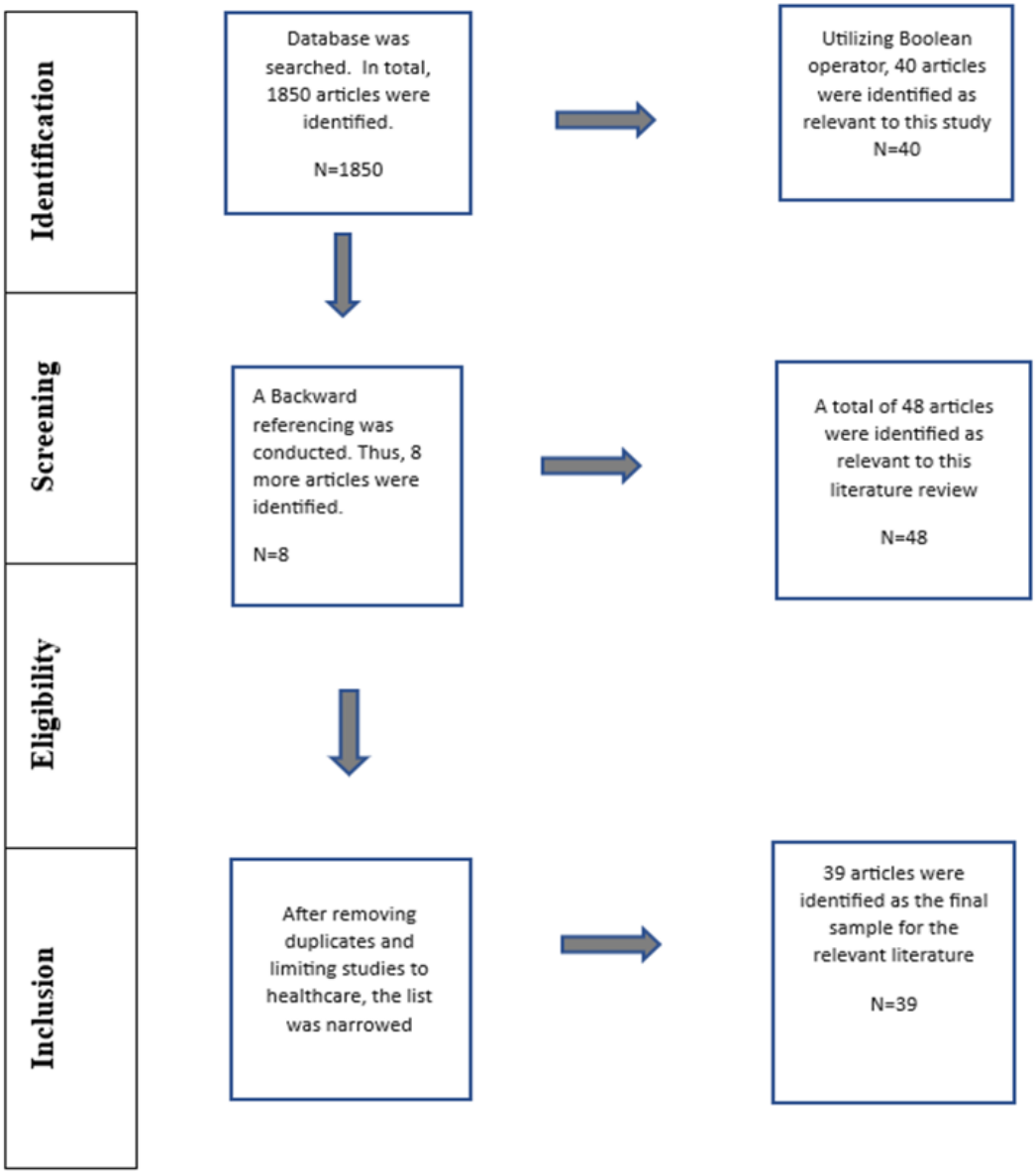

Fig.1: PRISMA for Identification and Inclusion Process of Systematic Reviews.

2.2. Healthcare Systems Challenges

Many healthcare organizations struggle with coordinating care, measuring quality, and reducing medical errors due to the way healthcare data are stored and managed (Bawany et al., 2022; Yaeger et al., 2019). Data are collected digitally from numerous sources, but the challenge lies in recording, storing, and securely sharing this information across various applications and systems. As the data generated through various channels has expanded, more concerns about the secure and efficient exchange of medical data have arisen. Portability and compatibility of data across diverse systems remain critical challenges (Hillestad et al., 2019; Wong et al, 2018; Xiao et al., 2021). In the ideal scenario, patients should be able to own, share, and exchange their medical information with multiple providers without jeopardizing their confidentiality or privacy. However, the literature has pointed out that the current healthcare data management and exchange systems are inefficient, challenging, and time consuming (Attaran, 2020; Clim et al. 2018). The exchange of electronic health records (EHRs) data among different hospitals, clinics, pharmacists, health insurance providers, and researchers has been inefficient, costly, and time consuming (Alzahrani et al., 2022; Ismail et al., 2019; McGhin et al., 2019). The lack of interoperability and data sharing between healthcare storage systems creates challenges in transmitting, retrieving, and analyzing data. Consequently, much of the data remain isolated in siloed databases, restricting patients' access to and engagement with their own medical histories (Bawany et al., 2022; Hughes et al., 2016; Seh et al., 2021). The global pandemic has highlighted the lack of interoperability in the current healthcare system and the need for accurate clinical data that can be securely exchanged among healthcare providers (Abdel-Basset et al., 2021).

A large number of healthcare organizations keep important health data in centralized systems that rely on outdated IT infrastructure, making them particularly vulnerable to ransomware

and other forms of cyberattacks (Attaran, 2020). Over the past decade, cyberattacks have tripled in the United States, with ransomware incidents alone affecting more than 42 million patients from 2016 to 2021 (Alanazi, 2023). Moreover, the literature highlights that approximately 80% of healthcare studies struggle with errors and misconduct (Benchoufi & Ravaud, 2017). Cyberattacks on hospitals and healthcare systems have tremendously increased over the past decade; such security attacks not only negatively impact health care delivery, causing financial stress, but also compromise patients' trust in healthcare systems (Argaw et al., 2019; Luna et al., 2016). Data integrity is a critical concern since data from trials are not immediately shared with stakeholders like doctors, researchers, and patients, creating room for errors and lack of trust (Omar et al., 2021).

Modern healthcare systems face a variety of challenges, such as issues with security, interoperability, privacy, diagnostic and treatment delays, obstacles in information exchange, elevated operational costs, control over data, and ownership of data (Altab et al., 2022; Attaran, 2020; Dubovitskaya et al., 2020). Therefore, the healthcare sector is actively exploring technological advancements to address and overcome these pressing issues. Healthcare organizations are allocating resources toward advanced security technologies such as improved data backups, enhanced encryption methods, AI-driven solutions, and real-time security platforms to proactively prevent threats before they become major problems (Alzahrani et al., 2022; Fatoum et al., 2021). Therefore, there is a strong need for innovative technology that can support the move towards patient-centered interoperability. Blockchain technology has the potential to address several of the interoperability challenges in healthcare and can play an essential role in placing patients at the core of the healthcare system (Pirtle & Ehrenfeld, 2018).

2.3.Blockchain Technology

Blockchain is a digital peer-to-peer network. It was initially proposed by Satoshi (2008) and then commercialized with the introduction of Bitcoin as the first use case, marking the commercialization of this technology. As a distributed ledger technology, it enables secure transactions without the need for intermediaries. The blockchain continuously adds new data entries, which are grouped into blocks. Once accepted into the blockchain, these blocks are linked to previous and subsequent blocks using cryptographic protocols, which creates an immutable ledger of transactions that is difficult to alter (Raikwar et al., 2019). A blockchain is a series of time-stamped blocks that are connected using cryptographic hashes. These blocks are securely sealed and cannot be altered. The chain continuously expands as new blocks are added, with each new block containing a reference (a hash value) to the contents of the preceding block (Aste et al., 2017; Hölbl et al., 2018). Miners, a subset of nodes, validate transactions and create new blocks using consensus mechanisms like proof-of-work (PoW) or proof-of-stake (PoS). Full nodes store a complete copy of the blockchain ledger, validate transactions, and propagate new blocks across the network. This decentralized system ensures the integrity and security of the blockchain (Yli-Huumo et al., 2016). The three types of blockchains are public (permissionless), private, and consortium (public permissioned). The public blockchain is broadly used in cryptocurrencies; data can be viewed by all, and anyone can join. However, in a consortium blockchain, a limited number of selected groups of entities have access to view and participate in the consensus protocol. In a private blockchain, only selected entities can participate in the network, as it is managed by a central authority (Zheng et al., 2017).

Blockchain technology can contribute to advancing the healthcare sector by offering a secure, decentralized, and transparent framework for managing patient data, minimizing fraud, and

bolstering trust among patients, healthcare providers, and various stakeholders (Agbo et al., 2019; Hughes & Morrow, 2019; Kamble et al., 202; Lu et al., 2021). Epiphaniou et al. (2019) indicate that the healthcare industry is exploring blockchain technology for its potential to improve data exchange, patient privacy, and care outcomes. With the growing interest in blockchain technology adoption in various industries, the healthcare domain can be one of the most fertile grounds for blockchain applications. However, with blockchain being a relatively nascent technology, there is much inaccuracy and ambiguity surrounding the potential benefits of the technology in the healthcare sector (Agbo et al., 2019).

Blockchain features such as transparency, anonymity, and immutability can support and provide a potential solution to the implementation of the trusted exchange framework and common agreement (TEFCA) framework (Zhuang & Zhang, 2023), which aims at securely and seamlessly streamlining health information exchange (HIE) through leveraging standardized, nationwide principles across healthcare systems. TEFCA bolsters the Center for Disease Control and Prevention (CDC) data modernization initiative and public health data strategy to promote timely sharing of health information and systems interoperability (Tripathi & Yeager, 2023). The fast health interoperability records and blockchain (FHIR chain) is an initiative that incorporates EHRs to ensure data privacy and interoperability (Ekblaw et al., 2016). This enables private patient data to be securely shared on the blockchain and prevents any institution from maintaining operational control over the data. Above all, FHIR makes it possible for healthcare institutions and public health groups to work together to improve population health, care coordination, and outcome-based care (Gaynor et al., 2020).

Past literature has demonstrated the value proposition of blockchain technology in various industries, including healthcare (Gordon & Catalini, 2018). Researchers have investigated how

blockchain technology can transform the healthcare industry, introducing the technology's characteristics and applications that benefit the industry (Alzahrani et al. 2022; Badr et al., 2018; Kuo et al., 2017; Mettler; Zhang et al., 2018). The consensus mechanisms in blockchain, which involve participants agreeing to trust the network consensus, are crucial, particularly for the operation of automated smart contracts (Mackey et al, 2019; Onik et al., 2019). Yue et al. (2016) introduced a blockchain-based solution called healthcare data gateway, which is designed to allow patients to own, manage, and share their health information, thereby enhancing both the advancement of medicine and the protection of privacy. The technology has several key features that make it attractive for the healthcare industry, including data immutability, transparency, security, and decentralization (Yaqoob et al., 2022). The decentralized nature of the peer-to-peer distributed network empowers healthcare systems to overcome the pervasive security and privacy issues (Hassan et al.2019).

Researchers have emphasized that blockchain technology has demonstrated its effectiveness as a platform for managing patient records, and the implementation of a private, permissioned blockchain is the most appropriate and widely used technology (Alzahrani et al.,2022). Blockchain has the potential to enable patients to manage their own data, which can be accessed through their personal computers or mobile devices, thus supporting interoperability among different healthcare providers and displaying patient records in a consistent format (AbdelSalam et al., 2025; Fatokun et al., 2021). This reduces the possibility for unauthorized users to access personal health information (Dagher et al., 2018) and provides physicians and scientists with access to a vast amount of data, facilitating significant discoveries while protecting patient privacy (Khezr et al. 2019).

2.4. Blockchain Characteristics and Value Propositions in Healthcare

The decentralized distributed ledger system presents a viable solution to the significant challenges of security, privacy, and data integrity in managing sensitive healthcare data (Katuwal et al., 2018). This technology differs from traditional centralized databases by employing a network of nodes that verify and securely log transactions (Agbo et al., 2019; Kamble et al., 2021). Each transaction is securely recorded in a blockchain, forming an unalterable sequence that ensures the authenticity of the data (Lu et al., 2021). Such transparency in data recording builds trust within the healthcare community (Yaqoob et al., 2022). Moreover, blockchain's decentralized structure enhances patient and provider control over personal data, potentially mitigating privacy issues associated with centralized repositories (Hassan et al., 2019; Khezr et al., 2019; Wang & Song, 2018). By facilitating a secure, transparent, and patient-focused exchange of information, blockchain stands to significantly transform how healthcare data is managed.

The Office of the National Coordinator for Health Information Technology (ONC) has identified several essential features necessary for creating an interoperable health system, and these are effectively demonstrated by blockchain technology (Vazirani et al., 2019). Technology can enhance the leveraging of different technologies such as artificial intelligence and big data (Dimitrov, 2019). The decentralized nature of the distributed network enables overcoming some challenges that the healthcare industry is currently facing (Hassan et al.2019). Blockchain has different distinguishing characteristics that can augment the secure healthcare data management ecosystem as shown in **Figure 2 (**Yaqoob et al. 2021**)**. The key blockchain characteristics and advantages in healthcare are described in **Table 1**.

Table 1: Key Blockchain Characteristics and Advantages in Healthcare.

Blockchain Characteristics	Advantages in Healthcare	Citation
Decentralization	Blockchain technology has eliminated the need for a central entity or intermediary to store, retrieve, and exchange healthcare data. Decentralization of patient data can enhance care coordination and improve patient safety. Decentralizing data along with enhancing security and transparency in data processing significantly boost interoperability, quality, and collaboration within the healthcare system. This also cuts administrative expenses and elevates the authenticity and verifiability of information.	Azaria et al., 2016; Narikimilli et al., 2020; Alexopoulos et al., 2017; Hasan et al. 2021; Nguyen et al., 2021
Transparency	Blockchain's transparency can greatly benefit clinical trial research, enhancing the structure, transparency, and reliability of the clinical trial process, as the technology promotes frictionless data exchange. It can improve the quality management processes that are crucial in healthcare service delivery. It can also create a climate of trust within the healthcare ecosystem.	Benchoufi & Ravaud, 2017; Gokalp et al., 2018; Mettler, 2016; Govindan et al, 2022
Immutability	Blockchain can secure electronic health records and clinical trials to ensure regulatory compliance. It uses cryptographic hashing to create secure and tamper-proof networks, thereby increasing the reliability, authenticity, and integrity of healthcare records and transactions.	Prokofieva, M., & Miah, 2019; Quasim et al.2020; Umar et al., 2022.
Anonymity	Blockchain-based networks ensure that all transactions are anonymized to ensure privacy and security. Blockchain technology allows user interactions to occur through automatically generated addresses that keep the users' identities anonymous. This capability is particularly useful in managing healthcare complaints, where privacy is crucial.	Zheng et al. (2018); Ivan, 2016

Table 1: Key Blockchain Characteristics and Advantages in Healthcare (Continued).		
Blockchain Characteristics	**Advantages in Healthcare**	**Citation**
Smart contract	Smart contracts facilitate secure and efficient transactions among authorized parties. Blockchain's smart contracts and consensus algorithms can verify the validity and reliability of clinical trial results, thus eliminating errors and maintaining integrity. Blockchain can automate and streamline the medical billing and claims process by securely storing and verifying transactions. Using smart contracts to automate payment processing can reduce administrative expenses and increase transparency.	Ng et al., 2021; Lu et al., 2021; Moatari-Kazerouni et al., 2023; Hasan et al., 2021; Dimitrov, 2019; Gokalp et al., 2018.
Interoperability	Blockchain enhances data security, confidentiality, and interoperability, and permits patients to become integrated into the ecosystem. The technology enables interoperability among diverse healthcare providers and presents patient records in a standardized format. This creates a transparent, interoperable environment where rules can be established, enforced, and modified. Additionally, cross-institutional sharing will enable considerable advances in healthcare outcomes and research efficiency.	Hussien et al 2021; Aste et al. 2017; Fatokun et al., 2021
Traceability	The traceability offered by blockchain technology is crucial for verifying the authenticity of drugs, reducing the presence of counterfeit medications in pharmaceutical supply chains, and overseeing clinical trials. The technology validates the authenticity of medical drugs and devices and enables tracking patient records. Ethereum platform contracts enable automated interventions in a secure environment by offering real-time patient monitoring applications.	Kim & Laskowski, 2018; Engelhardt, 2017; Hasan et al., 2021; Griggs et al., 2018; Lu et al., 2019.

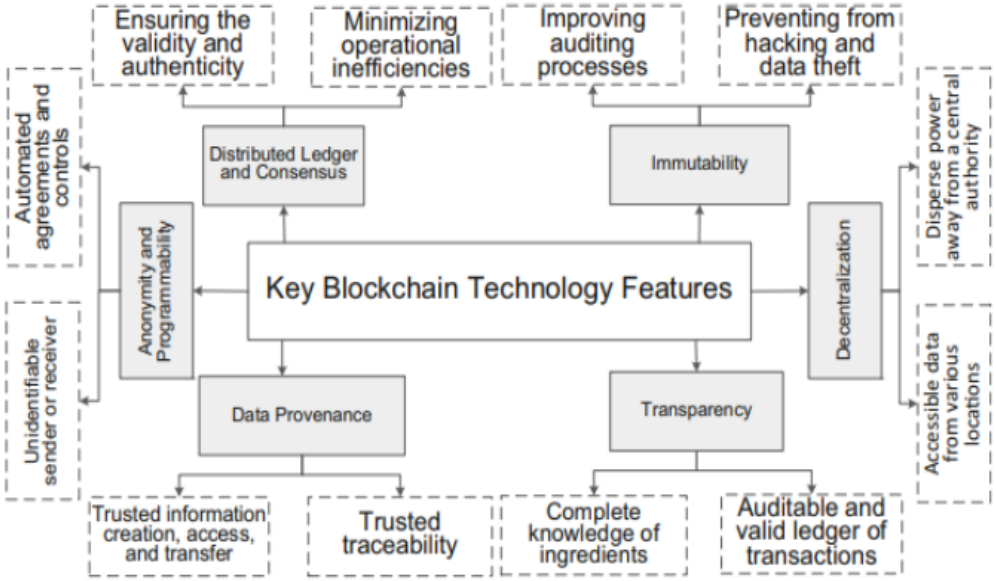

Figure 2: Blockchain Technology Features and Benefits in Healthcare Industry (Yaqoob et al., 2022).

2.5. Technology-Organization-Environment Framework

The main theoretical framework for my research model is the technology-organization-environment (TOE) framework. In this section, I discuss the TOE literature to guide the identification of factors for blockchain adoption. For any technology adoption, technical, organizational, and external issues must not be underestimated, as they significantly influence the success of the implementation (Singeh et al., 2020). The TOE framework (Tornatzky & Fleischer 1990) has been utilized to investigate the technological, organizational, and environmental factors that impact the adoption intention of blockchain in several industries, including healthcare (Silva, 2015). This study contributes to the literature by offering an integrated technology adoption model that combines diffusion of innovation (DOI) (Rogers, 2003) and technology-organization-environment (TOE) (Tornatzky and Fleischer 1990). Compared to other adoption models widely

explored, such as the technology acceptance model (TAM) (Davis et al., 1989), the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003; Venkatesh et al. 2012), the theory of planned behavior (Ajzen, 1985), and the theory of reasoned action (TRA) (Ajzen, 1980), the current study proposes a comprehensive, integrated TOE-DOI framework. The TAM focuses on how individual users approach technology adoption, analyzing factors that affect their personal behaviors. However, the TOE evaluates the technology adoption decision at the firm level through incorporating the technological, organizational, and environmental contexts (Kumar et al., 2021). The technological context pertains to the attributes of technology that affect its adoption process. The organizational context involves the impact of an organization's characteristics and resources on decisions to adopt innovations. The environmental context refers to the effect of the external and interorganizational environment in which a business operates. Given the significance of context in the adoption of technology, the TOE framework serves as an effective foundation for analyzing the adoption process in its actual setting (Baker, 2012).

Researchers have studied information technology in organizational innovations and have recognized various technological, organizational, and environmental factors that contribute to the broader discourse of the organization's decision to adopt an IT innovation (Clohessy & Acton, 2019). Other literature has studied factors influencing blockchain adoption from TOE perspectives, as demonstrated in **Table 2**. The technological aspect outlines technological attributes such as technology complexity, technology compatibility, and the status of the current technology used by the organization. The organizational context encompasses the organization’s characteristics and resources, including innovativeness, organizational readiness, and management support. The environmental context examines external factors such as the regulatory environment and competitive organization pressure (Batubara et al., 2018). These antecedents’ interactions can

influence the technology adoption decisions in the healthcare industry. TOE provides a comprehensive understanding of user technology adoption, its implementation, anticipated challenges, impact on value chain activities, post adoption diffusion among firms, factors influencing business innovation-adoption decisions, and the development of enhanced organizational capabilities through technology (Lin and Lin, 2008; Wang et al., 2010; Salwani et al., 2009; Zhu et al., 2004). Most previous studies have utilized the TOE framework, often in combination with other theories, to extensively analyze the direct factors influencing blockchain adoption (Lu et al., 2021). TOE offers an advantage over other adoption models in evaluating technology adoption (Clohessy and Thomas, 2019; Gangwar et al., 2015). However, as the constructs of the TOE model are highly generic, the literature proposes that the predictive power of a TOE model can be tremendously improved by integrating it with other models (Gangwar et al., 2015).

Table 2: Literature Summary of Technology Adoption Factors Based on TOE Framework.

Study	Technological Factors	Organizational Factors	Environmental Factors
Clohessy et al., 2020	Complexity, perceived benefits, security	Organizational readiness, top management support	Market dynamics, the regulatory environment
Batubara et al., 2018	Security, scalability, flexibility, compatibility	Organizational readiness, acceptability, new governance models	Laws and regulations
Clohessy et al., 2019	Perceived technological benefits, complexity, compatibility	Organizational readiness, top management support, organizational size	Regulatory environment, market dynamics

Table 2: Literature Summary of Technology Adoption Factors Based on TOE Framework (Continued).

Study	Technological Factors	Organizational Factors	Environmental Factors
Orji et al., 2020	Compatibility, complexity, security and privacy, perceived benefits, infrastructural facility, ease of being tried and observed, availability of specific blockchain tools	Top management support, firm size, presence of training facilities, organizational culture, perceived cost of investment, capability of human resources	Government policy and support, competitive pressure, stakeholder pressure, market turbulence
Krigsholm et al., 2019	Right application of technology, complexity, security, and data protection	Staff knowledge and use of technology	Societal values and attitudes
Schuetz & Venkatesh, 2020	IT features	Staff support	User characteristics, market externalities, market characteristics
Broni, 2019	Technology availability	Awareness, organizational readiness (human and business resources), commitment (top management support)	Government e-readiness (government support and regulations), market forces e-readiness (market competition), industry support

Table 2: Literature Summary of Technology Adoption Factors Based on TOE Framework (Continued).			
Study	**Technological Factors**	**Organizational Factors**	**Environmental Factors**
Mohamed et al., 2019	Cost of technology	Adoption and organizational readiness	Industrial support
De Castro et al., 2020	Technological compatibility, complexity, relative advantage	Top/middle management support	Financial economies of scale
Batubara et al., 2018	Security, scalability, flexibility, compatibility	Organizational readiness, acceptability, new governance models	Laws and regulations
Barnes et al. 2019	Perceived usefulness, compatibility, relative advantage, complexity, scope of technology	Top management support, organizational readiness, firm size, firm centralization	Competition, trading partner support, technology vendor support, government support, customer support

2.6. Diffusion of Innovation

The TOE model is highly generic, and the literature proposes that the predictive power of a TOE model can be tremendously improved by integrating it with other models (Gangwar et al., 2015). In this section, I discuss the literature on diffusion of innovation (DOI) to guide the identification of factors for blockchain adoption. DOI originated from the sociology field, and it examines user response to the adoption rate of new technology. Primarily, innovation is considered as any new idea, process, product, or technology. DOI theory suggests that the characteristics of an innovation influence how organizations form beliefs, which subsequently impacts their decision to adopt or reject the innovation (Rogers, 1983). DOI theory identifies five

technological attributes: perceived relative advantage (the technology is superior to the current system), compatibility (the technology can be integrated in the current system), complexity (learning the technology), observability (the extent of application visibility), and trialability (the ease of testing the technology); these are important to consider for successful adoption of an innovation (Almekhlafi & Al-Shaibany, 2021; Rogers, 2010; Yuen et al. 2020). The five technological attributes are described in **Table 3**.

Table 3: Attributes of Innovation (Rogers 1983).

Attributes	Definition
Relative advantage	A metric indicating the added value of the innovation or technology when adopted
Compatibility	An indication of how consistent the innovation is with the values and morals of the organization or target user group
Complexity	A measure of the perceived ease of understanding and use of the innovation
Observability	An attribute indicating the measurability of the innovation's outcomes and results
Trialability	The degree of experimentation allowed to the user for familiarization purposes

Perceived relative advantage typically has a positive impact on the diffusion of innovation. When an innovation is compatible, it tends to accelerate the adoption process in society, spreading more rapidly if it aligns with the norms and values of individuals or social systems (Amini & Jahanbakhsh, 2023). Generally, complexity negatively affects diffusion: the more complex an

innovation, the lower its chances of being successfully adopted. Relative advantage, compatibility, and complexity are factors that most significantly influence the adoption of innovations (Tornatzky & Fleischer, 1990). Innovation characteristics can affect the organization's decision to adopt a new technology (Hsu et al., 2006).

Since organizations vary in their capabilities to adopt new innovations, different organizations adopt innovative technology at different times (Oliveira & Matins, 2011). For new technologies to achieve their advantages and maximum potential, they must be broadly diffused and incorporated in different systems. In DOI, the adopter characteristics are classified into innovators, early adopters, early majority, late majority, and laggards (Taherdoost et al., 2012). The innovation decision encompasses implementation, knowledge, persuasion, confirmation, and decision-making processes that occur over time and through communication channels among members of similar social systems (Taherdoost et al., 2012). This model also identifies four elements that can affect the spread of a new idea across various types of innovations. These elements include communication channels, time, the innovation itself, and the social system involved (Taherdoost, 2022). The DOI framework is capable of explaining innovation adoption at the organizational, individual, and even global levels, providing a theoretical basis for these applications. However, it is also less focused on explanatory analysis. Consequently, this theory has shown less practical predictive power in outcomes compared to other adoption frameworks (Taherdoost, 2018).

Several studies have used the diffusion of innovation theory to explore blockchain technology adoption (Clohessy and Acton, 2019; Hartley et al. 2022; Kumar et al. 2021). While past studies have used DOI theory to explore the adoption of advanced technologies within organizations (Ali et al., 2020), earlier research has also introduced various constructs to create

more comprehensive interpretive models (Oliveira et al., 2014; Picoto et al., 2014). The core idea behind diffusion of innovation theory is the gradual adoption of innovations by individuals or organizations. It explains the pattern and speed at which the ideas are spread (Gondal, 2023). This model helps public health leaders and decision-makers think about strategies to address the uncertainties that accompany the implementation of new innovations (Scott et al., 2008). Hence, I conceptualize my research framework based on the integration of the TOE and DOI frameworks. In this research, I incorporate relative advantage and perceived complexity from DOI theory with constructs from the TOE framework. The proposed combination addresses the need for more research on blockchain adoption intention from institutional perspectives.

2.7. Blockchain Adoption in the Healthcare Industry

Despite the value blockchain provides to the healthcare industry, numerous challenges and considerations need to be addressed to ensure its adoption and diffusion through the ecosystem (Wong et al., 2018). Although there are several reviews on blockchain applications in the healthcare industry (Agbo et al., 2019; Abu-elezz et al., 2020; Balasubramaniam et al., 2021; Hasselgren et al., 2019; Holbl et al., 2018; McGhin et al, 2019), it is argued that less attention has been paid to blockchain adoption in healthcare studies (Bazel et al., 2023). Alzahrani et al. (2022) investigated low adoption and high failure rates of blockchain technology and the failure rate of existing blockchain-based applications. This slow adoption can be attributed to several factors, including lack of awareness among healthcare professionals, concerns about the technology's trustworthiness, and regulatory concerns related to data privacy and security (Malik et al., 2021). There is a lack of research assessing the readiness of healthcare organizations to adopt blockchain technology. Additionally, studies highlighting the internal and external factors affecting blockchain adoption and incorporating expert perspectives in healthcare are scarce (Alzahrani et

al. 2022). This section seeks to offer an exhaustive review of the literature on blockchain technology and its adoption in the healthcare industry to enhance the comprehension of blockchain technology and its benefits in the healthcare industry, along with highlighting drivers and barriers to blockchain technology adoption in the healthcare industry.

Blockchain faces technological, organizational, and societal hurdles on its path to operationalizing healthcare businesses. Researchers have identified several limitations and problems with blockchain in healthcare, including the absence of standardization, issues with decentralized storage and privacy breaches, challenges in managing keys, and scalability concerns (McGhin et al. 2019). Therefore, scholars have suggested that blockchain's successful adoption requires robust synergy and intentional collaboration among multidisciplinary stakeholders (Lee et al., 2012). Additionally, researchers have highlighted that blockchain implementation is challenging due to several underlying reasons such as immature technology, insufficient skills, regulatory constraints related to data privacy and security, lack of executive buy-in, unclear return on investment (ROI), lack of compelling business cases, lack of financial incentives to build blockchain solutions, and potential interoperability issues (Haleem et al., 2022; 2023; Malik et al., 2021; Pirtle & Ehrenfeld, 2018; Sharma & Joshi, 2021). Another major concern with implementing blockchain in healthcare addressed in literature is the scalability issue combined with regulatory uncertainty (Katuwal et al., 2018). There is a profound need for in-depth research on the ethical, social, and economic aspects of blockchain adoption in the healthcare industry (Alzahrani et al., 2022), as few studies have investigated the influencing factors of blockchain adoption in the industry (Lu et al., 2021).

Several researchers have investigated the barriers and challenges to blockchain adoption (Ben Fekih & Lahami,2020; Chen et al., 2019; Prokofieva & Miah, 2019; Yaqoob et al., 2022).

Some key factors addressed for blockchain adoption in the healthcare sector are regulatory and legal considerations, innovation readiness, privacy and trust, and supporting infrastructure (Dhagarra et al., 2019; Gassner, 2018; Onik et al., 2019). Clohessy et al. (2019) examined blockchain technology adoption determinants from technological, organizational, and environmental perspectives. The technological factors influencing blockchain adoption include complexity and data security (Lu et al., 2021; Sharma & Joshi, 2021). Organizational considerations highlighted by the scholars encompass organizational readiness, top management support, and organizational size (Balasubramaniam et al., 2020). Environmental considerations include the regulatory environment and market dynamics. Scholars conducted a systematic literature review to explore the challenges of blockchain adoption for e-government. The identified factors include security, scalability, acceptability, and lack of regulatory support (Aich et al., 2021; Batubara et al., 2018; Balasubramaniam et al., 2021). McGhin et al. (2019) addressed lack of standardization, scalability, privacy leakage, and management support as key limitations for blockchain adoption in healthcare. The factors influencing the adoption of blockchain technology addressed in the literature are summarized in **Table 4**.

Table 4: Summary of Factors Influencing Blockchain Technology Adoption.

Factors	Significance in Technology Adoption	Reference
Perceived Relative advantage	The more comparative benefits technology offers (if the stakeholders see clear advantages from it), the more likely it is to be adopted.	(Hartley et al., 2022) (Khwaji et al., 2022) (Toufaily et al., 2021)
Compatibility	Compatibility with current systems should be assessed before implementing a technology.	(Attaran, 2022)

Table 4: Summary of Factors Influencing Blockchain Technology Adoption (Continued).		
Factors	**Significance in Technology Adoption**	**Reference**
Management support	New regulations may also be introduced with the technological implementation. Therefore, management support should be provided.	(Nayak & Dhaigude, 2019) (Barnes III & Xiao, 2019) (Akram et al., 2020)
Organizational readiness	Various factors of organizational readiness have a direct and positive impact on the adoption intention of blockchain technology in healthcare.	(Balasubramanian et al., 2021) (Clohessy & Acton, 2019)
Competitive pressure	Competitive pressure accounts for both positive and negative impact on the adoption attention, as sometimes competitive forces contribute to inequalities in healthcare systems.	(Seshadrinathan & Chandra, 2021) (Malik et al., 2021)
Government support	The support of government officials indirectly poses a positive impact on the intention of blockchain technology adoption.	(Alazab et al., 2021) (Khwaji, 2022)
Interoperability	Interoperable healthcare systems enhance data security, integrity, and cross-platform deployment.	(Reegu et al., 2023) (Reegu et al., 2022)
Trust in technology	Confidence in the strength of blockchain as an antimalware and anti-fraud technology furthers the intention of adopting blockchain technology in healthcare.	(Hasselgren et al., 2021)
Convenience	Healthcare workers are more likely to see value in a blockchain-based healthcare system if they believe it to be convenient.	(Altamimi et al., 2024)

Table 4: Summary of Factors Influencing Blockchain Technology Adoption (Continued).		
Factors	**Significance in Technology Adoption**	**Reference**
Perceived cost	According to a study, online reservation services' perceived usefulness is positively impacted by their cost. This might potentially be investigated in relation to blockchain technology. Therefore, the likelihood that medical professionals will embrace a blockchain-based healthcare system will decrease as installation and staff training costs increase.	(Dehghani et al., 2021)
Perceived privacy	The perceived security and privacy of a blockchain healthcare system was found to have a significant impact on users' perceptions of its utility. The perceived security and privacy of the blockchain-based healthcare systems have a major influence on how beneficial they are seen to be.	(Altamimi et al., 2024) (Kumar & Jain, 2023)
Attitude	It was discovered that behavioral intention to adopt blockchain technology was significantly influenced by attitude. It has been postulated that as healthcare professionals view blockchain technology favorably, there will be a greater behavioral intention to use the blockchain-based healthcare system.	(Sciarelli et al., 2022) (Altamimi et al., 2024)
Effort expectancy	The behavioral intention of healthcare providers to utilize the blockchain-based healthcare system is also influenced by effort expectancy.	(Dbesan et al., 2023) (Venkatesh et al., 2012)

Table 4: Summary of Factors Influencing Blockchain Technology Adoption (Continued).		
Factors	**Significance on Technology Adoption**	**Reference**
Information transparency	One of the main aspects of BCT that draws organizations to adopting it is information openness. An organization's overall performance is improved by this.	(Sunny et al., 2020) (Saheb & Mamaghani, 2021) (Malik et al., 2022)
Perceived risks	Certain risks associated with new technologies, such as BCT, prevent businesses from adopting them.	(Malik et al., 2022)

Reviewing blockchain adoption literature in healthcare provides a profound understanding of the current literature landscape and sheds some light on gaps in research studies. The most prominent gap is the discrepancy between the growing interest in blockchain technology in healthcare and the slow actual adoption of the technology within the sector along with the limited number of research studies that seek to understand why this gap exists. Previous studies have been limited in scope, focusing on fewer factors, specific contexts, or not providing a holistic view. A comprehensive understanding of the factors driving organizational adoption intention in the healthcare sector is still lacking. Specifically, there is a need to explore how innovation characteristics, technological context, organizational readiness, and environmental pressures collectively influence the decision to adopt blockchain within healthcare organizations. This research investigates factors that support or hinder a healthcare firm's intention to adopt blockchain technology. By gaining a thorough picture of these adoption factors, healthcare stakeholders can identify strategies to enhance drivers and reduce barriers to the adoption in healthcare systems.

2.8. Research Model

2. 8.1 Research Model: TOE-DOI Integration

To answer the research question and based on a comprehensive review of extant literature, my research model integrates diffusion of innovation (DOI) theory and the technology-organization-environment (TOE) framework. Since the adoption of blockchain technology is not only dependent on individual user behavior but also on external, uncontrollable factors, a combination of the DOI and TOE frameworks are incorporated into the blockchain adoption model. A limited number of studies have incorporated TOE-DOI in blockchain adoption research in healthcare (Sharma & Joshi, 2021; Lu et al., 2022); therefore, I aim to address this combination to assess and determine factors of blockchain adoption intention in healthcare.

TOE looks at technology adoption from an organizational perspective, considering factors that influence the entire enterprise; it considers internal and external environmental factors. However, the TOE model is highly generic, and the literature proposes that the predictive power of a TOE model can be tremendously improved by integrating it with other models (Gangwar et al., 2015). On the other hand, DOI examines the characteristics of innovations that can facilitate technology adoption (Kumar et al., 2021). However, this theory has shown less practical predictive power in outcomes compared to other adoption frameworks (Taherdoost, 2018). The research indicates that DOI and TOE complement each other (Lu et al., 2021). Therefore, the integration of TOE-DOI aims to develop a comprehensive perspective and improve the understanding of determinants of blockchain adoption intention within technical and organizational contexts (Lu et al., 2021).

In this research, I propose incorporating relative advantage and perceived complexity from DOI framework, that are the innovation dimensions. Further, it considers perceived technology interoperability, which is the technological dimension of the TOE framework. Furthermore, the TOE model considers top management support and organizational readiness as organizational dimensions and government and regulatory support and competitive pressure as environmental dimensions in examining the adoption of blockchain technology at the healthcare firm level. The proposed conceptual model is shown below in **Figure 3,** and the following section discusses each of the research hypotheses.

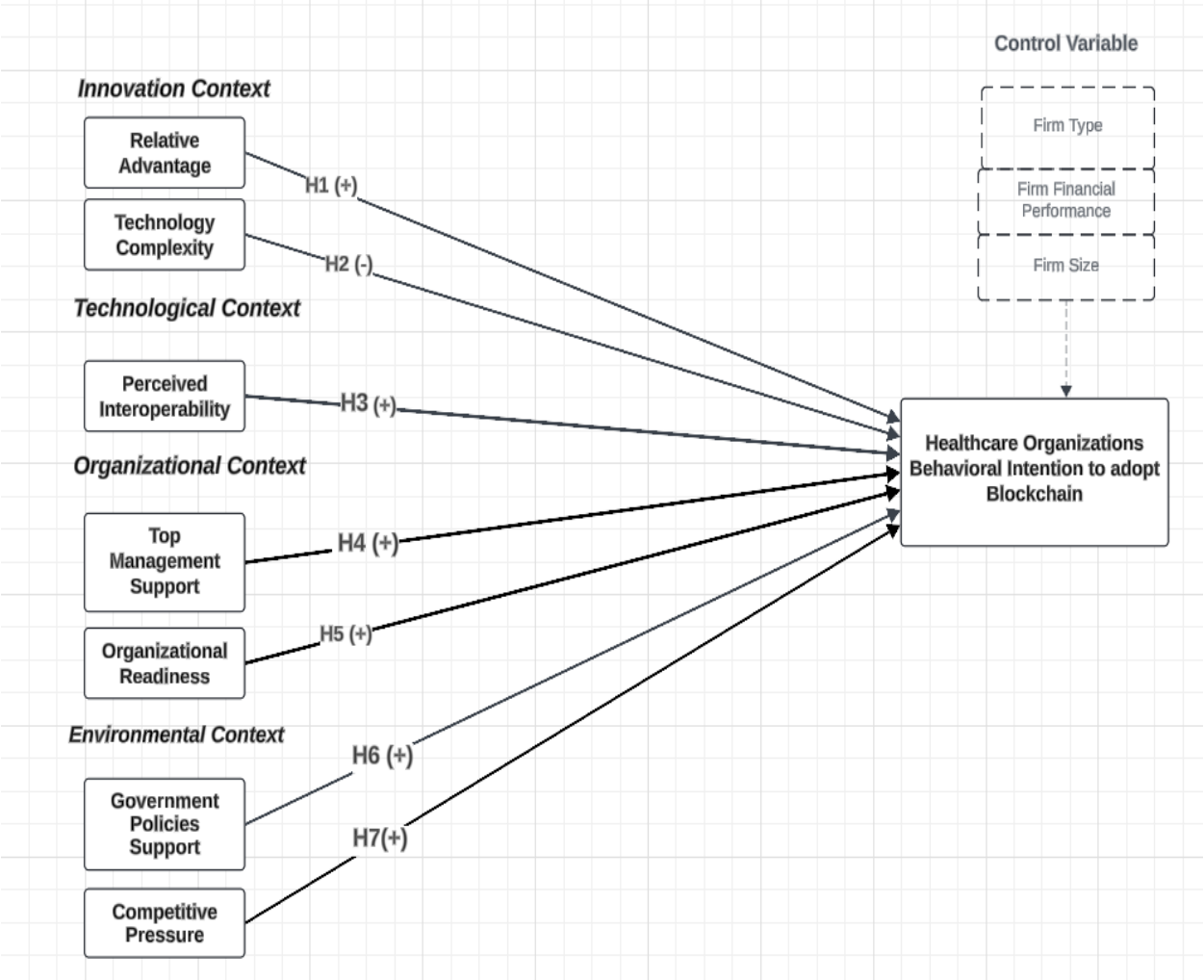

Figure 3: Conceptual Model of the Adoption Intention in Blockchain.

2.9 Hypothesis Development

2.9.1 Innovation Context

2.9.1.1 Perceived Relative Advantage

Rogers (2003) describes relative advantage as the perception that an innovation or technology will outperform the organization's current processes or technologies in terms of cost, quality, speed, flexibility, or other crucial factors. It includes comparing existing technologies to proposed technologies as well as evaluating the perceived benefits that follow (Hashimy et al., 2023). The more significant the perceived difference, the higher is the likelihood of adoption. The more technology like blockchain is seen as an improvement (like a decentralized database) over current systems, the more likely it is that the healthcare organization will adopt it. Relative advantage, as used in this study, describes how much blockchain technology is considered superior to its predecessor for healthcare firms. The more benefits blockchain technology offers to a company, such as security, quick transactions, and immutability, the more likely it is that the organization will embrace innovation (Toufaily et al., 2021). Different industries explore and adopt various technologies to address some issues and gain a competitive advantage (Jones & Wynn, 2021). A study by Lu et al. (2021) showed that innovation adoption is more likely to be successful if the users can clearly understand its benefits. Numerous studies in the healthcare domain have been carried out that suggest the significant benefits of expediting adoption (Hartley et al., 2022). Therefore, this construct has the strongest positive correlation with the adoption intention (Lu et al., 2021). It is considered the most critical factor for blockchain technology adoption (Clohessy & Acton, 2019).

Internet of things (IoT) wearable devices, including smartwatches, cell phones, and smart glasses, can be linked to the public blockchain of healthcare providers. This can enable efficient

health data exchange across different systems, which subsequently allows physicians to perform reliable treatments (AbdelSalam, 2023). It is believed that creating a public blockchain can reduce costs, accelerate learning, minimize risk, enhance technology adoption, and influence regulations (Hillestad et al., 2005). Furthermore, blockchain has some outstanding advantages over other technologies in terms of security and privacy protection (Shi et al., 2020). Blockchain technology integration in healthcare is predicted to provide better transparency, enhanced interoperability, and improved security (Fatokun et al., 2021; Katuwal et al, 2018), making organizations more credible and boosting their competitive edge (Quiroz et al., 2021). Al Omar et al. (2019) noted that a blockchain-based system for storing health data offers better privacy protection compared to earlier health data storage methods. Smart contracts enable safe and streamlined transactions among participating entities (Ng et al., 2021); they can substantiate the clinical trial's validity, trustworthiness, and outcomes (Moatari-Kazerouni et al., 2023). Therefore, they promote the technology's relative advantages that support the adoption intention. As previous studies have noted, blockchain offers numerous advantages that are believed to positively influence the organizational intention to adopt the technology and ultimately promote its adoption (Kamble et al., 2021). Therefore, this study posits the following hypothesis:

H1: *Blockchain technology perceived relative advantage positively associates with the intention to adopt blockchain technology in healthcare organizations.*

2.9.1.2 Perceived Technology Complexity

Perceived technology complexity is the degree to which technology is seen as difficult to adopt and use (Rogers, 2003; Sun et al., 2018; Wang et al., 2018). Complexity is a significant inhibitor of the adoption of new IS technologies (Aboelmaged & Hashem, 2018; Lu et al., 2021). Researchers have suggested that new technologies can be seamlessly adopted and incorporated

into systems if the technologies are perceived as easy to use (Lu et al., 2021). Difficulty in understanding the technology or acquiring the necessary skills to use and integrate it into operations may negatively affect the intention to adopt (Gangwar et al., 2015). Research have indicated that lack of technical knowledge regarding blockchain technology can be one of the impediments to the technology adoption intention (Hashimy et al., 2023). Blockchain networks' public and private keys and hashing algorithms are intricate processes that may make it challenging for healthcare organizations to adopt the technology. The elimination of central authority with blockchain technologies provides a decrease in process complexity (Gokalp et al.2020). However, the complexity of the digital transformation that would encompass a profound change in the system has led other large organizations to reject blockchain (Clohessy & Acton, 2019). Wong et al. (2020) suggested that blockchain technology is nascent, which increases anxiety about using the technology, thereby impeding technology adoption. The complexity of understanding the technology or acquiring skills to use it and integrate it into operations may negatively impact the adoption intention of this technology. Organizations may incorporate training and education to comfortably and seamlessly leverage technologies such as blockchain. Training services can be too costly for organizations with fewer resources (Hartley et al., 2022). Technological complexity is an essential determinant of the organizational intention to adopt blockchain technology in literature (Castro et al., 2020; 2017; Chen et al., 2018; Lansiti & Lakhani; Wang et al., 2016). Therefore, it is incorporated in the research model in the following hypothesis:

H2: *Perceived complexity of blockchain technology is negatively associated with the blockchain adoption intention in healthcare organizations.*

2.9.2 Technology Concept

2.9.2.1 Perceived Interoperability

Interoperability is the ability of blockchain to function effectively with other technologies and infrastructure (Vergouwen et al., 2020). It is frequently listed in existing literature as a limiting factor to blockchain adoption (Clohessy, et al., 2018; Rauchs & Hileman, 2017; Sadhya & Sadhya, 2018; Wang et al., 2016). Blockchain interoperability in healthcare is seen as the capability of different systems to function together seamlessly across the healthcare landscape to deliver more effective and efficient healthcare services (Villarreal et al. 2023; Yeung, 2021). A lack of interoperability with existing infrastructure and blockchain applications is an obstacle to adoption. Gordon and Catalini (2018) describe interoperability as the belief in the capability of different technological systems to exchange, operate with, and effectively use shared information. An organization is likely to adopt blockchain technology to benefit from the interoperability functions. Blockchain technology can enhance interoperability and data exchange between various healthcare organizations (Azaria et al., 2016; Azogu et al., 2019; Li et al., 2021). Interoperability is essential for the seamless flow of health information among providers, patients, and payers. It allows stakeholders to access, exchange, and collaboratively use data with the objective of optimizing care management and population health (Hasselgren et al., 2020). The more an organization perceives its technological infrastructure to be interoperable, the more it will be capable of adopting new technology (Dehghani et al, 2022). Blockchain technology can increase patient control over their sensitive information while enhancing privacy and confidentiality (Haleem et al., 2021). Therefore, technology has the potential to improve care coordination and provide real-time patient health status monitoring, which can help alleviate interoperability issues between participating entities. There is a chance that patient-driven interoperability will bring in new

methods and frameworks for sharing information in the healthcare system. However, the literature addresses some issues pertinent to privacy, security, governance, and incentives (Ezmaeilzadeh, 2022). Healthcare interoperability has demonstrated the system's efficacy in accomplishing numerous objectives and providing solutions for a variety of EHR-related issues (Ng et al., 2021). Nonetheless, healthcare interoperable systems have the potential to enhance data security, integrity, and cross-platform deployment with strong integration across many healthcare ecosystems (Reegu et al., 2022). Interoperability is seen as a significant construct in innovation and technology adoption research (Wang et al., 2010). Building on previous studies, this research proposes that greater perceptions of interoperability are associated with a higher intention to adopt blockchain technology. Thus, this study posits the following hypothesis:

H3: *Perceived interoperability with current systems is positively associated with the blockchain adoption intention in healthcare organizations.*

2.9.3 Organizational Context

2.9.3.1 Top Management Support

Top management support is one of the most salient factors under the organizational context and is referred to as the management support and guidance towards the information system in the organization (Ifinedo 2011). Wong et al. (2020) define top management support as how managers perceive the value of supporting the blockchain adoption. Top management is identified as the decision-makers who influence decisions or play key roles in influencing decisions that result in the adoption of innovation (Clohessy &Acton, 2019; Lai, Lin, & Tseng, 2014). Researchers have identified support from top management as a crucial and detrimental factor influencing the adoption of technology (Cruz-Jesus et al., 2019; Gangwar et al. 2015; Khayer et al., 2020; Nilashi et al., 2016; Sabherwal et al., 2006;). Similarly, robust support from management plays an

instrumental role in the adoption of blockchain technology. Research suggests that the adoption of blockchain technology in healthcare is positively impacted by senior management support (Khwaji et al., 2021). Therefore, it is challenging to integrate blockchain technology into the existing systems without the support and promotion of top management executives (Sharma & Joshi, 2021; Lu et al., 2021). The top management allocation of sufficient infrastructural, financial, and human resources is an indispensable force driving the adoption of new technologies such as blockchain (Swan 2015; Clohessy and Acton, 2019).

Top management support offers a strong vision that helps an organization overcome obstacles and fosters an environment of commitment and innovation and may provide sufficient guidance in the adoption process. Hameed et al. (2012) identified leaders and top management as constituting a key critical factor in the adoption of innovations. Past research on technology adoption has shown that top management support and motivation play a crucial role in the innovation adoption within an organization (Nath et al., 2022; Wang et al., 2010). In healthcare, executive and top management support accelerates new technology adoption and integration, therefore enhancing sensitive health data exchange to improve care management and outcomes. However, Holotiuk et al. (2017) indicate that the lack of top management knowledge of blockchain impedes its adoption. The literature highlights the positive role of top management support in blockchain technology adoption (Kamble et al., 2021): it provides direction and resources for the technology adoption process. Moreover, top management can lead and motivate employees to embrace change because of the emerging technology adoption (Oliveira et al., 2014). Based on the above discussion, the following hypothesis was formulated:

H4: *Top management support is positively related to a healthcare organizations' intention to adopt blockchain technology.*

2.9.3.2 Organizational Readiness

Organizational readiness is defined as the capacity of an organization to allocate resources, both financial and technological (Kim and Garrison, 2010). Generally, it has been described with two dimensions: first, financial resources are associated with the cost of the information system under assessment; second, technological resources are the degree of expertise and knowledge in the IT industry, infrastructure, and human resources related to technology usage and management (Oliveira & Martins, 2010). For example, poor IT infrastructure and lack of technical skills and expertise are often barriers to technology implementation. The ability of an organization to carry out and maintain a change program determines their readiness. According to Weiner (2020), organizational readiness is motivated by healthcare improvement interventions that entail collective behavior change in the form of systems redesign, that is, multiple, simultaneous changes in staffing, workflow, decision-making, communication, and reward systems. Several research studies have consistently revealed three attributes or criteria used to measure the readiness of an organization: facilitation, culture, and context (Kabukye et al., 2020).

Research has also established that various readiness factors have a direct, positive impact on the adoption intentions of blockchain within the healthcare sector (Clohessy & Acton, 2019). However, for organizations that are not equipped with sufficient technical, human, and financial capabilities, the willingness to adopt new technology is weak (Maroufkhani et al., 2020). An organization’s innovativeness is connected to its decision to adopt and implement new technologies. By enhancing the processes and paying attention to careful planning and implementation, the process of implementing new technologies has become less complicated in healthcare organizations. Organizational readiness assesses a manager's perception of their organization's capability to adopt new technology, based on various criteria such as awareness,

resources, commitment, and governance (Tan et al., 2007). Drawing from Wang et al. (2010), organizational readiness is characterized by the presence of personnel possessing the necessary information technology expertise and competencies, the allocation of financial assets for the adoption of IT innovations (such as a dedicated IT budget), and the infrastructure conducive to the development of blockchain applications.

Khoja et al. (2007) outline readiness in healthcare as the stakeholder's willingness to predict changes attributed to digital transformation: a high level of organizational readiness and preparedness positively influences technology adoption behavioral intention (Gangwar et al., 2015). It is thus crucial for healthcare organizations to assess their readiness prior to major technology adoption and implementation in order to earlier detect issues that threaten the success of the implementation. Given the requisite financial, technological, and human resources for its implementation and utilization, it is posited that the organizational readiness of a particular healthcare entity will influence the adoption intention of blockchain technology. Therefore, this study proposes that organizational readiness is one of the most essential conditions for healthcare organizations' intent to adopt blockchain. As such, I propose the following hypothesis:

H5: *Organizational readiness is positively associated with a healthcare organization's intent to adopt blockchain technology.*

2.9.4 Environmental Context

2.9.4.1 Government and Regulatory Support

The government is regarded as the most important stakeholder, as their involvement in blockchain adoption can be crucial and detrimental. Government and regulatory support encompass policies and laws that are essential in promoting the adoption of new technology (Guo and Liang, 2016). To minimize uncertain outcomes, government support and regulations are

mandatory to diffuse the innovation (Wunsche, 2016). Government regulations and legislation can significantly support the adoption intention of blockchain technology. Existing government regulations can either promote or hinder technology adoption. Blockchain policies and regulations can determine, control, and monitor the authorization of the participating organizations (Viriyasitavat & Hoonsopon, 2019). Williamson (1980) suggests that government regulations can support technology adoption through 1) designing legislation that supports and defines how technology can be implemented and scaled across different environments and 2) providing incentives to implement the technology (Clohessy & Acton, 2019). The government plays a crucial role in cultivating an ecosystem of partners for the adoption of technologies, and regulatory agencies are currently crafting guidelines to meaningfully manage the implementation and utilization of blockchain in healthcare (Lu et al., 2021). These rules are designed to balance encouraging innovation with protecting patient well-being. However, keeping up with these changing regulations presents challenges for healthcare providers and technology developers, requiring a deep comprehension of compliance requirements.

Government regulations can encourage healthcare organizations to invest in and adopt blockchain technology. Blockchain smart contracts and their legal validity compared to traditional contracts could be a concern that is even more significant in healthcare, where a patient's health or even life could be at risk (McGhin et al., 2019). As the technology is newly developed, the design of new regulations includes some challenges, such as the ownership of digital records and access rights (Çaldağ et al., 2019; Gökalp et al., 2018). To facilitate blockchain adoption, regulatory and legal frameworks must align with the framework of new blockchain applications, and these applications must adapt to comply with regulations (Balasubramaniam et al., 2021). Governments are required to facilitate transparency, especially in governance, pricing, and distribution of

resources, and the governments of many countries have expressed interest in blockchain technology for this purpose (Toufaily et al., 2021). However, the biggest obstacles to blockchain adoption in the healthcare sector are unclear regulatory regulations (Govindan et al., 2023). A lack of clear government rules and incentives for implementation contributes to the hesitancy of healthcare leaders to adopt this technology (Aich et al., 2021; Lee et al., 2020). In the realm of blockchain technology, organizations will be more motivated to adopt the technology, if a government establishes specific policies. Therefore, government policy and regulatory support is identified as a critical factor affecting organizational adoption of blockchain-based platforms. Based on the above literature, this study assumes a direct relation between regulatory support and blockchain technology adoption intention in the healthcare industry:

H6: *Government and regulatory support positively influence the adoption intention of blockchain technology in healthcare organizations.*

2.9.4.2 Competitive Pressure

Competitive pressure has been defined as the degree to which firms compete for resources (Zhu and Kraemer, 2005). External pressure is often defined as the pressure exerted on an organization by competitors and business partners as well as by the government (Malik et al., 2021). Healthcare organizations tend to have strategies to incorporate emerging technology to increase their market share, save money, and ensure the delivery of better services (Liang et al., 2021). Research indicates that industry competition significantly influences information technology adoption. Previous literature (Chong & Chan, 2012; Francisco & Swanson, 2018) has identified competitive pressure as a catalyst that affects the adoption of emerging technology. A firm gains a competitive edge and enhances its market position by differentiating its products through new features along with implementing technological innovations. The literature confirms

that technological innovation is a huge driving force for organizations to remain competitive (Lu et al., 2021). Koens and Poll (2019) state that there is competitive pressure on organizations because of fear of missing out (FOMO). Vergouwen et al. (2020) consider two forms of FOMO. The first is the fear that other organizations might gain a competitive edge by adopting blockchain. The second is the fear that other organizations have already achieved a tangible competitive advantage through their adoption of blockchain.

The integration of blockchain technology within the healthcare industry can lead to secure health data exchange, enhanced interoperability, reduced fraud, and improved operational efficiency (Khezr et al. 2019; Attaran, 2022). Furthermore, blockchain adoption can enable patients to own and manage their data, which was previously not possible. By adopting new technology and information systems, healthcare organizations can leverage new strategies to outperform their competitors. Zhang et al. (2016) demonstrated that competitive pressure is a predictive factor for healthcare organizations to adopt health information technology. In a competitive environment, if some healthcare systems begin to utilize blockchain, others may feel compelled to leverage the technology. Early adopters tend to derive considerable competitive advantages. Additionally, since new companies and organizations may be less likely to catch up with larger firms in adopting blockchain, competitive forces contribute to inequalities in access to healthcare (Yeung, 2021). Research has shown that industry competition has a positive impact on information technology adoption (Ramadani et al., 2009). It is posited that the organizations adopting blockchain technology will gain a competitive edge over their peers. Therefore, I postulate that competitive pressure positively influences blockchain adoption intention in the healthcare industry:

H7: *Competitive pressure is positively related to the healthcare organization blockchain adoption intention.*

2.10. Control Variables

2.10.1 Firm Size

Several studies have suggested that firm size is a crucial factor that influences the organizational willingness to adopt new IT technology (Damanpour, 1992). Numerous scholars have emphasized the need to consider firm size in technology adoption studies (Lee & Xia 2006; Yao et al. 2003). Firm size is often highlighted as a critical organizational context factor (Zhu et al. 2006) and is seen as a significant attribute influencing firm characteristics. Previous research has indicated that organizational size affects the adoption of innovation, although empirical findings on this relationship are inconsistent (Prisco et al., 2022). Large firms are found to be more willing to leverage technological opportunities, as they have more resources and infrastructure. According to the literature, many small firms are unfamiliar with blockchain technology but have heard of digital currency, while some firms are concerned about legal and regulatory issues associated with technology (Balasubramanian et al., 2021). Large firms were found to be more innovative than small firms due to resource availability. Therefore, larger firms showed a higher propensity for leveraging blockchain technology. Researchers have indicated that organization size is a crucial aspect of the adoption intention of blockchain-based platforms (Mendling et al. 2018). Lee and Xia (2006) conducted a meta-analysis on how organizational size impacts IT innovation adoption and discovered a significant effect of organization size on technology adoption. Therefore, it is defined as a determinant control variable in the research model.

2.10.2. Firm's Financial Performance (Annual Revenue)

A firm's financial performance refers to the extent to which a company meets its financial goals or achieves its financial targets. In essence, it involves assessing the outcomes of a company's policies and operations in monetary terms (Klewitz and Hansen, 2014). This measurement serves as a tool to evaluate a firm's overall financial condition over a specific time frame. Organizations commit substantial and essential resources to advance their infrastructures, aiming to digitize operations. This enhances the flow of information and knowledge sharing across departments, which in turn drives improved performance (Liu et al. 2013). Since information technology provides a competitive advantage that drives innovation and improved financial performance, organizations with higher financial performance tend to invest more in their infrastructure and technology adoption. Therefore, it is incorporated in the research model as a determinant control variable to blockchain technology adoption intention.

2.10.3. Firm Type

Firm type serves as a crucial control variable since different entities within the sector face varying challenges, priorities, and regulatory requirements. For example, a hospital or healthcare system might prioritize blockchain solutions for patient record management and interoperability, while pharmaceutical companies might focus on using blockchain for supply chain transparency and drug traceability (Agbo et al., 2019). Health insurance organizations, on the other hand, might adopt blockchain to streamline claims processing and reduce fraud (Clohessy et al., 2019). These varying needs and operational focuses influence the intention to adopt blockchain differently, making organizational type a significant factor in understanding blockchain adoption across the healthcare landscape. Therefore, the research model will incorporate it as a control variable to predict the intention to adopt blockchain technology.

CHAPTER THREE: METHODOLOGY

3.1. Research Design

To evaluate the hypotheses proposed in the theoretical model, an online survey was used to collect data for this quantitative study. The unit of analysis is the healthcare organization, and the data are collected from individuals working in healthcare systems who have blockchain-related knowledge and have influenced the adoption of blockchain in their organization (Yurdusev, 1993; DeCarlo, 2018). Individuals working in healthcare systems as CEOs, CTOs, or IT directors/managers were considered the most informed about the organizational strategies of adopting new technologies and were therefore the target population for the survey. Participants with appropriate decision-making authority regarding technology adoption received the survey through email. It was hosted on a secure online platform, and the request to participate was sent through emails to potential participants. The structured response options in the survey ensured the standardization of data collection, minimizing potential errors associated with self-report measures.

3.2 Sample Size

According to Guest et al. (2006), sample size can be mathematically calculated. When determining the minimum sample size, it is critical to consider two types of statistical errors. The first is the type I (α) error, which happens when a true null hypothesis is falsely rejected. The second is the type II (β) error, which occurs when a false null hypothesis is wrongly accepted. Typically, the alpha value is set at 0.05, and the power of the test ($1 - \beta$) is set at 0.95 (Banerjee et al., 2009). To calculate the minimum sample size, this research leveraged G*Power software (Faul et al., 2009). The proposed study includes seven independent variables, and three control variables, totaling 10 predictors. G*Power calculated the minimum sample size, as shown in **Figure 4**, to be

90 responses (firms) based on these parameters. However, to improve the statistical results, the study targets a sample size of no less than 150 complete responses from different healthcare organizations. It is worth noting that a sample size of 200 is considered appropriate for conducting a profound analysis (Hair et al., 2016).

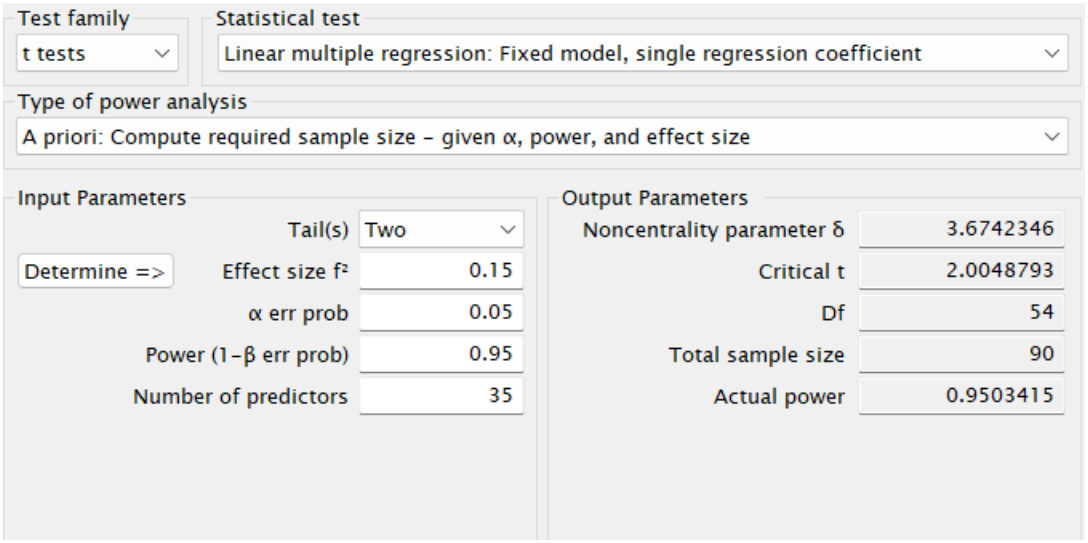

Figure 4: Results from Power Analysis Using Two-Tailed Linear Regression Model.

3.3 Instrument Development

To accurately determine the relationships between constructs, it is essential to develop a proper instrument (**see Figure 3**). This study employed an integrated TOE and DOI framework to examine the factors influencing blockchain adoption in healthcare organizations within the US. Based on existing literature and prior research, items and scales for TOE and DOI were selected. **Table 5** provides a description of the measurement items for each construct and references the literature from which they were adapted. In information systems research, five-point and seven-point Likert scales are commonly used, with the seven-point scale often preferred, as it offers more flexibility and choices to respondents and enhances the reliability and precision of the research

results (Zhu et al. 2004; Featherman & Pavlou, 2003). I used a sliding scale for my study to capture greater variance than that possible with five-point or seven-point scales.

The intention to adopt blockchain was measured using survey instruments where respondents (such as executives, IT managers, and key decision-makers in healthcare organizations) are asked to rate their level of agreement or disagreement with statements related to blockchain adoption. These statements are usually measured on a Likert scale (e.g., 1 = strongly disagree, 7 = strongly agree). Statements used to measure intention to adopt blockchain include "Our organization intends to adopt blockchain technology," "Our organization intends to use blockchain for requests (transactions or other processing requirements)," and "Our organization plans to invest in blockchain technology."

3.4 Measurement Items Description

The measuring items for the perceived relative advantage, perceived complexity, perceived interoperability, top management support, organizational readiness, government policies/regulations, and competitive pressure were adapted from previous peer-reviewed information system literature and modified to meet this research's requirements and context. The questionnaire comprises three segments. The first section introduces the participants to the motivation and objective of the study. The screening question determines whether the participants are qualified to pursue and complete the survey questions. The second section collects the respondent's demographic information such as gender, education, and technology experience. The third section includes all measurement items found in **Table 5**.

Table 5: Description of Measurement Items for Each Construct.

Construct	Variable	Measurement Items	Description	References
Behavioral intention	Dependent variable	BI_1 BI_2 BI_3	Our organization intends to adopt blockchain technology. Our organization intends to use blockchain for requests (transactions or other processing requirements). Our organization plans to invest in blockchain technology.	Venkatesh et al. 2003, Malik et al., 2021, Shin, 2017; Queiroz & Wamba, 2019.
Relative advantage	Independent variable	RA_1 RA_2 RA_3 RA_4 RA_5 RA_6	Blockchain will scale up our operations better. Blockchain will provide access to remote information from any time. Blockchain will provide access to remote information from any place. The adoption of blockchain technology will help to better serve and improve relationships with our customers. Blockchain will help us better access shared resources. Blockchain increases the organization's overall productivity.	Picoto et al. (2014a), Venkatesh and Bala (2008), Knauer and Mann (2019), Kamble et al., 2021, Malik et al., 2021.

Table 5: Description of Measurement Items for Each Construct (Continued).				
Construct	**Variable**	**Measurement Items**	**Description**	**Reference**
Technology complexity	Independent variable	TC_1 TC_2 TC_3	Using blockchain requires extra technical skills. Blockchain is difficult to understand from a business perspective. Blockchain is conceptually difficult to understand from a technical perspective	Kamble et al., 2021, Malik et al., 2021, Wong et al., 2019, Lu et al., 2021
Perceived interoperability	Independent variable	PI_1 PI_2 PI_3 PI_4	Blockchain would be compatible with our legacy systems. Blockchain would be compatible with our legacy processes. Blockchain would be compatible with our legacy databases. Blockchain would be compatible with our infrastructure.	Gordon & Catalini, 2018, Dehghani et al., 2022

Table 5: Description of Measurement Items for Each Construct (Continued).				
Construct	**Variable**	**Measurement Items**	**Description**	**Reference**
Top management support	Independent variable	TMS_1	Blockchain is viewed with strategic importance by our top management.	Fernando et al., (2021); Oliveira et al., (2014), Kamble et ala., 2021, Lu et al., 2021, Wong et al., 2020.
		TMS_2	Top management is ready to provide the resources needed for the blockchain technology adoption.	
		TMS_3	Top management will take the possible risks involved in the adoption of blockchain technology.	
		TMS_4	Top management promotes the culture of transparency and accountability acquired through information sharing.	
		TMS_5	Top management has exhibited strong leadership and engagement while adopting information technology innovations in the past.	

Table 5: Description of Measurement Items for Each Construct (Continued).				
Construct	**Variable**	**Measurement Items**	**Description**	**Reference**
Organizational readiness	Independent variable	OR_1 OR_2 OR_3 OR_4	The organization provides access to technical knowledge to implement blockchain. They actively seek new ideas and take risks. There is access to internet connectivity to implement blockchain. Sufficient funds are available to implement blockchain.	Malik et al., 2021; Balasubramanian et al., 2021, Lu et al., 2021; Venkatesh & Bala, 2012.
Government and regulatory support	Independent variable	GRS_1 GRS_2 GRS_3 GRS_4 GRS_5	There is sufficient government support to promote blockchain technology. The government promotes regulating the use of blockchain technology. The government policies support promoting the use of blockchain technology. Sufficient assurance exists to protect the users of blockchain technology. There are sufficient government regulations to reduce risks associated with blockchain technology.	Kumar Bhardwaj, A., Garg, A., & Gajpal, Y. (2021); Malik et al., 2021, Lu et al., 2021.

Table 5: Description of Measurement Items for Each Construct (Continued).				
Construct	**Variable**	**Measurement Items**	**Description**	**Reference**
Competitive pressure	Independent variable	CP_1	My organization fears losing a competitive advantage if they do not adopt blockchain.	Sutanonpaiboon and Pearson (2006), Kamble et al., 2021, Malik et al., 2021.
		CP_2	To be a leader in my organization's industry, we need to implement blockchain.	
		CP_3	Competitors are in the process of implementing blockchain.	
		CP_4	My organization sees their competitors benefiting from adopting blockchain.	

3.5. Control Variables

In addition to the primary constructs of the research model, control variables were included to account for potential confounding influences on blockchain adoption intention. The control variables included in this study are:

Firm Size: This variable was measured by the total number of employees in the organization. It is a critical factor in determining technological adoption (Oliveira & Martins, 2011). Larger firms usually have greater financial and technological resources, allowing them to adopt new technologies.

Firm's Financial Performance (Annual Revenue): The previous literature shows that large companies with high profits are more prone to adopting innovations than companies with constrained resources (Rogers, 2003). The firm's Financial Performance was measured by the organization's annual revenue.

Initially, "Firm Type" (hospital, clinic, insurance provider, etc.) was also considered as a control variable. However, analysis of the survey responses revealed a significant number of respondents (approximately 40%) selected the "Other" category when asked about the primary focus of their organization. This suggests that the pre-defined categories for 'Firm Type' were not representative of the diverse range of organizations included in the sample, potentially leading to misclassification and biased results. Furthermore, the lack of specificity within the "Other" category makes it difficult to draw meaningful comparisons or control for the influence of organization type. Therefore, due to data limitations and concerns about the validity of the "Firm Type" variable, it was excluded from the subsequent analysis. This issue will be further acknowledged in the discussion section later on.

3.6. Data Collection

After receiving university IRB approval (IRB-25-0262), I used the Qualtrics survey software to design and disseminate the questionnaire online. I gathered responses from professionals affiliated with the American College of Health Data Management and other associations and channels through email, invited them to participate in the survey, and posted a link to the survey through different healthcare forum. In addition, I invited Prolific platform members to participate in the survey. The qualified respondents were healthcare professionals with decision making authority in their organizations and knowledge of blockchain technology. Over

the course of four weeks, I received 170 completed surveys, indicating a response rate of approximately 68%.

3.7 Measurement Model Analysis

The proposed theoretical model in **Figure 3** consists of one dependent variable and seven independent variables, all measured at the firm level. PLS-SEM 4.0 software was employed to test the reliability and validity of the constructs (Urbach & Ahlemann, 2010; Ullman & Bentler, 2012). To assess the reliability of the model, Cronbach's alpha, composite reliability (CR), average variance extracted (AVE), discriminant validity through the square root of the AVE, and cross-loadings were calculated. The minimum acceptable values of outer loadings, Cronbach's alpha, and CR should be equal to or greater than 0.7, and the AVE should be greater than 0.5 (Hair et al., 2011).

PLS-SEM was employed for measurement analysis to test the proposed model. From the data collected, the reliability was evaluated by checking the factor loading, Cronbach's α, composite reliability (CR), and average variance extracted (AVE) of the model (Hair et al. 2012). Hair et al. (2016) suggest investigating multicollinearity for every exogenous factor through the value of the variance inflation factor (VIF). The multicollinearity was tested through measuring correlation coefficients and calculating a variance inflation factor (VIF) test. The correlation coefficients value should be less than 0.90 (Hair et al., 2006), and the constructs VIF values should be less than 5 (O'brien, 2007). The structural model is used to identify the strength of each proposed model relationship and hence, the support for each hypothesis.

CHAPTER FOUR: RESULTS

In this chapter, I present the findings from the data analysis, breaking them down step by step. To begin, I provide an overview of the sample using descriptive statistics, offering a clear picture of the data at hand. Next, I outline the methods used to analyze the survey responses.

For the main analysis, I used SmartPLS 4.0 software to apply partial least square structural equation modeling (PLS-SEM). PLS-SEM has gained popularity in recent years in multiple fields as a robust tool for predictive modeling and causal analysis (Hair et al., 2019; Hair et al., 2011). One of the critical features of the PLS-SEM is its ability to measure a model with a large number of indicators even with a small sample size (Henseler et al., 2015). Its strength lies in its ability to explain relationships between variables and predict outcomes, making it a valuable approach for this study. Since all the constructs in the model are reflective, I followed the guidelines provided by Hair et al. (2019) for evaluating reflective models. The measurement model describes the relationships between construct items and their indicator, whereas the structural model is used to investigate the relationship between constructs (Hair et al., 2017).

4.1 Demography and Descriptive Statistics

The descriptive statistics for the survey sample, which included 170 participants, are presented as follows: **knowledge of blockchain:** little knowledge 40%, good knowledge 51.2%, excellent knowledge 8.8%; **job title:** chief executive officer 8.2%, chief technology officer 4.1%, IT manager 17.1%, business development manager 34.1%, IT director 7.6%, technology strategy manager 2.4%, other 25.9%; **organization size (number of employees):** fewer than 500 48.2%, 600–1,000 18.8%, 1,000–2,000 10.6%, more than 2,000 21.8%; **organization's annual revenue:** less than $500k 11.2%, $600k–1M 19.4%, $1M–5M 31.8%, more than $5M 37.6%; **organization's primary focus:** hospital 1.8%, healthcare system 10.6%, medical practice 1.8%,

pharmaceutical company 4.7%, research institute 13.5%, health insurance 4.1%, health education 4.7%, healthcare consultancy 5.9%, health information technology 8.2%, healthcare supply chain 4.7%, other 39.4%; **highest level of education:** college certificate 11.8%, undergraduate degree 24.2%, postgraduate degree 31.8%, professional certificate 6.5%, other 1.8%; **gender:** male 57.6%, female 42.4%; **years of experience:** 1–5 years 14.7%, 6–10 years 20.6%, 11–15 years 11.8%, more than 15 years 52.9% (see demographic and descriptive statistics in **Table 6.)**

Table 6: Demographics and Descriptive Statistics

Blockchain Knowledge		
	Frequency	**Percentage**
Little knowledge of Blockchain	68	40.0
Good Knowledge of Blockchain	87	51.2
Excellent Knowledge of Blockchain	15	8.8
Organization Annual Revenue		
Less than 500,000 US $	19	11.2
Between 500,000 and 1,000,000 US $	33	19.4
Between 1,000,000 and 5,000,000 US $	54	31.8
More than 5,000,000 US $	64	37.6
Organization Size (Number of Employees)		
Less than 500	83	48.8
600 to 1000	32	18.8

Table 6: Demographics and Descriptive Statistics (Continued).		
Organization Size (Number of Employees)		
1000 to 2000	18	10.6
More than 2000	37	21.8
Years of Experience		
Between 1 and 5 years	25	14.7
Between 6 and 10 years	35	20.6
Between 11 and 15 years	20	11.8
More than 15 years	90	52.9
Organization Type		
Hospital	3	1.8
Healthcare Systems	18	10.6
Medical Practice	3	1.8
Pharmaceutical Company	8	4.7
Research Institute	23	13.5
Health Insurance	7	4.1
Health Education	8	4.7
Healthcare Consultancy	10	5.9

Table 6: Demographics and Descriptive Statistics (Continued).		
Organization Type		
Healthcare Information Technology	14	8.2
Healthcare Supply Chain	8	4.7
Other	67	39.4
Total	170	100.0

4.2 Construct Reliability Assessment

The PLS-SEM algorithm command in SmartPLS 4.0 was executed to measure the loadings of the outer measurement model for each item against the recommended value of 0.7 (Hair et al., 2019; Fornell & Larcker, 1981). One item each from Government and Regulatory Support (GRS_2) and Technology Complexity (TC_1), and two items from Organizational Readiness (OR_3 and OR_4) did not meet the above threshold. Hence, the items GRS_2, TC_1 OR_3 and OR_4 were removed and the PLS-SEM algorithm command in SmartPLS 4.0 was executed to measure the loadings of the outer measurement model for each item against the recommended value of 0.7 (Hair et al., 2019; Fornell & Larcker, 1981). One item each from Government and Regulatory Support (GRS_2) and Technology Complexity (TC_1), and two items from Organizational Readiness (OR_3 and OR_4) did not meet the above threshold. Hence, the items GRS_2, TC_1 OR_3 and OR_4 were removed and the measurement model analyzed again. All items had outer loadings above the recommended threshold. Additionally, "Firm Type" is also eliminated as a control variable as analysis of the survey responses revealed a significant number of respondents (approximately 40%) selected the "Other" category when asked about the primary

focus of their organization. The lack of specificity within the 'Other' category makes it difficult to draw meaningful comparisons or control for the influence of organization type. Therefore, due to data limitations and concerns about the validity of the 'Firm Type' variable, it was excluded from the analysis.

4.3 Measurement Model Assessment (Outer Model)

The validation of the outer model measurement was carried out using the PLS-SEM algorithm command before proceeding to evaluate the inner model through the use of the bootstrapping command (Hair Jr et al., 2021). The results, as shown in the path analysis below, have loadings above 0.70, hence confirming item reliability. The analysis results of the Cronbach's alpha, composite reliability, and average variance extracted (AVE) can be found in **Table 7.**

Table 7: Model Measurement Assessment

Construct	Items	Outer loadings	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Behavioral Intention	BI_1	0.964	0.957	0.957	0.972	0.92
	BI_2	0.957				
	BI_3	0.956				
Competitive Pressure	CP_1	0.831	0.894	0.901	0.927	0.76
	CP_2	0.869				
	CP_3	0.882				
	CP_4	0.903				

Table 7: Model Measurement Assessment (Continued).

Construct	Items	Outer Loading	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Government and Regulatory Support	GRS_1	0.793	0.907	0.91	0.931	0.729
	GRS_3	0.848				
	GRS_4	0.889				
	GRS_5	0.846				
	GRS_6	0.846				
Organization Readiness	OR_1	0.89	0.709	0.712	0.873	0.774
	OR_2	0.87				
Perceived Interoperability	PI_1	0.933	0.942	0.945	0.958	0.851
	PI_2	0.946				
	PI_3	0.895				
	PI_4	0.915				
Relative Advantage	RA_1	0.878	0.918	0.927	0.936	0.709
	RA_2	0.863				
	RA_3	0.798				
	RA_4	0.798				
	RA_5	0.844				
	RA_6	0.885				

Table 7: Model Measurement Assessment (Continued).

Construct	Items	Outer Loading	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Top Management Support	TMS_1	0.902	0.918	0.928	0.939	0.755
	TMS_2	0.916				
	TMS_3	0.89				
	TMS_4	0.825				
	TMS_5	0.805				

All constructs from the analysis findings shown in **Table 7** have Cronbach's alpha and composite reliability values above the accepted threshold of 0.7 (Jöreskog, 1971; Chen & Singpurwalla, 1996). Additionally, the average variance extracted (AVE) for all constructs, which is also presented in the table, is above the minimum acceptable value of 0.5 (Hair et al., 2019, Cortina, 1993).

To assess the discriminant validity of the conceptual model, the heterotrait-monotrait (HTMT) approach was utilized. No HTMT values exceeded the recommended threshold of 0.90 (Henseler et al., 2015; Hair et al., 2012), as shown in **Table 8**. Therefore, the constructs are considered to have acceptable discriminant validity.

Table 8: Heterotrait-Monotrait (HTMT)

	Behavioral Intention	Competitive Pressure	Government and Regulatory Support	Organization Readiness	Perceived Interoperability	Relative Advantage	Technology Complexity
Competitive Pressure	**0.873**						
Government and Regulatory Support	0.595	**0.631**					
Organization Readiness	0.825	0.749	**0.685**				
Perceived Interoperability	0.607	0.562	0.631	**0.732**			
Relative Advantage	0.732	0.745	0.499	0.739	**0.729**		
Technology Complexity	0.364	0.31	0.236	0.2	0.29	**0.388**	
Top Management Support	0.867	0.812	0.673	0.883	0.718	0.778	**0.366**

4.4 Structural Model Assessment (Inner Model)

The reliability and validity of the measurement model having been confirmed, the structural model was then analyzed. I examined the variance inflation factor (VIF) values, which are used to detect multicollinearity issues. The recommended VIF value is less than 3, although a value less than 5 is still acceptable (Hair et al., 2019; Mason & Perreault Jr, 1991). The VIF values for the model are presented in **Table 9**. All independent constructs except top management support had VIF values less than 3. Top management support had VIF less than 5. The VIF values show that multicollinearity is not a concern in my model. I next review the path coefficients and their statistical significance.

Table 9: Model Path VIF

	VIF
Competitive Pressure	2.785
Government and Regulatory Support	2.006
Organization Readiness	2.562
Perceived Interoperability	2.508
Relative Advantage	2.978
Technology Complexity	1.211
Top Management Support	4.113

In Table 10, the R-square and adjusted R-square values are reported to show the extent of variability in the dependent variable explained by the independent variables. Typically, an R-square value of 0.75 signifies a significant effect, whereas an R-square value of 0.50 is deemed moderate, and an R-square value of 0.25 is categorized as weak (Hair et al., 2011; Hair et al., 2013). The R-square value is 0.775 for my model, indicating that the model explains 77.5% of the variability in the behavioral adoption intention construct.

Table 10: R-square and R-square Adjusted

	R-square	R-square adjusted
Behavioral Intention	0.775	0.762

In Table 11, Cohen (1988) suggests that an F-square effect size of 0.02 or greater is small, 0.15 or greater is medium, and 0.25 or greater is large. Based on the data in Table 11, perceived

interoperability, government and regulatory support, organizational readiness, relative advantage, and technology complexity relationships with behavioral intention are expected to have F-squares below the threshold for a small effect. Therefore, removing these constructs from the theoretical model is expected to have a minimal impact, below that of a small effect. However, the connection between competitive pressure and behavioral intention shows an F-square value of 0.274, indicating that removing competitive pressure from the model will have a high impact. Top management support and behavioral intention, with an F-square value of 0.138, are considered medium effects. This medium effect implies that removing top management support constructs from the theoretical model will have a moderate impact.

Table 11: F-Square Values

	F- square
Competitive Pressure -> Behavioral Intention	0.275
Government and Regulatory Support -> Behavioral Intention	0.001
Organization Annual Revenue -> Behavioral Intention	0.002
Organization Readiness -> Behavioral Intention	0.040
Organization size -> Behavioral Intention	0.000
Perceived Interoperability -> Behavioral Intention	0.000
Relative Advantage -> Behavioral Intention	0.005
Technology Complexity -> Behavioral Intention	0.017
Top Management Support -> Behavioral Intention	0.138

The bootstrapping command in SmartPLS 4.0 was executed to analyze the structural model, which helped determine the model's explanatory power, path coefficient, and significance (Hair et al., 2019; Hair Jr et al., 2021). The technique was used with a bootstrapping sample of 5,000 (Henseler et al. 2016). The findings are presented in detail in both Figure 5 and **Table 12**. The path coefficients and their statistical significance were used to evaluate the support for the model hypotheses. The path coefficient allows for a deeper understanding of the relationships between the variables in the model and provides valuable insights into the research problem being investigated (Hair et al., 2019; Shmueli et al., 2016).

Table 12: Structural Model Results

	Path Coefficient	Sample mean	Standard deviation	T-statistics	P-values	Results
Competitive Pressure -> Behavioral Intention	0.414	0.411	0.083	5.013	0.000	Supported
Government and Regulatory Support -> Behavioral Intention	-0.019	-0.018	0.062	0.309	0.757	Not Supported
Organization Readiness -> Behavioral Intention	0.142	0.138	0.064	2.218	0.027	Supported
Perceived Interoperability -> Behavioral Intention	-0.015	-0.019	0.066	0.233	0.816	Not Supported
Relative Advantage -> Behavioral Intention	0.056	0.059	0.067	0.832	0.406	Not Supported
Technology Complexity -> Behavioral Intention	-0.064	-0.067	0.04	1.583	0.113	Not Supported
Top Management Support -> Behavioral Intention	0.367	0.373	0.104	3.531	0.000	Supported

The analysis findings presented in Table 12 reveal that hypotheses H4 (top management support -> behavioral intention), H5 (organization readiness -> behavioral intention), and H7 (competitive pressure -> behavioral intention) proven to be statistically significant. The p-value for these hypotheses was less than 0.05 (Hulland,1999) (H4 p-value = 0.000, H5 p-value = 0.027, H7 p-value = 0.000). In addition, their t-statistics value at a confidence level of 95% was more significant than the minimum 1.96 recommended value (Henseler et al., 2009) (H4 t-value = 3.531, H5 t-value = 2.218, H7 t-value = 5.013). This indicates strong evidence to support hypotheses H4, H5, and H7, as shown in Table 14. The results of H1 (relative advantage -> behavioral intention), H2 (technology complexity -> behavioral intention), H3 (perceived interoperability -> behavioral intention), and H6 (government and regulatory support -> behavioral intention) were not statistically significant. The p-values obtained for each of the constructs were greater than 0.05 (e.g., H1 p-value = 0.409, H2 p-value = 0.091, H3 p-value = 0.800, H6 p-value = 0.700), so they are statistically nonsignificant. Additionally, the t-statistics values were less than 1.96, which is below the minimum acceptable threshold (H1 t-value = 0.409, H2 t-value = 1.689, H3 t-value = 0.253, H6 t-value = 0.385). Therefore, the null hypotheses for H1, H2, H3, and H6 must be accepted, which suggests no direct relationship among relative advantage, technology complexity, perceived interoperability, government and regulatory support, and the behavioral intention of blockchain technology adoption. Therefore, these hypotheses are not supported.

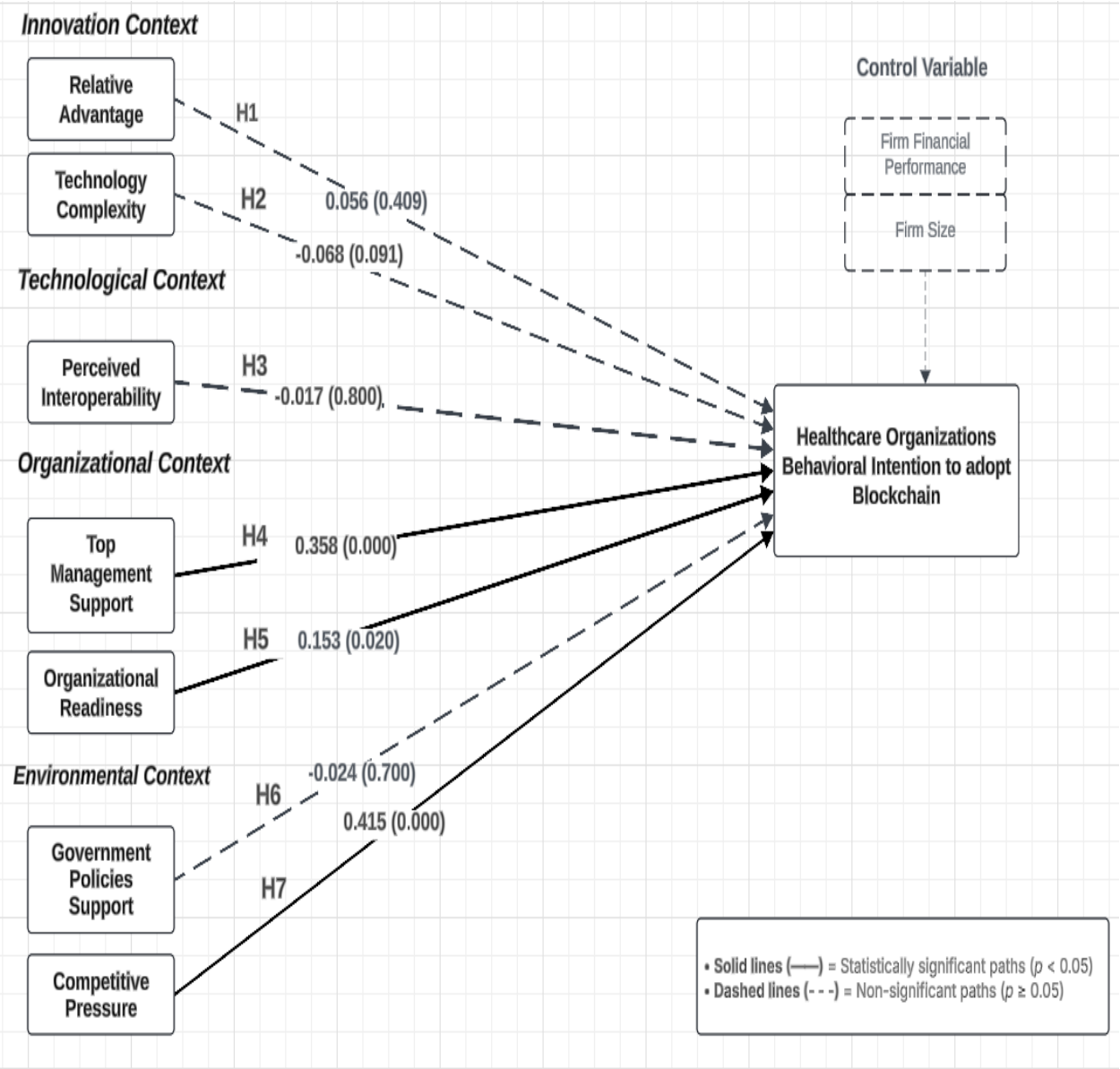

Figure 5: Blockchain Adoption Intention Model (Path Coefficients and P-Values)

Table 13 presents several values, including the Q-square (Q^2) values. The Q-square value indicates the predictive relevance of the model, and if it is greater than zero, it means that the model has good predictive power and the values are well reconstructed. Other values presented in the table are mean absolute error (PLS-SEM_MAE), root mean square error (PLS-SEM_RMSE), linear regression root mean square error (LM_RMSE), and linear regression mean absolute error (LM_MAE). The model has higher predictive power if all PLS-SEM values are lower than the LM values. The model has medium predictive power if some or all PLS-SEM values are less than the LM values. If some PLS-SEM values exceed the LM values, the model has low predictive power, and if none of them exceed the LM values, the model lacks predictive power. The PLS predict/CVPAT command was used to analyze the model's predictive relevance. The obtained values indicate that the model has high predictive power.

Table 13: Model's Predictive Relevance Findings

	Q^2predict	**PLS-SEM_RMSE**	**PLS-SEM_MAE**	**LM_RMSE**	**LM_MAE**	**IA_RMSE**	**IA_MAE**
BI_1	0.689	0.836	0.633	0.919	0.687	1.499	1.163
BI_2	0.691	0.833	0.628	0.927	0.695	1.499	1.162
BI_3	0.647	0.912	0.65	1.05	0.759	1.534	1.202

Table 14: Summary of Support for Hypotheses

Hypothesis	Description	Supported
H1	The perceived relative advantage of blockchain technology positively associates with the intention to adopt blockchain technology in healthcare organizations.	No
H2	The perceived complexity of blockchain technology is negatively associated with the blockchain adoption intention in healthcare organizations.	No
H3	Perceived interoperability with current systems is positively associated with the blockchain adoption intention in healthcare organizations.	No
H4	Top management support is positively related to healthcare organizations' intent to adopt blockchain technology.	Yes
H5	Organizational readiness is positively associated with healthcare organizations' intent to adopt blockchain technology.	Yes
H6	Government and regulatory support positively influence the intention of blockchain technology adoption in healthcare organizations.	No
H7	Competitive pressure is positively related to a healthcare organization's blockchain chain adoption intention.	Yes

CHAPTER FIVE: DISCUSSION

The primary objective of this study is to contribute to the ongoing discourse regarding the key determinants that influence the adoption of blockchain technology. The study emphasized exploring fundamental factors contributing to blockchain technology adoption intention through the lens of subject matter experts and leaders engaged in the decision-making process of adopting innovative technology in different healthcare domains and organizations. Furthermore, this research addressed the gap in existing literature by investigating and empirically evaluating factors from innovation, technological, organizational, and environmental standpoints that promote or impede blockchain technology adoption intention at the organizational level, and it highlights potential areas for future investigation. The findings offer measurable insights from theoretical and managerial perspectives, providing insightful input to help approach challenges and future opportunities.

5.1. Key Research Findings

The results of this research both confirm and refute the findings of earlier studies, as listed below.

- **Innovation context:** This study's first hypothesis (**H1)** proposed that the perceived relative advantage of blockchain technology positively associates with the intention to adopt blockchain technology in healthcare organizations; this was found to be nonsignificant and not supported. However, the literature recognizes the relative advantages of adopting blockchain (Wong et al., 2020; Martins et al., 2016), for instance, improving system efficiency and quality of care while enhancing trust and security of healthcare systems (Zhou et al., 2019). The nonsignificant impact of perceived relative advantage (**H1**) was unexpected, given blockchain's benefits (e.g., security, transparency). However, healthcare organizations may not view these advantages as compelling enough to drive adoption.

Blockchain technology is more secure and reliable than traditional systems. However, relative advantage did not show a significant impact on the adoption intention model, which suggests that healthcare organizations are not yet fully aware and convinced of the benefits blockchain offers compared to their current or traditional systems. They may not see clear enough advantages to justify the shift, or they might still be in the early stages of understanding how blockchain could improve healthcare operations while exploring its feasibility and usability. In addition, technological benefits alone are insufficient to drive adoption. Healthcare leaders prioritize practical feasibility (e.g., management support, readiness) and other key factors such as implementation cost, and potential risk might prevent these organizations from making the adoption decision. Technological complexity was found to negatively impact the adoption intention in this study. However, the correlation was statistically nonsignificant. The second hypothesis (**H2**), that the perceived complexity of blockchain technology is negatively associated with the blockchain adoption intention in healthcare organizations, was not supported in this study. This contradicts some previous literature that validates the negative influence of technological complexity on the adoption intention (Wong et al., 2020; Swan, 2015). This could be attributed to the organization having made adequate technical preparations prior to exploring and adopting blockchain technology, resulting in a lower perceived complexity (Lu et al., 2021). Given that, it may be assumed that innovation variables have an nonsignificant impact on blockchain technology adoption in the healthcare industry. This aligns with the technology-organization-environment (TOE) framework, where organizational readiness can mitigate the impact of innovation characteristics. Organizations might prioritize the strategic benefits of blockchain, such as improved trust and operational efficiency, over its technical

complexity associated with blockchain technology such as hashing and cryptography (Deghani et al. 2022). If the strategic value is measurable, technology complexity might not deter adoption (Wong et al., 2020).

- **Technological context:** This study examined perceived interoperability in the technological context. The findings reveal that the effect of perceived interoperability, which is the ability of blockchain to function effectively with other technologies and infrastructure (Vergouwen et al., 2020), is nonsignificant. The third hypothesis (**H3**), that perceived interoperability with current systems is positively associated with the blockchain adoption intention in healthcare organizations, is not supported. It is assumed that organizations with robust IT infrastructure and technical expertise might be better equipped to handle interoperability challenges. However, research has suggested that having a robust technology infrastructure makes it more difficult for organizations to adopt blockchain technology (Deghani et al., 2022). On the other hand, some organizations perceive blockchain technology as seamless to adopt if it is highly interoperable with their existing technological infrastructure. In these cases, researchers have suggested that developing a new infrastructure or business model is unnecessary with the adoption of the technology (Petersson and Baur 2018). Therefore, integrating blockchain with existing systems might not be a significant challenge. This aligns with the technology-organization-environment (TOE) framework, where organizational readiness can mitigate the impact of technological interoperability challenges (Wong et al., 2021).
- **Organization context:** This research emphasized the significance of top management support in adopting blockchain technology in the healthcare sector. The fourth hypothesis (**H4)**, which proposed that top management support is positively related to the healthcare

organizations' intent to adopt blockchain technology, was supported. This finding aligns with what previous studies have shown about the adoption of new technologies (Awa et al., 2017; Khayer et al., 2020), where a high percentage of adoption success has been linked to top management support (Oliveira et al., 2014; Orji et al., 2020). When upper management endorses adopting a new technology, it typically means that they are allocating the necessary resources, channeling clear responsibilities, and supporting the necessary environment to promote that technology adoption (Clohessy et al. 2019). The findings contradict the research of Wong et al. (2020a, b) which concluded that top management has no effect on the intention to adopt blockchain technology. Some of the variables tied to successful blockchain adoption, like an organization's readiness to adopt, are very much in the purview of upper management (Faber et al., 2017). The results show that the fifth hypothesis (**H5**), that organizational readiness is positively associated with the healthcare organizations' intent to adopt blockchain technology, is supported, thus aligning with previous research. This indicates that an organization equipped with the necessary infrastructure, employee training in relevant business practices, and adequate financial resources is more likely to facilitate the adoption of blockchain technology (Orji et al., 2020). For instance, researchers found a significant positive relationship between organizational readiness and innovativeness and the intention to adopt blockchain technology (Chen et al. 2018). Therefore, it is presumed that the organizational context has a significant impact on blockchain technology adoption decision.

- **Environmental context:** The results of this research show that government and regulatory support have no significant influence on blockchain technology adoption decisions, which is contrary to some previous studies that identified regulatory support as a crucial factor

shaping blockchain adoption behavior (Wamba et al., 2020; Orji et al., 2020). The sixth hypothesis (**H6**), that government and regulatory support positively influences the adoption intention of blockchain technology in healthcare organizations, was not supported in this research study. The information system research provided mixed insights on the role of government support on technology adoption intention (Nath et al., 2022). Some government policies hinder the adoption of blockchain technology (Lu et al., 2021), while other policies may support and guide organizations in blockchain adoption. Therefore, it is important for governments to develop relevant standards to remove the uncertainties hindering the adoption of technology. Blockchain is still a nascent technology, and its adoption is predominantly driven by organizational interest rather than government mandates (Lu et al. 2021). Some studies have highlighted that governments have not yet established clear regulations for blockchain technology across various industries, including the healthcare sector (Chalmers et al., 2021). This is indicative that blockchain technology adoption intention is not initiated by government and regulatory support (Kumar et al., 2021). In the early stages of technology adoption, regulatory frameworks are often unclear, making their influence less pronounced. Wong et al., 2020 recognized government and regulatory support as a variable for blockchain adoption intention that is nonsignificant. Therefore, the policymakers are encouraged to develop the essential regulatory policies and standards to govern the utilization of the technology. Competitive pressure is significant in this study and is seen as a facilitator for the adoption of blockchain technology in the healthcare sector. This finding is consistent with similar research studies (Gangwar, 2015; Clohessy et al., 2018; Clohessy et al., 2019). The seventh hypothesis (**H7**), that competitive pressure is positively related to the healthcare organization

blockchain adoption intention, was supported in this research. This finding implies that when competitors adopt blockchain technology as a competitive technology and tool, other organizations encounter fierce competition and feel pressured to adopt the technology to maintain a competitive edge. Blockchain technology can positively impact healthcare systems competitive performance by increasing the traceability of transactions and data exchange (Deghani et al., 2022). Since one hypothesis of the organizational context was found to be supported, it is clear that environmental context has a partial impact on the blockchain technology adoption intention in the healthcare industry.

5.2 Theoretical Implications

From the theoretical perspective, this research provides some contributions that enrich the body of knowledge in the information system research. The study adds to the limited number of quantitative empirical research studies on blockchain adoption in the healthcare sector. By integrating two well-established theories, the technology-organization-environment (TOE) framework and the diffusion of innovation (DOI) theory, a critical gap in the existing literature is addressed, and a comprehensive understanding of the adoption intention of blockchain technology in the healthcare industry is provided. The integrated model provides more explanatory power than the original TOE framework. While these theories have been applied in other technology adoption contexts, their application to blockchain in healthcare offers new insights and practical implications.

The model proposed in this research accounts for 77.5% of the variation in the blockchain adoption intention. This means that the integrated model has a strong ability to predict whether organizations are likely to adopt blockchain technology. In simpler terms, the model does a good job of explaining blockchain adoption decision-making. The findings shed light on the importance

of organizational and environmental factors in shaping healthcare organizations' decisions to adopt blockchain technology. By identifying, addressing, and operationalizing key factors that influence adoption intention, this research enriches the body of knowledge on blockchain technology, particularly within the healthcare sector. The results of this research are particularly valuable, as they are tailored to the unique organizations of the healthcare industry, which is increasingly focused on fostering innovation and collaboration.

As interest in blockchain technology continues to grow, both in practice and in academia, this study offers a meaningful contribution by clarifying the factors that drive organizational adoption decisions. By doing so, it not only advances academic understanding but also provides practical guidance for healthcare organizations navigating the complexities of blockchain implementation.

5.3 Managerial Implications

As blockchain technology gains traction in both practical applications and academic research, this theory-driven exploration of the factors influencing its adoption intention by healthcare organizations is both timely and essential. Technology has the capability to make a tremendous impact on the future evolution of hospitals and healthcare organizations in terms of their data management and exchange systems, safety measures, and operational efficiencies. This research study serves as a crucial base for comprehending how blockchain is adopted within various healthcare environments. Further, based on the study's findings, top management support was found to be the strongest and most statistically significant driver of blockchain adoption intention in healthcare. If given a limited budget, I would prioritize resources to invest in leadership support. The research findings may encourage decision-makers to develop enhanced strategies aimed at sharing information, while enabling fund, training, and alignment with innovation

adoption. Therefore, the research analysis will help healthcare leaders and stakeholders to prepare for successful blockchain adoption.

From a practical perspective, the findings of this research can provide decision-makers with valuable insights to gauge their organization's readiness for blockchain adoption and to formulate a clear, executable strategy for moving forward. When leaders are clear about the intent and structure of the project and when resistance to change at various levels of the organization has been adequately addressed, implementation can be faster, easier, and less costly (Wong et al,.2020). Additionally, if the readiness assessment is used as a guide, management can design training programs that are much more likely to succeed when it comes to developing the knowledge and skills necessary for all blockchain stakeholders to make a substantial, positive difference. Introducing training and awareness programs to equip employees with the necessary knowledge to adopt blockchain and effectively utilize it will bridge the knowledge gap and enhance the effectiveness of the adoption process (Ifinedo, 2011).

Regulatory support has a nonsignificant impact on the blockchain adoption intention in this model, indicating that healthcare organizations have not yet received substantial regulatory support from the government in terms of establishing governance rules for blockchain-based transactions in the healthcare sector. Therefore, the government should introduce and implement a clear and supportive legal framework for blockchain technology while also providing various incentives to encourage its adoption and make the transition smoother. This research study will allow regulators, policymakers, governments, and healthcare professionals to recognize the critical factors that influence blockchain integration in healthcare systems since the early adoption of blockchain technology will enrich the competitive advantage (Choi et al., 2020).

5.4. Limitations and Future Research Direction

Despite its theoretical and managerial implications, this research has some limitations that lay the foundation for future research. This study is limited to the healthcare systems in the United States, a country that actively encourages and promotes technology development and adoption, which limits the findings' generalizability. Attitudes and approaches toward blockchain adoption can differ remarkably from one country to another (Saberi et al., 2019). Future research can focus on blockchain technology's adoption factors in broader geographical locations. As blockchain is a nascent technology, there are few experts who have excellent knowledge of blockchain technology and its applications in healthcare. At the same time, I focused on a specific sector. Therefore, future research should extend on this study to enhance outcomes generalizability by fostering a broader geographic distribution of participants and more cross-industry settings to determine possible factors influencing the adoption decision of blockchain technology.

The non-significant findings (e.g., relative advantage, interoperability) may stem from varying interpretations of survey questions across respondent subgroups (e.g., vendors vs. clinicians). For instance, vendors might assess 'interoperability' technically, while clinicians focus on workflow integration. highlights the need for future studies to tailor questions by stakeholder role. Furthermore, the study removed four items (GRS_2, TC_1, OR_3, OR_4) due to low loadings, potentially limiting construct coverage. For instance, GRS_2's broad phrasing may have confused respondents about "The government regulations of the use of blockchain technology". Future research should refine such items by specifying concrete examples (e.g., "The government mandates blockchain standards for patient data" or "My organization has received government guidance on blockchain implementation") to improve validity and ensure they align with real-world adoption drivers. Additionally, Since the term "organization type" in the model includes a

broad range of organizations such as pharmacies, health insurance providers, health research centers, hospitals, and clinics, a more detailed investigation is needed to understand specific factors influencing the adoption and unique challenges faced by each type of healthcare organization. While this study aggregates organizational types, future research could stratify the sample to compare healthcare institutions (e.g., hospitals, insurers) against "Other" sectors (e.g., startups, IT vendors). This might uncover sector-specific adoption dynamics offering tailored insights for policymakers and implementers. Expanding the sample to differentiate startups, health IT vendors, and legacy healthcare systems could reveal how innovation vs. regulatory constraints shape adoption, offering targeted strategies for each sector. Future studies may also extend the proposed integrated TOE-DOI framework to explore more determinants of blockchain technology adoption in various small and large organizations across the healthcare sector.

This study is cross-sectional, capturing a snapshot in time rather than tracking changes over time, which limits understanding of long-term adoption dynamics. Future research should focus on conducting longitudinal studies to investigate the factors influencing blockchain technology adoption in healthcare systems and how they evolve over time and to understand post-adoption practices. This research hypothesized a direct relationship between the independent variables, or adoption factors, and a dependent variable to create a theoretical model on which other relationships can be investigated. Future research could investigate the model differently to identify any potential moderating effects of trust in technology that may significantly impact the emerging technology adoption intention. Trust has been recognized as a facilitator of transactions, giving those who receive services expectations of a valuable exchange relationship with the technology providers (Dhagarra et al., 2020). Trust can include trusting technology providers and the technology itself (Nath et al., 2022). In information system literature, trust has been identified

as a factor driving user behavior intention in the adoption of technologies (Pavlou, 2023). Trust in technology plays an important role in influencing the adoption intention of blockchain technology, especially in the healthcare sector, where there is a concern about data security and privacy (Hasselgren et al., 2021). Trust affects an organization's behavior towards a certain technology, which further affects their intention to adopt the technology. For instance, if technology is perceived as risky, organizations will be reluctant to adopt it or integrate it into their systems (Alazab et al., 2021). Thatcher et al. (2010) claim that technology can be adopted or avoided based on the level of trust in technology. Matemba and Li (2018) suggest that trust, privacy, and security are among the factors contributing to technology adoption. Therefore, assuring decision-makers and stakeholders that their data are safe and anonymous is crucial for the adoption intention of blockchain-based applications (Balasubramanian et al, 2021). Practically, trust is essential for interactions in uncertain environments; in such contexts, beliefs about technology become critical.

In healthcare settings, blockchains enable organizations to securely store and exchange records, which protects patient privacy. This establishes trust among healthcare providers and stakeholders (Albayati et al. 2020). Therefore, trust is considered a significant factor that impacts the adoption intention of several technologies, including blockchain (Wanitcharakkhakul & Rotchanakitumnuai, 2017). Therefore, future research may also investigate in-depth case studies to understand how trust can influence the decision of adopting blockchain technology in the healthcare sector.

A final avenue of future research could be to conduct a longitudinal study considering how innovation, technological, organizational, and environmental factors influence the adoption intention of blockchain technology and provide a comprehensive approach to the adoption process

by shedding light on postadoption attitudes and best practices and integrating blockchain with other emerging technologies like the internet of things (IoT) and artificial intelligence (AI).

5.5 Conclusion

As we move further into the digital age, protecting privacy and security is becoming more essential. Blockchain technology can serve as the key cornerstone for creating systems that address the current healthcare system needs. While many industries see blockchain as a game-changing technology, its potential in healthcare is especially promising. This study explored the factors driving and hindering blockchain adoption in healthcare organizations by combining the technology-organization-environment (TOE) and the diffusion of innovations (DOI) frameworks. The findings highlight the significant influence of top management support, organizational readiness, and competitive pressure on blockchain technology adoption decision-making in the healthcare sector.

The findings also highlight the need for standardized protocols, user-friendly solutions, and supportive regulatory frameworks to facilitate blockchain adoption in healthcare. Implementing training and awareness programs can equip employees with the knowledge and skills required to leverage blockchain effectively. Overall, this research contributes to extending the understanding of blockchain technology adoption in the healthcare industry and enriching the technological adoption literature.

The study contributes to the growing body of knowledge on blockchain adoption in healthcare by providing a comprehensive analysis of the factors influencing adoption intention. However, it also highlights the need for further research, particularly longitudinal studies, to examine adoption trends over time and industry-specific investigations to explore the unique challenges and opportunities in different healthcare settings.

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APPENDIX A: COVER LETTER AND SURVEY

ACADEMIC SURVEY TO EXAMINE THE FACTORS INFLUENCING BLOCKCHAIN-BASED APPLICATIONS ADOPTION IN HEALTHCARE ORGANIZATIONS

Title of the Research Project: Blockchain Technology in the Healthcare Industry: An Empirical Study of Factors Influencing Organizational Adoption of Blockchain Technology.

Principal Investigator: Fatma AbdelSalam

Faculty Advisors: Dr. Chandra Subramaniam & Dr. Reginald Silver

You are invited to participate in this research study. This questionnaire is part of a doctoral research study by the University of North Carolina at Charlotte to examine the adoption intention of blockchain technology. The research investigates the ways blockchain technology can be adopted in healthcare systems to inform academics and policymakers who are attempting to develop supportive ecosystems to accelerate the expansion of health data secure exchange through blockchain technology. The survey investigates factors influencing blockchain-based applications' adoption in healthcare organizations. We anticipate considerable theoretical and managerial contributions from this study. There are no right or wrong answers to the questions—we are interested in in your professional opinion.

Participation in this research study is voluntary, and the responses will be anonymous and confidential. The data collected will be secured and used purely for academic purposes. Your timely completion of the questionnaire provides valuable input for this contextually significant research work. The questionnaire may require 20-30 minutes to complete. Survey responses will be stored with access to this information controlled and limited only to researchers who have the approval to have access. We might use the survey data for future research studies, and we might share the non-identifiable survey data with other researchers for future research studies without

additional consent from you. To participate in this survey, respondents must meet the following criteria:

- Must be a manager or have decision-making authority within their organization, as the study focuses on blockchain adoption dynamics in healthcare, which typically involves managerial or executive-level input.
- Respondents must have at least some knowledge of blockchain technology.
- Participants are screened with a question assessing their knowledge level. Those who select "No knowledge of blockchain technology" will be excluded.

For questions about this research, you may contact Fatma AbdelSalam (Fabdelsa@uncc.edu) or Dr. Chandra Subramaniam (Csubrama@uncc.edu). If you have questions or concerns about your rights as a participant in this study, contact the Office of Research Protections and Integrity at (uncc-irb@charlotte.edu).

Screening Question

Q1. How would you rate your knowledge of blockchain technology? (Survey stopped if respondent answers "No knowledge")

- No knowledge of blockchain technology
- Little knowledge of blockchain technology
- Good knowledge of blockchain technology
- Excellent knowledge of blockchain technology

Demographic Questions

Q2. Please indicate which of the following technologies your organization has been involved with.

- Cloud Computing
- RFID
- Robotics
- Internet of Things (IoT)
- Blockchain Technology
- Electronic Data Interchange (EDI)
- Artificial Intelligence

Q3. Please indicate which of the following job titles best describes your role.

- Chief Executive Officer President Chairperson
- Chief Technology Officer Chief Information Officer Chief Digital Officer
- IT Manager
- Business Development Manager
- IT Director
- Technology Strategy Manager
- Other (Specify title)

Q4. What is the size of your organization in terms of the number of employees?

- Less than 500 (1)
- 600 to 1000 (2)
- 1000 to 2000 (3)
- More than 2000

Q5. What is your organization's annual revenue in thousands of $?

- Less than $500,000 US
- Between $600,000 and $1,000,000
- Between 1,000,000 and 5,000,000 US$
- More than $5,000,000 US

Q6. Which of the following is the primary focus of your organization?

- Healthcare System
- Hospital
- Medical Practice
- Pharmaceutical Company
- Research Institute
- Health Insurance
- Health Education
- Healthcare Consultancy
- Healthcare Information Technology
- Healthcare Supply Chain
- Other

Q7. What is the highest level of your education?

- College Certificate
- Undergraduate Degree
- Postgraduate Degree or Higher
- Professional Certificate/Diploma

- Other (please type)

Q8. What is your gender?

- Male
- Female
- Not Specified

Q9. How many years of work experience do you have?

- Between 1–5 years
- Between 6–10 years
- Between 11-15 years
- 15 years and above

Please respond to each statement by indicating the degree of agreement or disagreement by using the following scale.

1 = Strongly Disagree

2 = Disagree

3 = Somewhat Disagree

4 = Neutral

5 = Somewhat Agree

6 = Agree

7 = Strongly Agree

Q10. In my opinion:

- Blockchain will scale up our operations better.
- Blockchain will provide access to remote information at anytime
- Blockchain will provide access to remote information from anywhere
- Blockchain adoption will help with improving the relationship with our customers
- Blockchain will help with accessing shared resources better
- Blockchain will increase the organization's overall productivity

Q11. In my opinion:

- Blockchain requires extra technical skills to use
- Blockchain is difficult to understand from a business perspective
- Blockchain is conceptually difficult to understand from a technical perspective

Q12. In my opinion:

- Blockchain would be compatible with our legacy system
- Blockchain would be compatible with our legacy processes.
- Blockchain would be compatible with our legacy databases.
- Blockchain would be compatible with our infrastructure

Q13. In my opinion:

- Top management sees blockchain technology as a strategic importance
- Top management is ready to provide the necessary resources for the introduction of blockchain technology

- Top management is willing to take the possible risks involved in the adoption of blockchain Technology
- Top management promotes the culture of transparency acquired through information sharing
- Top management have exhibited strong leadership while adopting Information Technology innovations in the past

Q14. In my opinion:

- My organization provides access to technical knowledge to implement blockchain
- My organization has sufficient funds available to adopt blockchain technology
- My organization actively seeks new ideas
- My organization is taking risks

Q15. In my opinion:

- There is sufficient government support to promote blockchain technology
- There are sufficient government regulations to monitor blockchain technology
- The government supports regulating the use of blockchain technology
- The government supports promoting the use of blockchain technology
- Sufficient assurance exists to protect the users of blockchain technology
- There are sufficient government regulations to reduce risks associated with blockchain technology

Q16. In my opinion:

- My organization fears losing a competitive advantage if they do not adopt blockchain
- To be a leader in my organization's industry, we need to implement blockchain

- Competitors are in the process of implementing blockchain
- My organization sees their competitors benefiting from adopting blockchain technology

Q17. In my opinion:

- Blockchain based apps providers are trustworthy.
- A blockchain-based app provider is one that keeps promises and commitments.
- Blockchain-based apps provider keeps organizations best interests in mind
- Blockchain technology-enabled authentication will preserve data safely

Q18. In my opinion:

- Our organization intends to adopt blockchain technology.
- Our organization intends to use blockchain for requests (transactions or other processing requirements).
- Our organization plans to invest in blockchain technology